Developing Communications Skills in the Next Generation of Engineers

Christine Bala Burgoyne
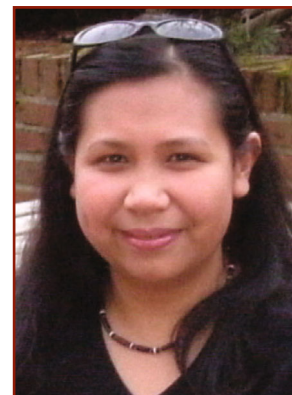
Christine Bala Burgoyne

Background

This article provides an overview of a curriculum-embedded engineering communications program that addresses the need to acknowledge and address the importance of writing instruction in science and engineering. The Engineering Communications Program (ECP) at the Virginia Polytechnic Institute and State University (Virginia Tech) has positively impacted the materials science and engineering (MSE) curriculum by providing technical and professional communications instruction and feedback to students from their sophomore through senior years. With the department's rapid growth, the ECP faces the challenge of teaching much larger classes and is in the process of revisiting current teaching models to render the program sustainable, while still functioning effectively within the curriculum.

Overview of ECP

Virginia Tech's ECP is an in-house communications program that provides substantial instruction in written, oral, and visual communications within the Materials Science and Engineering Department and Biomedical Engineering and Mechanics (BEAM) Department. The ECP, as an integrated program in the undergraduate curriculum, includes communication instruction in both traditional engineering courses and dedicated professional development courses across the sophomore, junior, and senior years. Since 1993, the program has expanded to address MSE Undergraduate Program Objectives and Accreditation Board for Engineering and Technology (ABET) professional outcomes expected of engineering students. Currently, the program is staffed by a program director who also serves as an instructor, three graduate teaching assistants (GTA) from the Rhetoric and Composition Doctoral Program in the Virginia Tech English Department, and four to five MSE/BEAM teaching assistants who are undergraduate seniors. ECP staff members teach courses, conduct workshops, tutor students, grade writing and speaking assignments, and conduct regular programmatic

About This Article

The information presented in this article was initially shared as a presentation at the 2016 Continuous Improvement of Academic Programs (and Satisfying ABET Along the Way): The Elizabeth Judson Memorial Symposium. A slate of valuable talks on advancing innovation in science and engineering education is set for the 2017 installment of this symposium series at Materials Science & Technology 2017 (MS&T17), October 8–12, Pittsburgh, PA. Register today at www.matscitech.org.

Learn more about MS&T17 in the meeting preview published in the August 2017 issue of *JOM*: The Magazine. The *In the Final Analysis* column in the same issue also discusses the future of MS&T.

This article is the latest in an occasional feature series developed by the TMS Education Committee. For additional information, contact Lynne Robinson, *JOM*: The Magazine editor, at lrobinson@tms.org.

ECP-Intensive Courses in MSE

Year 2
- MSE Professional Development Seminar
- Materials Laboratory 1: Sample Preparation and Characterization
- Fundamentals of Materials Engineering

Job Applications
Elevator Speeches
Interviews
Poster Sessions
Research Paper
Laboratory Report

Year 3
- Materials Laboratory 2: Processing and Characterization
- Physical Ceramics
- Professional Development 2: Preparations for Senior Design

Business Proposals
Collaborative Reports
Scholarly Writing
Literature Review
White Paper Proposals
Status Updates

Year 4
- Fall and Spring Senior Capstone Design

Project Management: Gantt Charts, Progress Reports, Scholarly and/or Industry Reports
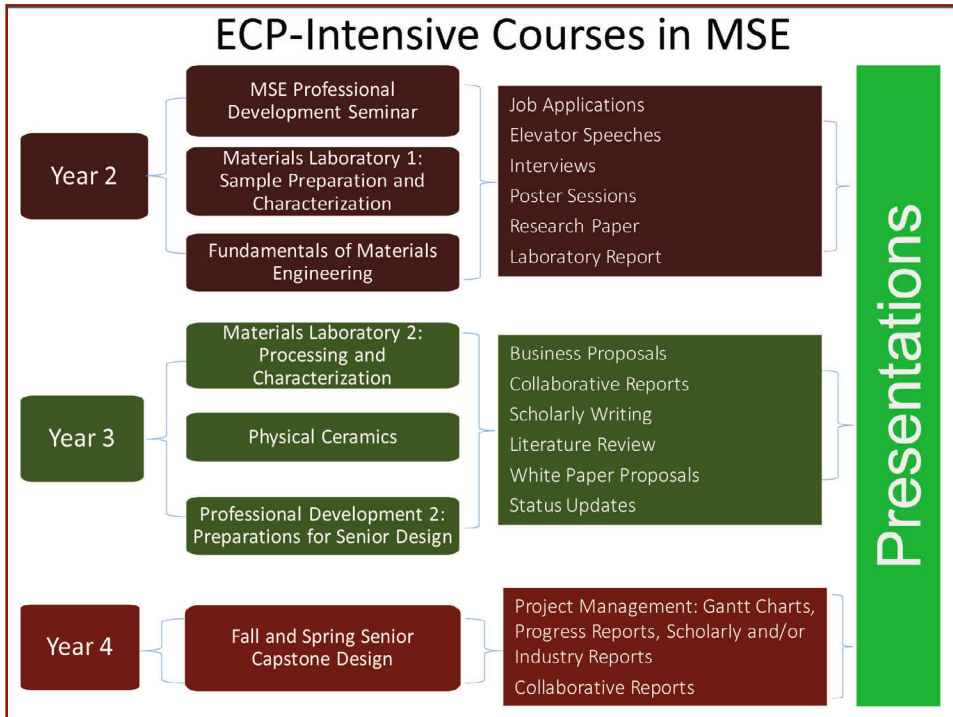Collaborative Reports

Presentations

Figure 1. ECP-involved courses and deliverables in MSE (2016-17).

Context awareness: Identifying explicit and implicit goals in different communication situations

Document design: Adapting the content, organization, language, tone, and medium of the appropriate genre to meet the demands of the specific communication situation at hand)

Collaborative and management skills: Team contracts, updates, gantt charts, project timelines, risk assessment)

Scientific Writing (and Presentation) is not a Mystery.

ECP students are repeatedly exposed to a "bottom-line-up-front" approach in their documents, and the "3 Cs" (clarity, cohesion, and coherence) in their language use and document design. Some examples of the "bottom-line-up-front" include letters of transmittal for research papers, abstracts in laoratory reports, executive summaries in business proposals, and white papers for senior design proposals.

For presentations, students must always have an assertion or a phrasal description for every slide. Also, clarity, cohesion, and coherence come into play through class and/or individual instructions on syntax and semantics. Students are required to pay attention to vagueness and ambiguity in pronouns such as "this" or "it," the importance of transitions between paragraphs and sentences, and language inflation.

Focus on Process versus Product

The ECP instructor is involved during the entire process of the communications assignment, from formulation to evaluation. Throughout the semester, the ECP instructor is given the time and space to work with the students, inside and outside the classroom, to provide writing instruction, workshops, outlines, peer reviews, and one-on-one draft conferences.

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assessment.[1,2]

As of the 2016-17 academic year, the ECP worked with 16 MSE/BEAM courses and roughly 400 MSE and BEAM students. Covered topics included business and professional communications, technical communications, and teamwork and project management skills. Figure 1. presents ECP-involved courses and deliverables in MSE.

Principles and Implementation

The primary goal of the ECP is to help students communicate effectively and efficiently to prepare them for the workplace, whether in academia or in industry. This goal is achieved through the following approaches:

Focus on the ACDC Model.

In all of the communications instructions and requirements, the ECP emphasizes the importance of:

Audience awareness: Identifying different genres of engineering communications, such as business correspondence, poster sessions, laboratory reports, feasibility reports

To implement these approaches, MSE/BEAM technical instructors and ECP staff collaborate closely to develop communications requirements that are relevant in academia and industry. High value is placed on these communications requirements; in some instances, the writing criteria are given equal weight as the technical criteria. Table 1 is an example of how the ECP works with a technical course.

Program Successes and Challenges

Commendations from ABET reviewers and advisory board members, and, most importantly, positive student input provide measurement of the program's success. In 2013, as part of the ABET review of the MSE Department at Virginia Tech, the program evaluator highly commended the integration of the ECP within the MSE undergraduate curriculum. As of 2016, programmatic assessments showed that the majority of students and advisory board members regard the ECP as essential to the professional growth and development of students in the MSE undergraduate curriculum. Students are cognizant that language and content are highly intertwined, while explicitly mentioning their ability to adjust their communications skills according to different genres and audience needs. They also express appreciation for the individual attention and mentoring on their papers and projects.

Granting these accomplishments, the ECP has recently experienced the challenges of a growing department. In 2010, the ECP staff worked with 110 MSE students and 112 BEAM students. During the fall of 2016, those numbers had risen to 248 MSE students and 178 BEAM students. This dramatic increase of students has placed a strain on how the ECP works with the classes. The biggest challenges include keeping up with evaluating extensive written and oral work and managing the expectation of individualized attention.

An Example of ECP Involvement

Course	Fundamentals of Materials Engineering
Comm Requirements	Research Paper on a Chosen Material
Audience	Scientific American
ECP Involvement, Instruction, Modules	5 Workshops on Choosing a Topic, Research Outline, Research Tools, Peer Reviews, Research Drafts; Individual Conferences with Drafts
Evaluation	Organization, Coherence, Cohesion, Conciseness, Audience, Document Design, Style

Table 1. Examples of how ECP works within a technical course

As an example, at the end of their first semester, MSE sophomores use material from their research papers in Introduction to Materials Engineering to develop a poster on their individual perspectives of the theme,"What is MSE." The poster is printed and each student presents this idea through a class poster session. This poster session serves as their "Welcome to MSE" networking activity where MSE faculty, upper class students, and graduate students get to meet the newest members of the MSE family. However, when the student numbers increased, it was logistically difficult to print out 50 posters and unrealistic to expect the MSE faculty and students to meet every MSE sophomore.

Processes for Continuing Improvement

To address the challenges of working with an increasing number of students, the ECP is continuously looking for ways to revisit teaching strategies without having to sacrifice individual attention and feedback.[3] A strategy that the ECP has recently implemented is to explore and embrace multi-modal technologies as tools to help streamline communications instructions and assignments. For example, to manage the sophomore poster session more effectively, instead of producing an individual poster, students are divided into teams of four to five members and required to creatively use their materials research papers to produce a

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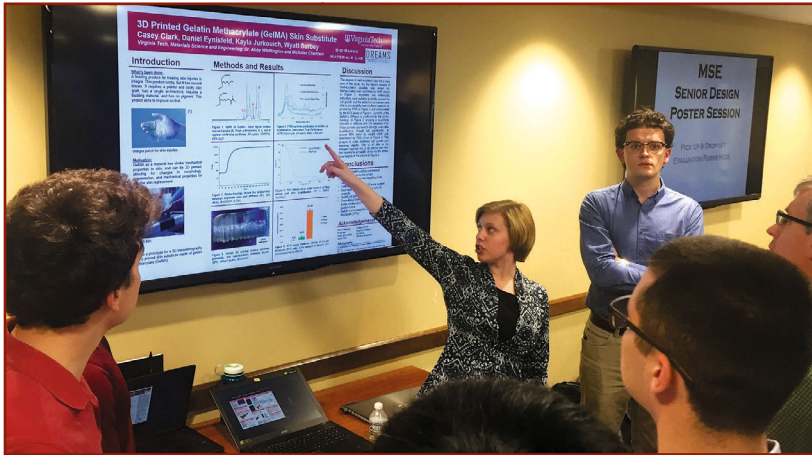
Figure 2. The digital, collaborative technologies used to facilitate ECP projects have been adopted by other programs at Virginia Tech, including the MSE Senior Capstone Design course, pictured above.

The ECP would like to join in existing conversations with any institutions that value the principles of effective and efficient communications in science and engineering.

collaborative vision of "What is MSE." The students use Google Docs to work together on their posters, with the ECP instructor providing feedback on their work. At the end, the students present their vision through a digital poster session to which the MSE faculty and student body are all invited.

The digital poster session, divided in three sessions with seven digital presentations per session, is held in a multi-purpose room equipped with several large monitors. With this approach, the ACDC model is still implemented, no money is spent on the posters, and the students still get to network with the MSE faculty and graduate students. The digital poster session is now implemented in other MSE and BEAM courses such as the BEAM Professional Development Seminar and MSE Senior Capstone Design. (Figure 2.)

A Call for Collaboration

The ECP is open to collaborations for ideas and strategies from different engineering sectors in industry and academia. The ECP team is excited to find out how other science and engineering departments address communications challenges within their curricula. Also of interest are information and insights on the changing communications standards within the industry and strategies for incorporating and assessing these standards into its curriculum. Finally, with a growing department and the fast-paced changes in uses of media and technology, the ECP would like to join in existing

conversations with any institutions that value the principles of effective and efficient communications in science and engineering.

References

1. C.B. Burgoyne and R.W. Hendricks, "Revisiting Engineering Communications in a Materials Science and Engineering Curriculum," presented at The Elizabeth Judson Symposium, Materials Science & Technology 2016 Conference and Exhibition, Salt Lake City, UT. Oct 23-27, 2016.
2. M. C. Paretti and C. B. Burgoyne, "Work-In-Progress: An Integrated Engineering Communications Curriculum for the 21st Century." *Proceedings of the 2005 Frontiers in Education Conference*, 20-22 October 2005, Indianapolis, IN.
3. K. McNabb, R.Corell, A. Wright-Cron, C. Burgoyne, V. Mouras "Teaming Up to Deliver Communication Modules to Large Courses in STEM." Conference on Teaching Large Classes, Virginia Tech, VA, July 16, 2015.

Christine Bala Burgoyne is currently the program director for the ECP at Virginia Tech and has been with the program since 2005. Her research and teaching work and interests include pedagogies in teaching engineering and professional communications, critical discourse analysis, and applied linguistics in engineering communications. She can be contacted at cbala@vt.edu.