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Scaling and Sustaining of a Liberal Arts Speaking Course That Targets Engineering Students

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Introduction

Engineers need to communicate complex messages across diverse audiences and do so with skill and confidence. The opportunity for engineers to affect audiences and spur significant social and technical progress is considerable. However, without proper training and practice for how to engage audiences and successfully communicate complex ideas, the full potential of engineers is limited. With public safety, economic progress, and scientific advancements at stake, engineering education should place more value and emphasis on the garnering of professional communication skills within the discipline.

This paper presents a detailed account of how one large mid-Atlantic university designed a targeted communication course, which focuses on meeting the communication demands placed on engineers. The course, currently taken by about 350 engineering students per semester (14 sections with no more than 26 students per section), is the collaboration of the College of Engineering and the Department of Communication Arts and Sciences. This partnership, referred to as integrated instruction, is defined as a collaboration between communication experts in the liberal arts and a college of engineering. By offering a communication skills course specifically for engineering students, the course helps satisfy the frequent calls for engineers to obtain more robust training in communication, a call that is frequently cited in engineering research and required by accreditation standards.

Many studies have pointed to the importance of communication skill for engineers [1-9], but at the same time, many other studies have pointed to a gap in the preparation of engineers to present their work. For instance, at Ohio State University, a survey of 2,100 engineering alumni [1] ranked the importance of communicating orally as 4.30 (out of 5) but rated their preparation in the skills as only 3.26. Likewise, respondents in a survey of 243 electrical engineers [3] reports that "engineering programs rarely required them to demonstrate skills in public speaking, presentation, or interpersonal communication" (pp. 38 – 39). These results align with other instances where engineering students often cite feelings of incompetence when asked about their presentation and communication skill abilities. Concerns about such feelings of inadequacy are compounded by the fact that engineering accreditation standards call for outcomes that prepare students to communicate in diverse environments where they communicate both technical and non-technical messages skillfully [3]. Further, employers in industry also consistently list communication skills as a high priority [1-9], often above technical ability. In a 2013 study of engineers (N = 300) with 5 to 20 years of field experience, researchers found that out of 64 engineering competencies, those directly or closely related to communication were ranked in the top one-third [4]. These results show that communication skills training is needed, but often not realized.

Colleges and universities can play a critical role in the development of students' professional development, but the attention given to teaching and learning core communication skills targeted to engineers, like public speaking, is often insufficient. Though some colleges and universities sometimes require students to take a regular general education course focused on communication effectiveness, the requirement is not consistent across higher education. It is not surprising then that targeted communication courses for engineers are also uncommon. Researchers who focused on the top engineering schools in the U.S. found that only 14% offer communication opportunities geared specifically to engineers [2]. The same survey found of the 73 top engineering schools in Canada and the U.S., only half require students to take a course in technical communication at all. And only one-third of these schools use integrated instruction (defined as a collaboration between communication experts and colleges of engineering) [2]. Our work in creating a targeted communication course through integrated instructions helps to address this and other gaps in communication skills training whereby rhetorical principles meet the rigors of presentations given in the field of engineering.

While most engineering curricula do not require a communication course focusing on public speaking, the Pennsylvania State University has, since the 1960s, required all undergraduates to take an oral communication class. Despite the success of the class through the decades, our informal surveys of engineering students taking the class during the school years of 2006-2007 found that engineering students did not see the connections from that required course to the speaking and presentations given by engineers. In 2007, to address this disconnect, the College of Engineering in collaboration with the Communication Arts and Sciences Department piloted a version of the course that targeted engineers. For the two sections of engineering students (roughly 25 students in each section for a total of 50 students), the course was a success [11].

In this paper, we outline the history, curriculum design, and implementation of a communication course targeted to engineering students. While the course centers on oral communication and public speaking, it is best described as a targeted communication course because the curriculum also includes written and teamwork components. Because the course is a collaborative effort between a Communication Arts and Sciences Department and a College of Engineering, it serves as a model for other universities and colleges interested in implementing a communication skills course specifically for engineers. A goal in the paper is to walk the reader through the reasoning behind a pilot of the targeted communication course, the core objectives met through assignments, and the decisions related to scale-up in the number of course sections. Our experience in designing and evaluating the course for its impact on students' perceptions of communication effectiveness reveals the importance of interdisciplinary collaborations between communication experts and engineers in helping students obtain sophisticated communication skills that contribute to the field of communication.

From Piloted Course to Full Implementation: The History of Building a Targeted Communication Course for Engineering Students

In this section of the paper, we describe the pilot of the targeted communication course and how the results of the pilot contributed to a full implementation of the targeted course that is now a staple of course offerings for engineering students. We offer the reader a history for how the targeted course came to be and the differences between the regular course required by the university and the targeted course.

In 2007, a collaboration between a Communication Arts and Sciences Department and a College of Engineering at the Pennsylvania State University set out to address the gap facing engineers in oral communication skills by building a pilot course specifically designed for engineers. The pilot course was logistically and programmatically designed the same as the regular course with enrollment caps staying the same at an average of 26 students. The class also satisfied 3-credit hours and was offered on a Monday-Wednesday-Friday schedule for 50-minutes or Tuesday-Thursday for 75-minutes. Classroom design and locations also stayed the same as the regular course.

The three main differences between the regular required course and the targeted course centered on the course objectives and finer details of the curriculum that was geared toward engineers. First, where the regular course explores classic examples of speechmaking, the engineering course was grounded in supplying relevant examples from the scientific community. For example, students were shown full presentation examples delivered by engineers about engineering topics. Students were also supplied case studies that highlight missed opportunities and communication failures in the field where improved oral and visual communication may have changed the course of an event (such as the Space Shuttle Columbia) [11]. Second, students had to choose a technical topic to explore for a sizable part of the semester. The students' charge was to find a problem that can be solved through an engineering solution. This content differed from the content in the regular section of the course where students choose a value issue and propose a policy solution. Table 1 shows examples of topics in the targeted course for engineers versus common topics explored in the regular section.

Third, students were introduced to the practice of effective visual aids through the assertion-evidence approach to slide design. While the regular course allows instructors the latitude to include their own visual aid strategies, the assertion-evidence method was made a mandatory element of the engineering sections. The assertion-evidence method stresses the full ownership of content by delivering extemporaneous messages without the use of note cards. The A-E approach, explained in more detail later in this paper, varies from the regular course where students often rely heavily on note cards.

In a 2006 – 2007 study of the piloted course, the engineering students who took the pilot of the targeted course and engineering students who took the regular course were surveyed [11]. Overall, students in the engineering sections increased their public speaking self-efficacy slightly more than students in the regular public speaking skills sections; this difference approached statistical significance ($p = .06$). The same was true of delivery improvement, where engineering

students found the targeted course more of an asset because it more accurately aligned to the principles taught in the college of engineering ($p = .054$). For example, the targeted course required a conversational approach to delivery away from the podium and without use of note cards. Most notable was the difference in competence in using visual aids ($p = .02$), which is attributed to the use of an assertion-evidence approach to slide design, which works counter to the often-ineffective topic-subtopic approach often used in presentations.

Because data for the pilot course was considered a success by the collaborative team, the course was implemented and has since grown in the number of sections offered each semester. Since the piloted course in 2007, the curriculum, class size, and credit hours for the targeted course stayed the same as the pilot. The one exception was that the number of course sections available to students has increased. We believe that other colleges and universities would benefit from a detailed description of the targeted course projects, assignments, and exercises. To that end, we next offer a detailed overview of the key curriculum that can elevate course designers from a theoretical to a practical implementation. In addition, Appendixes A offers example syllabus language of the course description and learning objectives. Appendix B supplies implementation through an example course schedule.

Table 1: Examples of technical topics in the targeted course vs. values topics in regular sections.

Targeted Course Problem	**Targeted Course Technical Solution**	**Technical/Value Issues**		**Regular Section Problem**	**Regular Section Solution**
Carbon emissions	Carbon capture bricks	<=Technical	Value=>	Gun control	Ban on high-capacity clips
Meat sustainability	Lab grown meat	<=Technical	Value=>	Implicit bias in K-12 classrooms	Inclusion, diversity, and equity training for teachers
Flood zones	Permeable concrete	<=Technical	Value=>	Wage gaps	Raise the minimum wage

Communication Arts and Sciences and College of Engineering Collaboration: Scope and Core Principles of the Targeted Course

Because the targeted course for engineering students is a collaboration between the Communication Arts and Sciences Department and the College of Engineering, the course is a merger of the fundamentals of effective communication and rhetorical analysis aligned with expectations and standards common in engineering presentations. Though principles common to any regular course exist, they are nested in engineering terminology and samples which underscore presentation designs in engineering. The scope and core principles of the class are as

follows: (1) delivering professional and technical information in a variety of situations, including teams; (2) researching an independent technical topic; and (3) applying effective visual strategies, such as the assertion-evidence approach, to communicate technical information. Table 2 demonstrates the intersection between course design and objectives and the core presentations.

Table 2: Course Design/Objectives and the Core Presentations

Course Design/Objectives	Non-Technical	Technical Talks Using A-E Visual Aid Method			Non-Technical
	Elevator Pitch	Group Process	Topic Proposal	Problem-Solution	My COE Experience
Delivering non-technical and technical information in a variety of situations	X	X	X	X	X
Researching an independent technical topic			X	X	
Structuring researched information to target a wide audience		X	X	X	
Creating visuals to communicate technical information		X	X	X	X

1. Delivering professional and technical information in a variety of situations

The targeted course for engineers begins and ends with an opportunity for students to communicate their technical and non-technical skills in professional situations. The first talk of the semester is an elevator pitch in which students highlight their technical skills learned in courses, projects, co-ops, and internships coalesced with essential and soft skills gained through part-time employment, clubs, and organizations. Students research a specific company and make a connection between their own experiences and the mission and values of the organization. The elevator pitch is presented in a mock career fair format.

Near the end of the semester, students again communicate firsthand experiences in engineering, but this time do so for the purpose of ambassadorship in a *My COE Experience* talk. Here, students talk about experiences gained in the College of Engineering such as research opportunities, engineering clubs, internships, and team collaborations. The talk is useful for sharing with prospective or incoming students, alumni, and sponsors. In comparison with the

elevator pitch, which emphasizes technical and non-technical experiences delivered in a fast-paced environment, the *My COE Experience* is framed as a narrative talk in which students are encouraged to use rhetorical strategies like a story or a theme to convey their passion for the field and how the College of Engineering has fueled that passion. The *My COE Experience* is situated as the last talk of the semester because students often have the confidence in delivery and comfortability with peers to share these experiences in creative ways.

Classroom collaboration with peers is an essential function of the course. The importance of group dynamics is implemented early on as students work in teams to develop a group process talk, which takes place after the elevator pitch and becomes the students' first effort at communicating a message to a wide audience. The goal of the group process talk is to inform, educate, and explain to the audience a specific engineering process. Topics are technical in nature and groups have the choice to explain how a process is done, how something operates or functions, or how an engineering process was involved in an event. The goal of the group process talk is to educate a general audience on the steps of the process as well as emphasize the greater significance and importance of the process. Example topics include the recycling process of soda cans, how the Panama Canal works, and how the BP Deepwater Horizon oil spill occurred and was contained. The group process talk is valuable because it underscores the importance of audience analysis, attention to process details, and the effective communication practices imperative to teams.

The elevator pitch, the *My COE Experience,* and the group process talk offer students the opportunity to practice adapting to audiences in varying contexts. The elevator pitch and the *My COE Experience* prepare students for interactions where non-technical and behavioral skills are the focus. This goal stands in contrast to the other presentations in the class which are grounded in the communication of technical material as in the group process talk, the topic proposal, and the problem-solution talk (explained next).

2. Researching an independent technical topic

Students in the targeted communication course have the autonomy to choose a technical topic to explore for a sizable part of the semester. The student's topic choice spans two connected talks; a topic proposal (3 – 4 minutes) followed by a problem solution talk (8 – 10 minutes). Various in-class exercises, readings, and lectures are built into the course to help students choose and research a topic that sparks a personal connection or interest. Students may choose a societal problem followed by an engineering solution, or students may find an innovative solution and pair it with a societal problem that the technology can solve.

Once students settle on a technical topic, they work to develop a practical scope and depth that refines the topic. For example, a student who expresses interest in the problem of climate change is encouraged to focus on a sub-issue such as rising sea levels or deforestation. A student interested in pursuing new and innovative solutions for amputees is encouraged to focus on lower or upper body amputations, not both. Refinement of the student's topic enables a manageable scope and a depth that is ideal for a technical talk given to a wide audience.

The goals of the topic proposal are for students to clearly communicate a specific societal problem that can be solved or lessened by an engineering solution, to cite a research team in the academy or industry that is specifically working to solve that problem, and to lightly introduce the specific engineering technology. In this talk, students propose an agenda for their next talk where they will go deeper into the problem and solution.

The topic proposal is an opportunity for the student to receive feedback from their instructor and peers. For example, the instructor may redirect the student to specific changes in scope and depth. Peers add feedback through a question-and-answer session which allows the student to gauge how the audience is receiving their message. Feedback on the topic proposal enables future success as the talk is expanded later in a detailed problem-solution talk.

After the topic proposal, students expand on their knowledge of their chosen technical topic in several ways. First, they explore research on their topic more deeply. Students must orally cite a variety of sources including scholarly and peer-reviewed sources as well as mainstream ones like newspapers and magazines. Second, they refine a thesis and a managed structure that appeals to a wide audience. Importantly, students are encouraged to supply technical content that will be received broadly and to those whom the information will be new and unknown. Students are encouraged to use supporting materials like examples, analogies, and demonstrations that promote audience engagement and comprehension. Additionally, students must use specific visual aid strategies to deliver content.

3. Applying effective visual strategies, such as the assertion-evidence approach, to communicate technical information

Because of the demand for engineers to translate complex ideas into visual aids, any course concerned with communication strategies for engineers should include specific training on how to use visual aid tools properly and effectively. An important feature of the targeted course is the integration of the assertion-evidence (A-E) method for slide design [12]. Traditional use of PowerPoint has relied heavily on text and point-subpoint structures, but experts agree this default method of presentation is counterintuitive to learning outcomes [13, 14]. One reason is because when audiences are presented with text heavy slides the audience quickly experiences cognitive overload where they become overwhelmed by information presented in written and spoken form [13]. The natural response of an audience to the topic-subtopic structure is to tune out either the speaker or the slides being presented [13].

The A-E method is an alternative approach to building visual aids which veers away from PowerPoint slide defaults and instead relies on an argumentation approach. In the A-E method students carefully craft assertions backed by visual evidence such as pictures, charts, and graphs. Data represented in graphics is distilled into digestible messages that are quickly understood by audiences. The minimizing of text on slides helps students own their content, focus on delivery and audience connection since turning and reading text from slides is deterred. As a result, a speaker's delivery is extemporaneous and allows the speaker to better interface with the audience. Researchers have also found that the A-E method leads to higher rates of message retention than the commonly used topic-subtopic approach [15].

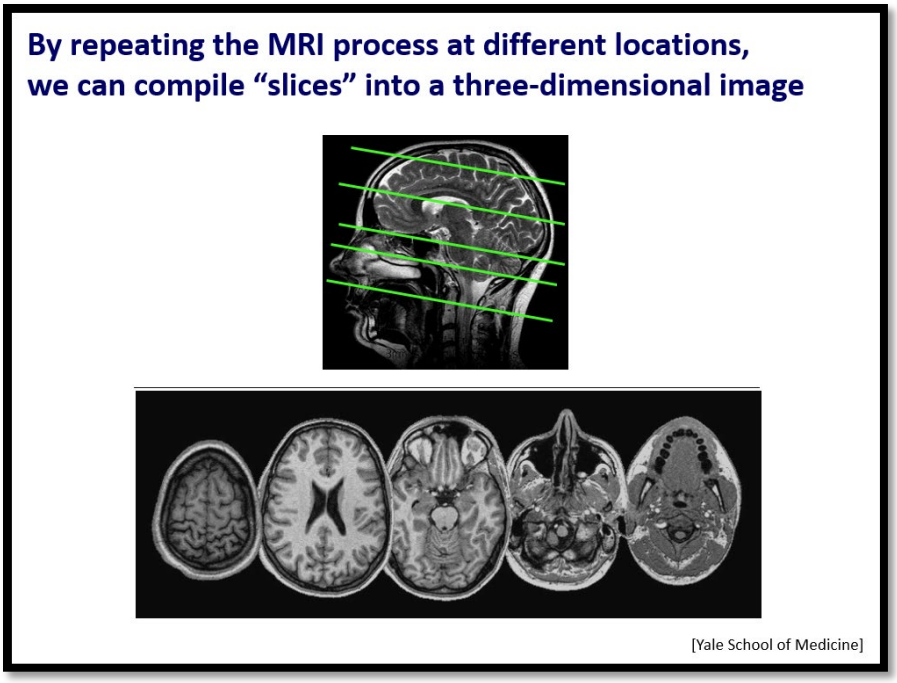

Figure 1: Sample slide from a student presentation showing the A-E Method.

Decisions related to scale-up of course sections

A 2011 study of the targeted course found that the engineering students who took the course cited more value than engineering students who took the regular course [11]. Since the 2011 study, the targeted course has increased in the number of sections three times. Figure 2 shows the history of course scale-up from 6 sections in Spring 2014 to 10 sections in Spring 2015 to 15 sections in Fall of 2018. In the decision to scale-up the course, key indicators of success were considered: (1) course enrollment numbers, (2) end-of-semester evaluations, and (3) students' individual course reflections. When taken together, these key indicators were an especially vital tool in the decision to scale-up the targeted course.

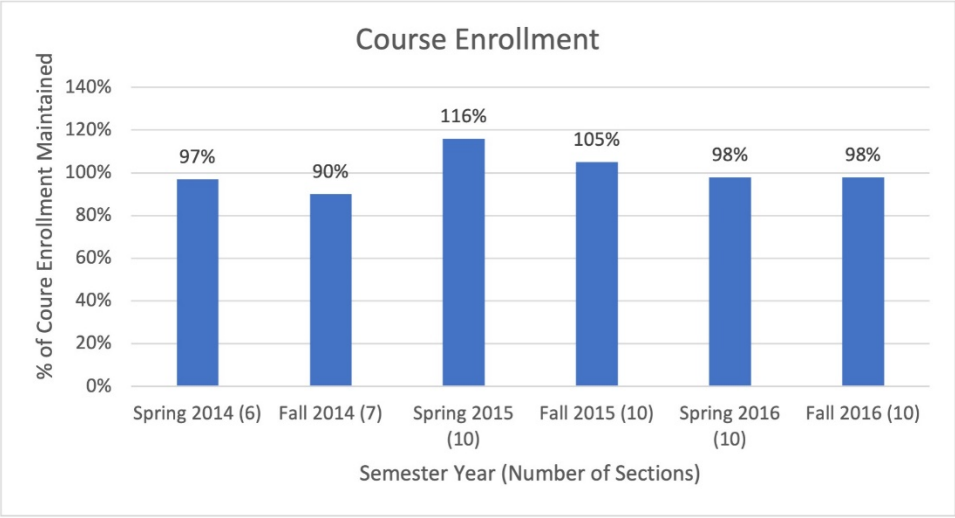

Figure 2: A history of course section scale-up from Spring 2014 to Fall 2018.

Sustained Enrollment Numbers

Enrollment numbers for the targeted course have remained consistently high since implementation. An analysis of enrollment data from Spring 2014 through Spring 2018 showed a course enrollment average of 99% (see Figure 3). Though we do not have data to show enrollment maintenance in the regular course, the high number of students who started and completed the class was seen as a positive indicator for its continued success.

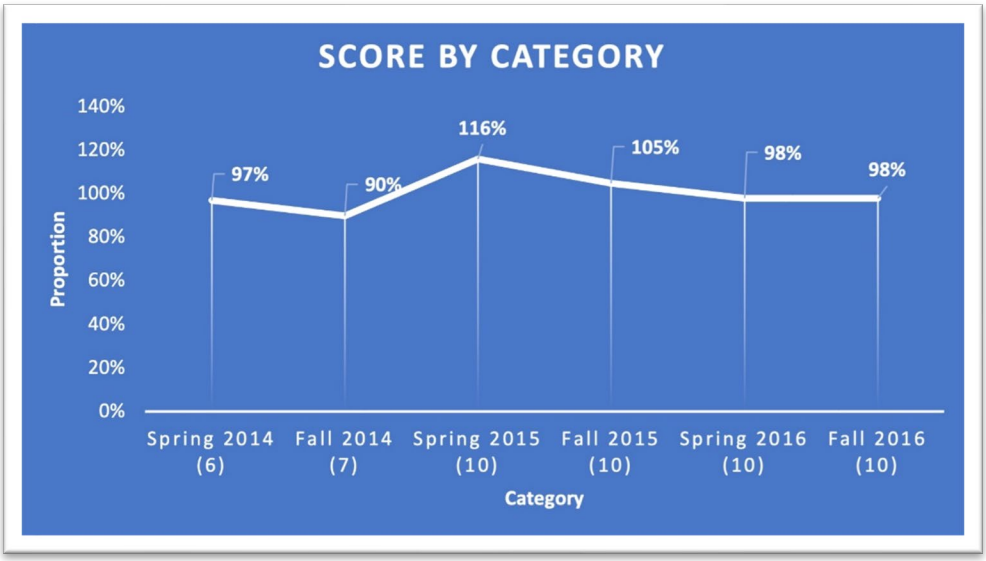

Figure 3: Course enrollments for the targeted course based on course caps. Courses with over 100% enrollment allowed overrides of typical course caps.

Consistently high "Overall Course Quality" in End-of-Semester Evaluations

In anonymous end-of-semester evaluations from Spring 2014 through Fall 2016, the course received an overall average rating of a 6.0 out of 7.0 in the category of "Overall course satisfaction." Because discussions related to course offerings and scale-up of the course took place well in advance of the Fall 2018 scale-up, data from Spring 2014 to Fall of 2016 is presented here as a way of showing course success that led to the latest scale-up to 15 sections in Fall 2018. Figure 4 stands for the distribution of course evaluations. From Spring 2014 to Fall of 2016. Distributions show that when course sections were added, the overall quality of the course remained high.

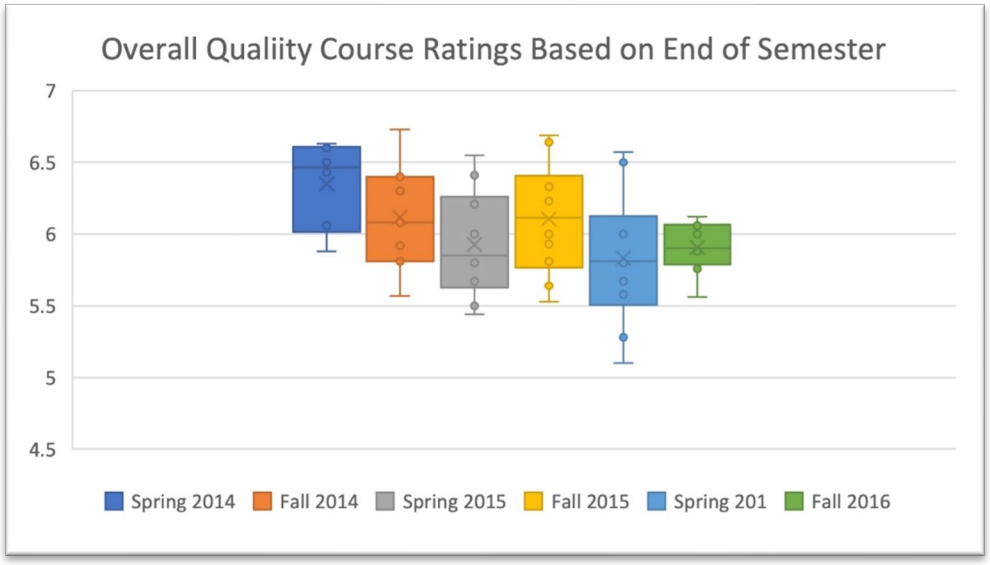

Figure 4: "Overall Quality of Course" ratings from end-of-semester evaluations.

Positive Narrative Statements from Students

In graded, non-anonymous course reflections, students note the course's value to them personally in narrative statements. Using an informal basic content analysis method, 120 course evaluations received by the Lead Instructor for the course were combined and frequent key terms were searched and counted that most aligned with course objectives. High frequency terms were then used to find narrative statements from students that added meaning to the term. These terms were then combined to create Table 3, which depicts a qualitative representation of course success.

Table 3: Summary of high-frequency terms from course evaluations and key quotes that align to course objectives.

Common terms noted in narrative analysis of 120 course reflections	# of times mentioned	Key quotes from students in written course reflections
Confidence	62	One of the main ways is that my delivery skills have generally gotten better and I think that is due to getting a lot of practice throughout the semester and building up my confidence. I feel like my confidence level was way higher in my Problem-Solution Talk than in my group presentation. Perhaps the most valuable skill I'll take away from this class is the ability to get up in front of a room to give a talk with confidence.
Future	73	This focus made me easily see how all the skills I was acquiring would help me in my future career. While I may not be perfect at presentations, I feel as if there are things I have learned that I can use in the future as an engineering professional. I plan on using assertion evidence in the future when I am able to due to its effectiveness and quality...

Helpful	87	The topics and strategies we learned were actually really helpful and applicable to my life. I attribute much of my success in this class to all the helpful resources that were available to me. It was also helpful to have a TA that understood the current student experience.
Improve	100	This class gave me resources and advice which has made me more confident in my public speaking abilities and enabled me to improve upon my delivery during speeches. Throughout the speeches I gave after receiving feedback I slowly started to improve upon these delivery problems. As for my greatest improvement, I would have to say that my growth in professionalism was the best.
Important	52	Learning about the assertion-evidence model may very well be the most important aspect of the class, as it will be of great use in any engineering venture. One of the most important skills I learned in this class is understanding how to convert highly technical information into an engaging presentation suitable for all audiences. Overall I feel like this class was one of the most important classes I have taken at Penn State and I am glad I took it as early as I did with my time here.
Learned	142	I learned how to use the assertion evidence method to create good presentations. I also learned how to present in a professional and effective way. We learned highly applicable skills. It was cool to see not only myself but also my classmates improve so much throughout this semester. Another extremely useful skill that I learned is when the class had to develop an elevator pitch. It will definitely be something I will use when interacting with recruiters in the future.
Skills	123	Throughout the class, I think one of the most important skills I learned and will take with me was the mental aspect and conditioning as part of preparation for our presentations. I also liked that this class focused on scientific presentations. This focus made me easily see how all the skills I was acquiring would help me in my future career. Overall, I appreciate that the course does serve a purpose and assists students in developing frequently neglected skills.
Professional	59	As this is what the course is designed for, I felt as if I was able to give presentations in a technical and professional setting. I found learning assertion evidence was extremely effective and useful presentation style. Of course this requires more preparation due to less content in a visual, but it was definitely more professional. The class helped me realize the unprofessional tactics often used by students so that in future classes, I am able to create a more pleasing presentation that will impress my professor.

Ensuring Quality of Sections

With the scale-up of targeted course sections, it was imperative to consider the addition of human resources that would help ensure the quality of the course across sections. In doing so several safeguards were put in place such as the appointment of a lead instructor for the course, hiring student mentors, and implementing a public speaking contest specifically designed for students in the targeted course.

Student Mentors

As a way of supporting the quality across sections, students who took the targeted course previously are hired as student mentors. The mentors perform teaching assistant-like responsibilities such as attending class, grading key assignments like visual aids, running student help sessions, and performing their own presentations as examples. The student mentors are recommended by instructors based on exemplary work ethic that was demonstrated as a student of the course. They receive payment as employees of the university. Student mentors are a critical part of the course as they provide a student point of view. Through this experience, the student mentors continue to develop more communication skills through mentorships.

Lead Instructor

Another way of managing quality across sections is the investment in and appointment of a lead instructor who acts as a liaison between the Communication Arts and Sciences Department and the College of Engineering. The lead instructor helps to manage a team of instructors who are typically fulltime faculty members in the Communication Arts and Sciences Department. The lead instructor matches student mentors with instructors, coordinates student mentor help sessions, provides guest lectures for key course concepts, and performs regular debriefs with the instructional team. The lead instructor keeps the course current, gives new teaching tools to the teaching team, and hears concerns from instructors and students from all sections.

Public Speaking Contest

Each semester, an on-campus center affiliated with the College of Engineering, sponsors a public speaking which is coordinated by a student organization for undergraduate engineering majors. At the instructor's discretion, two students' problem-solution presentations are selected from each course section (for example, by instructor appointment or by votes from the class). First a semifinal round takes place toward the end of each semester where students deliver their problem-solution talk to a group of student panelists and the finalists are narrowed down to eight students. The finalists then compete a few weeks into the next semester and new students from the targeted course attend the contest as a way of previewing the problem-solution talk. The contest is an important tradition that celebrates the accomplishments of the students and the collaboration between the Communication Arts and Sciences Department and the College of Engineering.

Continued Support from Administrators

In the sustaining and scaling-up the targeted course, university administrators have played a key role in supporting and fostering its growth. The key indicators of success obtained from informal data like that shown in Figures 2, 3, and 4 and Table 3 and the organization of resources like a Lead Instructor and Student Mentors, and the meeting of accreditation standards, have weighed heavily on the decision to scale and sustain the course. The collaboration between the Communication Arts and Sciences Department and the College of Engineering also sets the class apart as it is a unique relationship. Since the targeted course uses integrated instruction, it allows engineering students the opportunity to work under the guidance of communication experts as students shape messages for varied and diverse audiences. In support of the course, the Communication Arts and Sciences Department Head said,

> This course exemplifies our department's mission to create and share knowledge about communication practices with the aim of a making substantive and concrete improvement in our society. How better to do that than to promote effective communication skills among Penn State's outstanding engineering students?

The Assistant Dean for the College of Engineering had similar sentiments related to course goals that will advance engineering students' undergraduate requirements as well as career trajectories beyond the classroom.

> This course helps prepare our students for success in their careers. It helps programs meet General Education goals and ABET student outcomes related to effective communication.

Second, as opposed to presentations given in engineering courses that offer students a snapshot of their communication skill strengths and weaknesses, in the targeted course, improvement in communication skills drives all outcomes and students receive exhaustive feedback that allows them to improve over the course of the 15-week semester. Again, Assistant Dean in the College of engineering said,

> Communication has always been central to success in engineering; modern times make communication ever more important. This course has proven to be very effective in developing our students ability to prepare and deliver great presentations using state-of-the-art tools and methods. Supporting it was a "no brainer."

Finally, the interdisciplinary relationship between CAs and the College of Engineering promotes the values and missions of the university because expertise is shared and appreciated. Rather than working in silos, the collaboration is viewed as a rewarding experience capable of having exponential effect for the university. Again, the Department Head of Communication Arts and Sciences underscores the importance of this relationship,

> This course illustrates the interdisciplinary values of Penn State, where collaboration across colleges is grounded in deep respect for the particular expertise each partner brings to the table. The result is a program that puts CAS

faculty in the classroom with terrific students working on important engineering issues and provides engineering students with an experience that will give them an edge on the job market and skills for a lifetime.

Since its start in 2007, the targeted course has received much support from administrators. Without this administrative support it is unlikely that the targeted course would enjoy such a high degree of success. As engineering education curriculums consider the idea of a targeted communication course, we suggest brokering a relationship between experts in communication and engineering. Investing in this relationship will greatly benefit students, departments and their colleges, offer interdisciplinary benefits to the university overall, and contribute to better communication across industry.

Conclusions and Implications

In this paper, we have presented the history of a targeted communication course for engineers. Our model for implementation and considerations for scale-up of the targeted course could serve as a model for other universities interested in building a course that focuses on communication principles unique to the field of engineering. Included here have been examples of exercises, activities, and methodologies that combine the classic elements of a communication course but go further in understanding and acting on the communication demands facing engineers. Our data about course enrollments, overall quality of the course on end-of-semester evaluations, and narrative statements from students show that the course has met the intended goal of a creating a useful course that enhances the communication practices of engineering students.

A key element of the course's success deserving further underscoring is the collaboration between the Communication Arts and Sciences Department and the College of Engineering. This interdisciplinary partnership has proved invaluable as a means of preserving the integrity and credibility of each discipline but has also had a synergistic effect on outcomes for students. For universities looking to develop a targeted course, we suggest integrated instruction as first line of preparation. The implications of such a partnership serves as a reminder to administrators that collaboration among experts sharing a common goal often garners positive outcomes for key stakeholders.

Data collected about the targeted course has showed success since it began in 2007 and has led to the scale-up from two sections in 2007 to 14 sections in 2018. In decisions related to scale-up, we suggest administrators use data related to enrollment, student evaluations of the course along with narrative statements that will support any decision to add course sections. Other safeguards should also be considered such as the appointment of student mentors, hiring a lead instructor, and hosting events that highlight the benefits of the course (we hold a public speaking contest, but roundtable discussions, or poster sessions are alternatives). The implementation of these resources has helped ensure that the quality across course sections has persisted even with substantial addition of course sections.

The type of targeted communication course for engineers described here addresses the Engineering Accreditation Commissions priorities and prepares engineers for the engineering workplace. The variety of presentations within the course and the use of effective visual strategies give students experience and skills that can be used to effectively communication technical content to those with and without a technical background. Developing these skills at the undergraduate level set these students up for success when they enter the engineering workforce. The collaboration between the Communication and Arts and Sciences department and the College of Engineering at Pennsylvania State University has led to the successful scaling of a communication course for engineers that continues to effectively prepare students to excel as engineering professionals.

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Appendix A: Example Course Description and Learning Objectives from Course Syllabus

Course Description: This course is open only to engineering students and you will be researching and speaking about social issues and engineering-related solutions. A major goal of this course is to bridge the technical and practical demands of communication in the engineering field with the rhetorical elements of effective public speaking. The information presented in the course aims to help you become a better communicator of technical information—an important skill to be a successful engineering student and professional.

Course Objectives:

1. To understand the role of public speaking in civic and professional arenas
2. To be able to adapt messages to varied situations and audiences
3. To develop outlining skills and general organizational ability
4. To be able to determine when visual aids, such as slides, are appropriate and to design such visual aids to serve the audience, purpose, and occasion
5. To be able to explain technical engineering concepts and ideas so they will be understood by diverse audiences (for example, at a public/community level)
6. To be able to support one's beliefs with reasoning and evidence to make them compelling to an audience
7. To be able to deliver oral messages effectively in public settings and online

Appendix B: Course Implementation and Mock Schedule (3-Credit Hours)

Date	Course Content	Readings & Assignments
Monday	Course Introduction; Public speaking anxiety	Read pp. 1-13 & pp. 259-272
Wednesday	Rhetorical situation	Read pp. 15-34
Friday	Invention (topic selection, scope & depth)	Read pp. 59-67 & pp. 79-83
Monday	Elevator Pitches	Elevator Pitch Module on Course Management System
Wednesday	Form groups	
Friday	Elevator Pitches & Mock Career Fair	QUIZ 1 on Course Management System by 11:59 PM
Monday	NO CLASS – Labor Day	
Wednesday	***Evening Class - ATTEND SPEAKING CONTEST from 7:00-7:50 and/or 8:00-8:50 PM in lieu of regular class meeting	
Friday	Arrangement (organization, assertions, intros, conclusions, & transitions)	Read pp. 49-58, pp. 69-78, & pp. 83-94
Monday	Style (effective visual aids—the Assertion-Evidence (A-E) strategy)	
Wednesday	Responsible use of sources (library resources)/oral, written, and visual citation styles, methods and procedures	Read pp. 105-170; HW #1: due on Course Management System by 11:59 PM
Friday	Memory and Delivery	Read pp. 213-258; QUIZ 2 on Course Management System by 11:59 PM
Monday	Slide design tips; Slide critique	HW #2: due on Course Management System by 9:00 AM
Wednesday	Group Talk workshop - bring laptops; Delivery Exercises	QUIZ 3 Course Management System by 11:59 PM
Friday	Group Talks	
Monday	Group Talks	
Wednesday	Group Talks	
Friday	Group Talks	QUIZ 3 on Course Management System by 11:59 PM
Monday	Creating a handout; Slide design tips	
Wednesday	Delivery/Impromptu activities; Student Mentor Topic Proposal Demonstration	Problem-Solution Talk speaking order sign-up: link on Course Management System at 5 PM
Friday	Topic Proposal workshop - bring laptops	HW #4: due on Course Management System by 11:59 PM
Monday	Topic Proposals	
Wednesday	Topic Proposals	
Friday	Topic Proposals	
Monday	Creating and supporting effective arguments	Read pp. 35-47 & pp. 95-101

Wednesday	Creating and supporting effective arguments	
Friday	Title, mapping, and conclusion slides	Read pp. 171-184 & pp. 221-227; HW #5: due on Course Management System by 11:59 PM
Monday	Problem-Solution Student Mentor Demonstration; Q & A sessions; Introducing a colleague	Read pp. 264-268
Wednesday	Introducing a colleague	
Friday	Colleague Intros; Problem-Solution Talks	QUIZ 4 on Course Management System by 11:59 PM
Monday	Colleague Intros; Problem-Solution Talks	
Wednesday	Colleague Intros; Problem-Solution Talks	
Friday	Colleague Intros; Problem-Solution Talks	
Monday	Colleague Intros; Problem-Solution Talks	
Wednesday	Colleague Intros; Problem-Solution Talks	
Friday	Colleague Intros; Problem-Solution Talks	
Monday	Colleague Intros; Problem-Solution Talks	
Wednesday	Colleague Intros; Problem-Solution Talks	
Friday	Colleague Intros; Problem-Solution Talks	
Fall Break		
Monday	My COE Talk explanation	Message Analysis Assignment: due on Course Management System by 11:59 PM
Wednesday	My COE Talk Student Mentor Demonstration	
Friday	My COE Talk Workshop – bring laptops; Impromptu talks	QUIZ 5 on Course Management System by 11:59 PM
Monday	My COE Talks	
Wednesday	My COE Talks	
Friday	Course conclusion	Read pp. 273-275; Course Reflection: due on Course Management System by 11:59 PM