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Capstone Design as an Individual Writing Experience*

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As the culminating experience in ABET-accredited undergraduate engineering programs, capstone design courses might seem an ideal setting for fine-tuning graduating seniors' professional communication skills prior to entering the workplace. Most capstone courses, however, involve team deliverables, including the written project report. As such, ensuring an equal opportunity for writing skills advancement and assessment for all course participants is difficult. But in the mechanical, industrial and manufacturing engineering (MIME) capstone design course at Oregon State University, incorporating an individual writing experience is necessitated by its status as the designated writing-intensive (WI) course for MIME majors. As such, and despite its large size (typically 100–140 students), the course must satisfy the associated university-wide WI requirements—including the specification that individual writing accounts for at least 25% of students' final course grade. Meeting this requirement involves three interwoven course components: (1) An iteratively developed project report in which team members are assigned specific authorial and editorial roles and that involves formative assessment and revision cycles, (2) a metacognitive element involving reflective self-assessment and individual goal setting, and (3) a variety of infrastructural support resources and tools that facilitate production and assessment of student writing. This article describes the MIME approach as a case study for incorporating individual writing in capstone design. The authors recognize that as a solution devised in response to local opportunities and constraints, its "off-the-shelf" adoption at other engineering institutions may be neither appropriate nor viable; the information is being offered solely in the spirit of showing that such an effort is possible and to invite wider cross-institutional conversation on this topic.

Keywords: capstone design; engineering writing; ABET outcome g; writing-intensive courses, writing assessment

1. Introduction

In 2003, Brinkman and van der Geest described assessment of individual engineering students' writing competencies in team-produced writing assignments as one of the most "urgent" needs in project-based engineering curricula. They correctly observed that while collaborative group work is the dominant pedagogical paradigm in engineering education, ABET-accredited engineering programs are accountable for *all* program graduates being effective written communicators—not just the strongest writer on a given project team [1].

In the decade since Brinkman and van der Geest's article was published, the needs of the engineering profession (which strongly inform the ABET requirements) for graduates with excellent written communication skills has only grown stronger, as amply documented in [2]. Indeed, in the authors' experience, the prioritization of excellent communication skills by today's engineering employers in their hiring selections and promotion decisions has become so widespread that even engineering students themselves are beginning to view it as commonplace.

For the engineering students at the authors' home institution, a useful local testimonial was recently provided by the Oregon's Engineering and Technology Industry Council (ETIC). A 2013 ETIC survey of regional engineering and technology employers showed that respondents consider written communication the second-most important of 16 fundamental engineering proficiencies—and the one least satisfactorily performed by new college graduates [3]. See Fig. 1.

Providing an individual writing experience to all engineering undergraduates would ideally involve a writing-enriched curriculum in which opportunities for individual writing skills development and assessment are embedded throughout the engineering program and culminate in something akin to the "Case 1" longitudinal writing portfolio described in [4, pp. 100–102]. But in the absence of that ideal scenario, satisfaction of ABET outcome g would seem to require giving students a robust individual writing experience in at least one engineering course before they graduate. And as the culminating element of undergraduate programs, and one that typically involves projects sponsored by the very industry employers who are calling for stronger undergraduate preparation in writing, capstone design courses might seem the most logical place to incorporate such an experience.

The problem here, of course, is that while capstone courses traditionally involve team-produced design reports handed in at the end of the course, the

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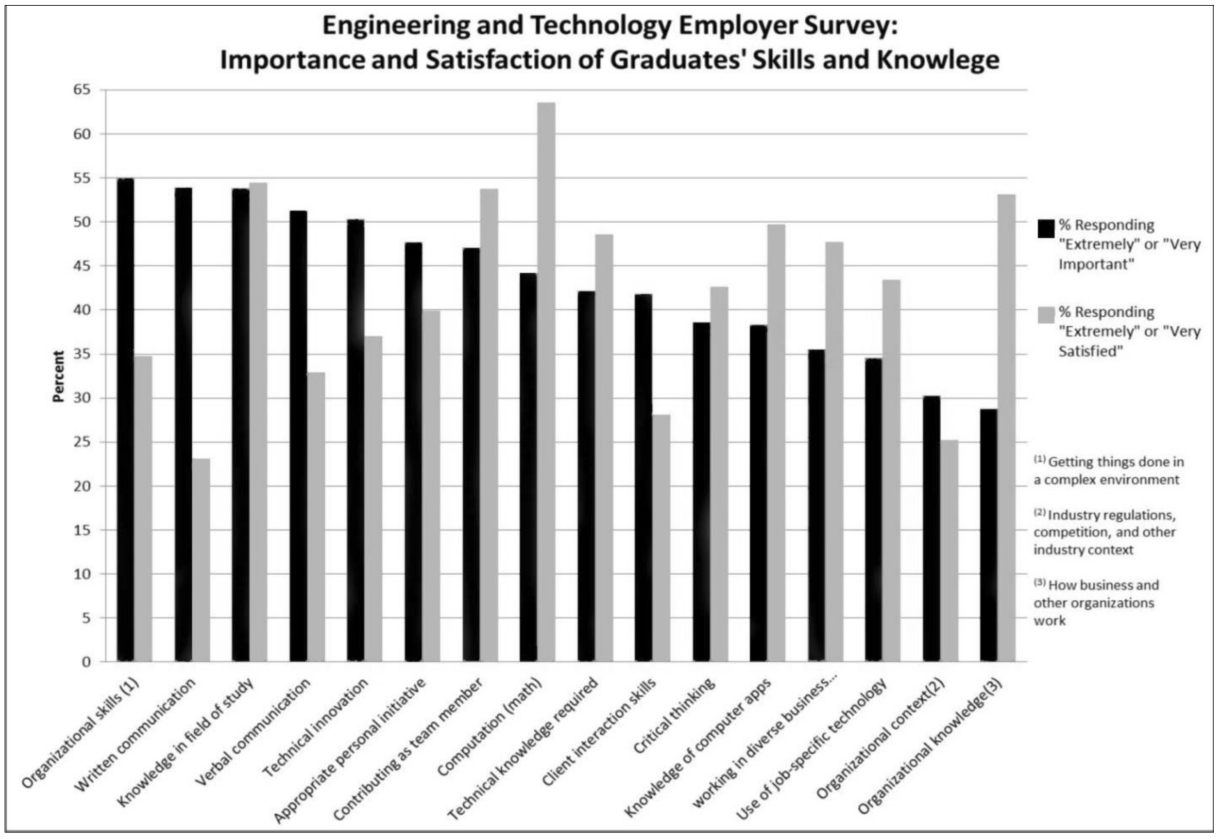

Fig. 1. Results of a 2013 ETIC survey show that among 16 skills needed in engineering and technology workplaces, employers believe written communication is the second-most important—and the least satisfactorily performed by new engineering graduates. Source: [3].

strong connection between writing skills development and opportunities to revise based on feedback [5–7] suggests the need (in a course committed to helping students strengthen their writing skills) for a radically different project report assignment structure: one that includes at least one interim report iteration, substantial and identifiable writing contributions from every team member, and a report evaluation process that generates substantive formative feedback for use in revision. The challenge of designing and implementing this type of assignment structure may seem sufficiently daunting as to discourage many capstone faculty from even making the attempt.

As a reminder that formidability need not deter engineering faculty, this article describes the strategies developed by one institution—the School of Mechanical, Industrial and Manufacturing Engineering (MIME) at Oregon State University—to meet the challenge of incorporating an individual writing experience in its capstone design course. Evidence provided in the article suggests that the solution, while still far from perfect, is proving beneficial for the students at the study institution and may therefore be of interest to a wider audience. Presenting this information comes with two caveats, however. First, the original driving force behind this effort was external to our engineering program. The mandate to include individual writing in MIME Capstone Design emerged from the course's status (a choice made by the MIME faculty) as a designated writing-intensive (WI) course, and its corresponding accountability for meeting the university-wide WI requirements, one of which is inclusion of a substantial individual writing component. Second, the solution described here was devised in response to local opportunities and constraints, making its viability for off-the-shelf adoption at other engineering institutions highly improbable. The authors therefore offer this information solely in the spirit of demonstrating that such an effort is possible and as a potential opening for further cross-institutional conversation on this topic.

2. Individual writing strategies in MIME capstone design

MIME Capstone Design is a two-quarter (20-week) sequence in which students, working in teams of three, collaboratively develop and implement a solution for an industry-, government-, community-, faculty-, or student-organization-sponsored

design project. (For examples of recent projects, see [8].) As more fully described in [9], all projects are assigned to one of three designated tracks—product, process, or student competition—and have an MIME faculty (or designated graduate student) advisor who serves as a technical resource for the team and evaluates the technical content of the team's project reports.

The MIME Capstone instructional team includes a mechanical engineering professor, an industrial and manufacturing engineering professor, and the School's communication specialist. The class lectures address technical and communication topics that support both the design development and report writing processes. Class enrollments are generally high; the 2013–14 section specifically discussed in this article, for example, included 135 students.

At Oregon State, all undergraduates must complete an upper-division writing-intensive (WI) course within their major as the third required writing component of their baccalaureate core. MIME Capstone satisfies the WI requirement for MIME majors, who have previously fulfilled their Writing I and II requirements through the university-wide first-year writing course and sophomore-level technical writing course. MIME Capstone must therefore adhere to the university-wide WI course criteria described in [10]—including that at least 25% of the course grade is based on assessment of individual writing that has undergone feedback and revision. Satisfying the WI curriculum requirements in MIME Capstone, within the context of producing the design-report deliverable, involves the following interconnected strategies, each of which is discussed in greater detail below.

1. Careful orchestration of the formal project report writing and assessment process, with specifically defined authorial and editorial roles and individual writing feedback to ensure balanced participation by all team members
2. Use of a metacognitive "frame" involving a start-of-term self-assessment and individual goal-setting tool to increase students' personal stake in their writing skills development during the course, followed up with mid- and end-of-course student self-reflections on their writing progress.
3. Implementation of infrastructural writing support mechanisms such as writing-focused lecture content, report-writing resources such as templates and rubrics, mid-course team writing conferences, and a project website that facilitates peer, project advisor, and instructor review of the project documentation.

2.1 Orchestration of project report as an individual writing experience

To foster both individual and collaborative effort on project report production, the MIME Capstone Design report-writing process includes the following elements:

- The project report comprises a sequenced assignment with several iterations, each new document a revised and expanded version of the previous iteration. In 2013–14, the sequence included four iterations, the first three of which—background report, preliminary proposal, and final proposal—were completed during the first term, and the final report during the second term.
- To ensure that all team members perform the requisite amount of individual writing and revision, the report content is divided into three author roles, with specific chapters (or sections within chapters) associated with each role.
- To ensure that all team members also have the opportunity to practice combining the individual contributions into a single cohesive document, each team member also serves as lead editor for at least one of the reports. The tasks associated with this function are clearly defined, to avoid overlap with the authorial roles.
- For each report, the authors and lead editor submit individual scoring sheets that list the items on which each will be graded. (For an example, see Appendix A.) Signed statements at the top of these scoring sheets certify that the team members performed their respective assigned tasks.
- Report feedback and evaluation are provided by the team's project advisor (an MIME faculty member or designated graduate student) and the communication instructor. Project advisors evaluate the individual report sections for technical content using a detailed grading rubric. The communication instructor uses an equally detailed rubric (shown in Appendix B) and provides extensive feedback on the quality of each author's contributions in four focal writing areas.
- While solicitation of report draft feedback from classmates, other engineering peers, and university writing center staff is encouraged, students are ultimately accountable for reviewing the technical and writing feedback within their own sections and revising these sections for the next report iteration. When they submit the next iteration, they attach the graded, marked-up copy of their previous report to facilitate evaluation of the quality of their revisions.

2.2 Use of a metacognitive frame

The function of metacognition in facilitating writ-

ing skills development is widely recognized [11–13], and the MIME approach includes a metacognitive tool that serves multiple purposes and stands to benefit student writers throughout the course. The authors agree with Paretti's observation in [4] that engineering students tend to resent metacognitive activities and other assignments that (in their view) pull them unnecessarily "off task" from their project work. However, the results noted in Section 3.2 suggest that the benefits of self-reflection for increasing students' engagement with the writing component of capstone design do make this course component worthwhile.

2.2.1 Capstone Communication Inventory: Writing engagement via self-assessment and individual goal setting

The Capstone Communication Inventory (CCI) is a metacognitive tool that introduces and frames the writing component of MIME Capstone Design. This tool is an engineering-specific adaptation of a self-assessment and goal-setting tool called the Writer's Personal Profile, which was previously developed by two of this article's authors for use in upper-division WI courses across the curriculum [14, 15].

A short (20–30-minute) exercise completed during the first week of the term, the CCI moves engineering seniors through a series of reflections designed to help them identify personally meaningful communication goals for their capstone course. The CCI questionnaire comprises about 25 multiple-choice and short-answer questions grouped into the four sections summarized below, and the full 2013–14 version (the content typically gets tweaked from year to year) is attached as Appendix C.

CCI Section 1: Undergraduate preparation as engineering communicators. This first set of CCI questions prompts students' self-reflection on their undergraduate development as technical communicators. The questions address such topics as when and where respondents completed their lower-division communication requirements, other college courses and extracurricular activities that helped hone their engineering communication skills, their current strengths and weaknesses as engineering writers and presenters, and their previous experiences writing-process-related activities such as peer review, collaborative writing, revision, etc.

CCI Section 2: Career aspirations and expectations regarding workplace communication. Students next complete a series of questions about their career aspirations and their perspectives and expectations about written communication in the engineering workplace, e.g., how much time engineers spend on writing tasks, qualities most valued in engineering writing, etc.

CCI Section 3: Report-writing proficiencies. The third CCI section presents a listing of engineering report-writing proficiencies and asks students to identify any in which they think they need more practice. The 2013–14 MIME CCI included the following proficiencies. Most of these items correlate with the principles of engineering communication presented in Irish and Weiss [16], but several represent student writing weaknesses specifically identified by MIME faculty.

- Identifying audience and purpose
- Discerning credibility of online sources
- Incorporating and citing borrowed information
- Assembling and incorporating visual information
- Assembling and incorporating appendixes
- Writing summaries, introductions, and conclusions
- Keeping readers oriented to their report location (also called "sign posting")
- Designing comprehensible paragraphs
- Transitioning effectively
- Crafting strong and succinct sentences
- Reviewing and revising effectively

CCI Section 4: Personal communication goals for the capstone design course. The reflective thinking required for completing Sections 1–3 positions students for the culminating piece of the CCI: identifying two personally relevant communication goals that they will pursue as part of their course experience. At least one of these goals must relate specifically to technical report writing; the other can involve development of either report-writing or technical presentation skills. Both must be sufficiently relevant, realistic and specific that students will able to show evidence of following through on them in this 20-week course and that classmates and instructors will be able to provide feedback on their efforts. To follow up on the goals listing and move the students into "goal achievement" mindset, they must next list some viable strategies for pursuing their goals.

2.2.2 CCI follow-up

To ensure that students make the most of this metacognitive exercise and carry their individual goals and commitment to achieving them into and through the course, CCI use in MIME Capstone Design follows the best-practice recommendations for Writers Personal Profile implementation in WI courses [17]. Specifically:

1. To forefront the integral role of the CCI (and the communication component more generally) in students' capstone design experience, the exercise is assigned during the first class meeting, and CCI completion is required for all students.
2. Students are encouraged to include the writing goals identified in their CCI on all iterations of their project report, allowing the instructor to provide (ungraded) goal-specific feedback while also addressing the global writing elements on which all reports are formally evaluated. In the final iteration of the report, students are invited to identify passages that showcase what they believe to be their strongest performance on their writing goals.
3. At the start of the second term of MIME Capstone Design, students complete a mid-course CCI goals review in which they self-evaluate their progress on their existing goals and either recommit to those goals or set some new ones for the second half of the course. As well as helping students keep their personal goals on the radar screen as the course progresses, these reviews provide a conversational starting place at the teams' mid-course writing conferences.
4. The end-of-course "capstone experience memo" assignment (the third and last self-assessment exercise) includes a section in which students reflect on their development as engineering communicators, based partly on a review of their initial CCIs and their mid-course goals reviews. They also identify some "next-step" communication goals that they can carry forward with them into the workplace.

2.2.3 *Other benefits of CCI use*

While the primary beneficiaries of the CCI and related activities described above are the student participants, the collective CCI data can also help shape the writing-related instructional content of any given course offering, provide a springboard for class discussion of writing process issues, and even generate useful data for broader curriculum planning and assessment.

As an example of how CCI results can help shape instructional content, the compilation of 2013–14 CCI respondents' report-writing-related concerns shown in Fig. 2 revealed appendix use as the students' top concern. This result was unexpected and prompted higher prioritization of instruction in this skill than had originally been planned for this course cycle.

As an example of how CCI content can serve as writing discussion springboards, showing students the collective class perceptions about the relative value of writing feedback provided *to* peers vs. that received *from* peers offers a humorous segue into discussing effective peer review strategies. The data shown in Fig. 3 is specific to the 2013–14 course cycle, but CCI feedback invariably indicates that students think more highly of the feedback they

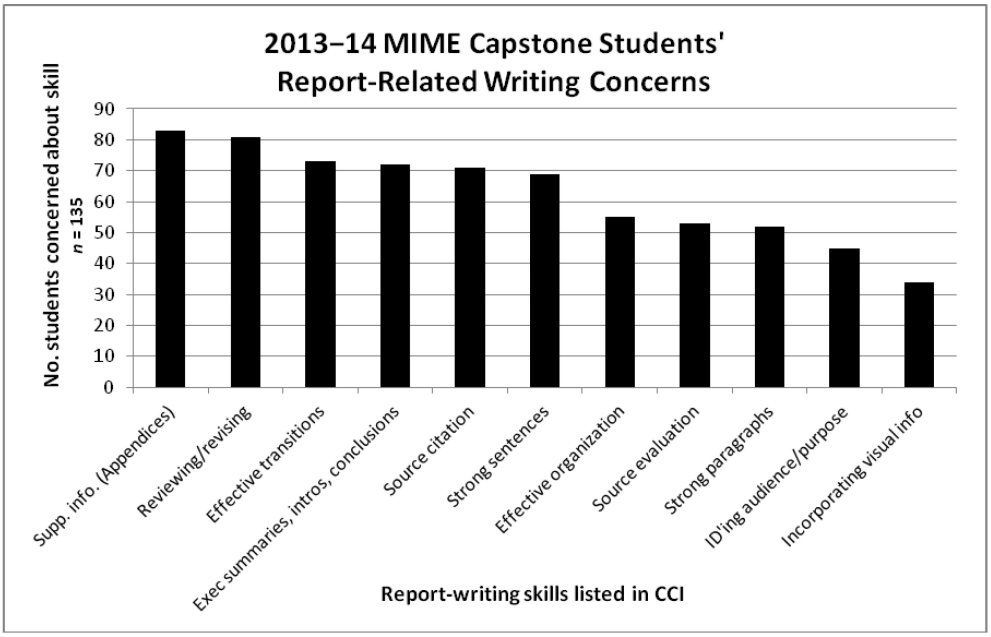

Fig. 2. Collective 2013–14 class responses to CCI inquiry about students' report-related writing concerns. The collectively high level of uncertainty about appendix use was unexpected, and the information prompted greater instructional emphasis on appendix writing skills in this course cycle.

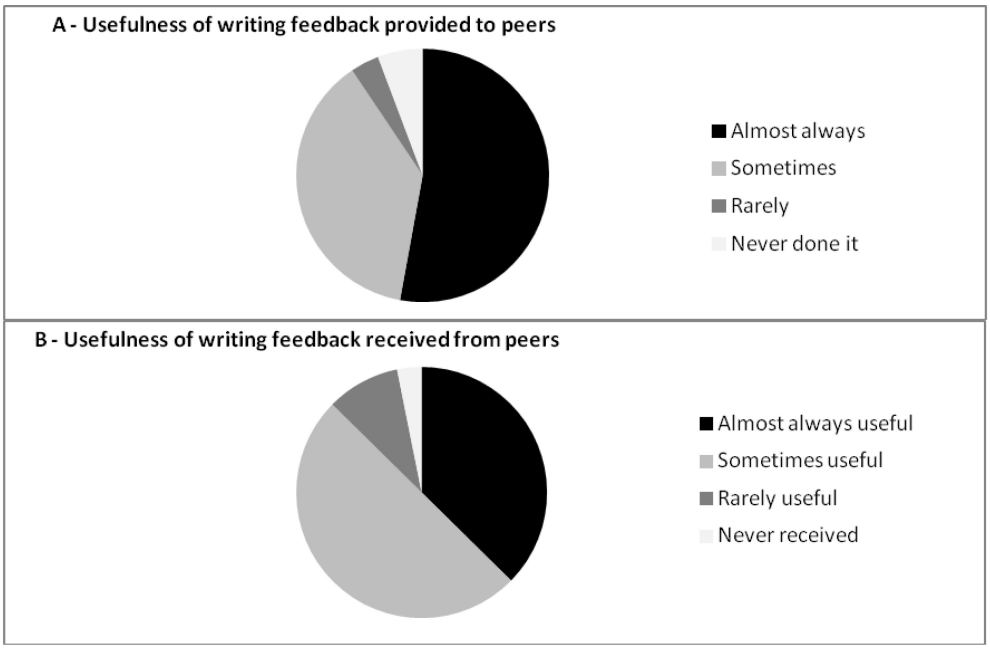

Fig. 3. Collective 2013–14 CCI results showing (A) the perceived value of writing feedback respondents provide *to* peers vs. (B) the perceived value of writing feedback they receive *from* peers. These comparative results remain consistent from year to year and serve as a humorous segue into a discussion of effective peer review practices.

provide to others than they do of the feedback they receive.

The CCI also generates data that can be useful at the department level for curricular planning and assessment. For example, students are asked to identify the single course that they found most useful in preparing them as engineering writers. Among other uses, this information can be helpful in identifying opportunities for more widespread implementation of writing instruction and assessment in a given engineering program.

2.3 Infrastructural support for the individual writing experience

Infrastructural support for individual writing in MIME Capstone Design is summarized in [9] and includes the following components:

- Writing-focused lecture content that reviews practical strategies for improvement in the four areas of writing performance and assessment included in the report rubric. In the 2013–14 course cycle, these categories included clarity and conciseness, organization, technical writing conventions, and incorporation of sources.
- A report template for each project track (product, process, and student competition) that standardizes the report structure and content. This template is what enables fair division of the authorial writing responsibilities, and teams are therefore asked to follow it closely; but for projects that clearly do not fit the standard structure, the template can certainly be customized with instructor guidance.
- Author- and lead-editor-specific scoring rubrics for each iteration of the project report. For an example, see Appendix A.
- An MIME capstone report style guide that includes the formatting requirements and technical writing conventions for these reports.
- Peer review activities, team writing conferences, and informal writing assignments that provide ungraded practice in the writing focal areas.
- Team project websites that facilitate team member, project advisor, and instructor access to project documentation.

3. Student writing progress in MIME Capstone Design

Comparing the degree of improvement in individual students' writing skills before and after implementing an individual writing component in a course that previously included only group deliverables was not possible, since there were no ''before'' artifacts of individual writing. However, having completed the first full course cycle (2013–14) in which all of the individual writing elements described in Section 2 were implemented, it was possible to generate the following characterizations of students' progress based on both direct and indirect assessment strategies.

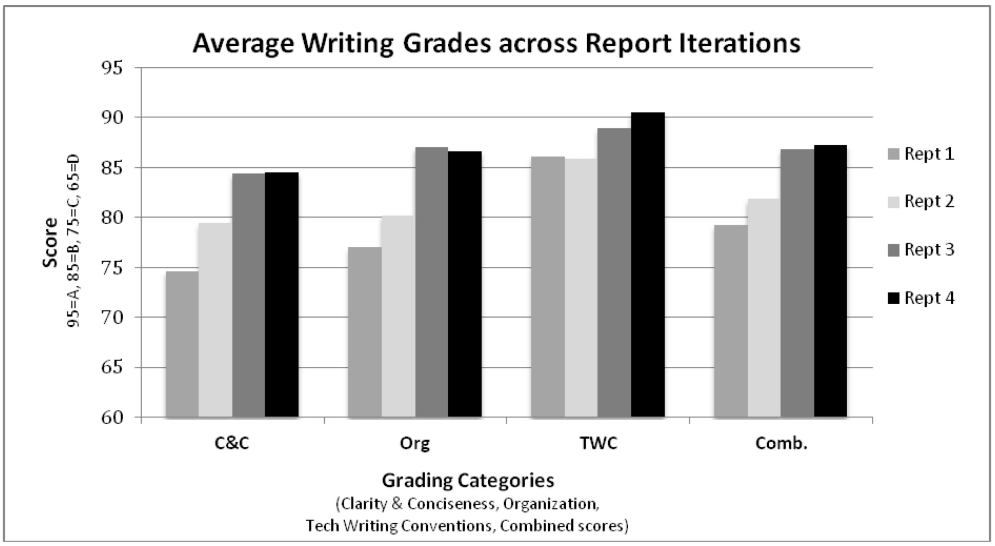

Fig. 4. Progression of 2013–14 class grade averages for three writing skills over four capstone report iterations. Reports 1–3 were completed during the first term; Report 4 was submitted at the end of the second term. Evaluation criteria for these grading categories are listed in Appendix B.

3.1 Direct assessment: Report writing grade improvement

Judging from the progression of writing grades through the formal report iterations, most MIME Capstone students in the 2013–14 cohort made noticeable progress on their writing skills in this course—most significantly during the first term where the writing focus is strongest. Figure 4 shows the progression of average class scores on three writing categories across the four project report iterations; n = 129–135 depending on report. The evaluation criteria for these writing categories are shown in Appendix B. (The fourth writing category included in the scoring rubric, "Citing Sources," is not included here because it was used only during the first two report iterations).

Moreover, as illustrated in the Fig. 5 box plot, the median 2013–14 combined writing scores (seen at the interface between the dark- and light-gray boxes, which represent the first and third quartiles respectively) also increased over the four report iterations, revealing a score distribution shift towards the higher quartiles as students gained experience.

3.2 Indirect assessment: Student self-reporting on progress in writing skills development

Students' beliefs about their writing skills development in this course, and more specifically about the

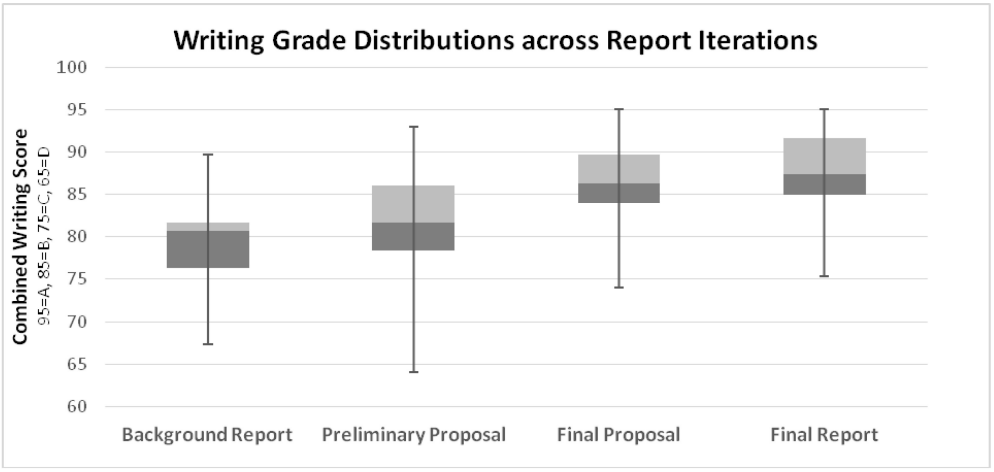

Fig. 5. Evolution of the distribution of 2013–14 combined writing scores (i.e., averaged scores for clarity and conciseness, organization, and technical writing conventions) as students progressed through report iterations and received feedback. The vertical bars indicate the range of combined writing scores for each report.

extent to which they met their individual writing goals, were assessed for the 2013–14 cycle both in face-to-face interactions at the mid-course team writing conferences and through content analysis of written feedback at the end of the course.

3.2.1 Qualitative evidence from mid-course writing conferences

All 2013–14 MIME Capstone Design students completed the mid-course communication goals review form shown in Appendix D and brought it to their team writing conferences at the start of the second term of capstone. In these conferences, the team members discussed their progress thus far on their personal communication goals specifically and their communication skills development more generally. Most students reported having made noticeable progress on both counts. In addition, many students specifically attributed their progress to classroom instruction, feedback on their report drafts, and/or the structured revision cycles. Their comments also revealed increased awareness of their own writing processes, of the relationship between time-management skills and success in writing production, and of their teammates as valued partners in communication skills development.

3.2.2 Content analysis of written student feedback

The final deliverables for MIME Capstone Design include a reflective self-assessment fashioned as a "Capstone Experience Memo" (CEM). The first question in the 2013–14 version of this assignment (included as Appendix E) included the following instruction:

> *After reviewing your CCI and mid-course communication goals review, assess the progress you made on your CCI personal communication goals, and note any other areas in which you have progressed as an engineering communicator during this class.*

The directed content analysis approach described in [18] was applied to students' responses to this question in order to quantify their self-assessments of (1) their overall writing skills development in this course and (2) the degree to which they felt they had met the personal writing goals set in their CCIs.

For both assessments, the directed content analysis focused on identifying the level of improvement noted by students. Three coders analyzed the student responses to CEM Question 1, and they reached consensus on all responses after three rounds of coding.

Figure 6 shows the results of the content analysis for overall writing skills development during MIME Capstone Design, with responses coded for "no improvement," "some improvement," and "significant improvement." Coders found no instances of students reporting a decline in their overall writing skills.

Figure 7 shows the degree to which students reported they had met their personal writing goals set in their CCIs, with responses coded for "did not improve," "somewhat met goals," and "exceeded goals." This quantification was achieved by cross-referencing the goals specified in students' CCIs with their corresponding responses to CEM Question 1. The number of total observations here is lower than in Fig. 6 because some students did not explicitly address their original CCI goals in this question.

4. Conclusions

As noted in the introduction, the authors' primary goal in presenting this case study was to revive the conversation initiated in 2003 by Brinkman and van

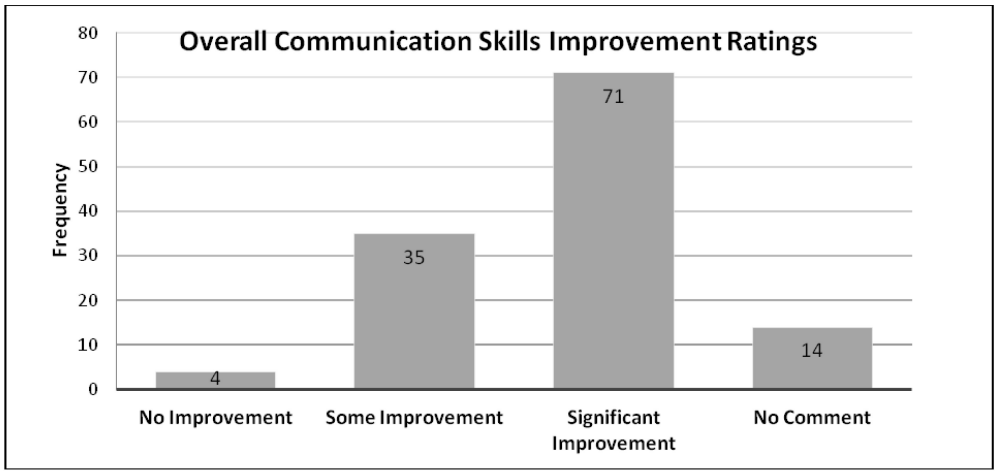

Fig. 6. 2013–14 MIME Capstone Design students' perceptions of writing skills improvement during the course, as measured through a content analysis of the students' responses to CEM Question 1.

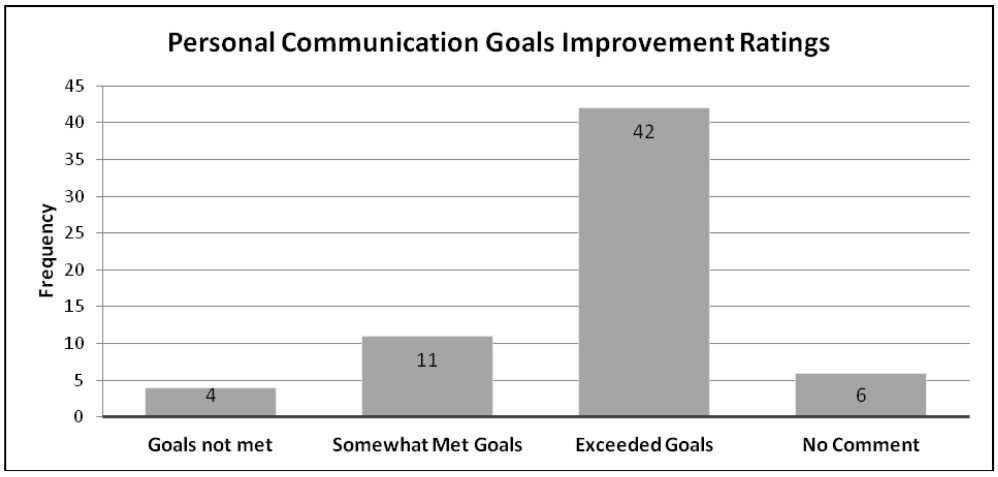

Fig. 7. Students' perceived progress on their personal communication goals, as measured through a content analysis that cross-referenced the goals specified in their CCIs with their responses to CEM Question 1.

der Geest [1] about the need for individual writing development and assessment in undergraduate engineering programs and to demonstrate that capstone design courses may be a viable setting for meeting this need.

Of course, ''viable'' does not always mean easy; and the authors are the first to acknowledge that incorporating a robust individual writing component in capstone design is fraught with challenges. While the direct and indirect assessments described above suggest that the curricular strategies described in this article do benefit students, numerous obstacles to their successful implementation remain in MIME Capstone, including (but not limited to) student/teacher ratios that are far from optimal for an intensive individual-writing component; the problem of limited familiarity on the part of most external project advisors with the course content and expectations, which sometimes leads to project and report feedback that is inconsistent with the specified assignment requirements; and faculty workloads that limit the course instructors' abilities to fully serve capstone students in need of extensive writing support and consultation. The writing assignments and assessment approaches discussed here are therefore never static. Continuous improvement of MIME Capstone Design involves ongoing assessment of weaknesses in the curricular design and development/deployment of new strategies to address them.

The second objective in writing this article was to encourage cross-institutional discussion and strategy sharing leading to wider experimentation with incorporating individual writing in capstone design courses. The MIME solution described in these pages emerged from a combination of local circumstances that might not exist elsewhere, but parts of it might be adaptable at other locations. In turn, information about strategies in use elsewhere may be helpful to continuous improvement efforts in MIME Capstone Design.

Future research opportunities include replication of the study in MIME Capstone and in capstone courses at other institutions, with local adaptations made. To allay concerns of bias in using grades as a measure of writing improvement, assessment could also include a blind review method of holistically evaluating both early-course individual writing and late-course individual writing.

In conclusion, ABET-accredited engineering programs are accountable for preparing all of their students as effective engineering writers. Based on the encouraging results of the MIME model described here, it appears possible to provide at least some of this preparation as part of the capstone design experience. The authors encourage other capstone faculty to experiment with the ''just do it'' approach to incorporating—even if only imperfectly—an individual writing experience for students and to join this conversation in the interest of more widespread collaboration in developing the best local solution for each engineering program.

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John Parmigiani is a research assistant professor at the School of Mechanical, Industrial and Manufacturing Engineering at Oregon State University and a co-instructor of MIME Capstone Design. Dr. Parmigiani has long and varied experience in engineering. Academic training began with metals-machining and mechanics courses prior to college, BS and MS degrees in mechanical engineering from the Pennsylvania State University, and a PhD in mechanical engineering from the University of Michigan. Professional experience includes 10 years as a practicing engineer in industry with several Pennsylvania manufacturing firms. Research interests include interface fracture and composite mechanics and prototype device development to solve compelling engineering problems.

Vicki Tolar Burton is a professor of English and the director of the Writing Intensive Curriculum Program at Oregon State University. She holds a BA in English from Wake Forest University, an MA in English and Education from Duke University, and a PhD in English from Auburn University. She is the author of *Spiritual Literacy in John Wesley's Methodism: Reading, Writing, and Speaking to Believe* from Baylor University Press as well as articles on the teaching of writing, and is the co-producer of the Telly Award-winning documentary film *Writing Across Borders.*

Appendix A: Example of individual scoring sheets used for MIME Capstone Design reports

(Note: Grayed-out areas are report sections written by other authors)

GRADING SHEET FOR PRELIMINARY PROPOSAL: AUTHOR 1
ME/IE 497

Project # _____ Author 1 Name: _____
I certify that for the sections assigned to Author 1, I served as primary author. This includes:

- Generating the initial or revised draft of each assigned section
- Incorporating any feedback provided on these sections by other reviewers

Signature: _____ Date:_____

Category	Summary of Rubric Criteria	Grade Weight	Grade (A-F)
1 BACKGROUND	Technical and editorial revisions incorporated to create clear, succinct, and complete presentation of required chapter content	20%	
2 REQUIREMENTS 2.1 & 2.2 HOQ & CRs 2.3 ERs	Technical and editorial revisions incorporated in 2.1 and 2.2 to create clear, succinct, and complete presentation of specified section content. New Section 2.3 content satisfies rubric specifications.		
3 EXISTING DESIGNS 3.1 Methodology 3.2 Functional Decomp.	Technical and editorial revisions incorporated to create clear, succinct, and complete presentation of required section content		
3.3 System Level 3.4 Subsystem Level	Technical and editorial revisions incorporated to create clear, succinct, and complete presentation of required section content	20%	
4 DESIGNS CONSIDERED 4.1 Solutions Considered	Describes at least one complete design that addresses all subsystems identified in Section 3.2; clearly derives from the research reported in Sections 3.3 and 3.4; and is distinctly different from the other solutions presented in this section. Advantages and disadvantages of described solution(s) vis-à-vis project requirements are clearly and systematically summarized. **4.1 Subsection authored: _____**	15%	
4.2 Solution Selected	Identifies solution selected for implementation and justifies selection based on best fit with project requirements. Discussion maps to the CR and ER design alternatives evaluations in HoQ.		
Clarity and Conciseness	Clear, concise, and focused; main ideas stand out; supporting details and references are effective and relevant. Writing is free of padding with no unnecessary repetition. Document is free of grammar, punctuation and spelling errors that could impede message clarity.	15%	
Organization	Clear visible structure, informative textual signposting (including chapter and section introductions), logical sequencing, and effective transitions between sentences, paragraphs, and ideas make writing easy to follow. Details fit where placed.	15%	
Conventions	Writing shows control of standard writing conventions noted on full report rubric and uses them effectively to enhance communication. Errors are few and minor.	10%	
Citing Sources	Writing demonstrates proficiency in locating, evaluating, incorporating, and citing borrowed information.	5%	

Individual report-related communication goal(s):

Appendix B: MIME Capstone Design Rubric—Writing Categories

Grading Category	A/A+ (Note: A+ is faculty level / journal quality)	B	C	D	F
CLARITY and CONCISENESS	Writing is polished and controlled. Sentences are easy to follow, with meaning clear on first reading and length correlating with message complexity. Wordy and awkward sentence constructions are infrequent, and writing is free of padding (i.e., does not include extraneous, repetitive, or redundant verbiage). Supporting details and references are effective and relevant, and modifiers are used selectively to increase message precision. Adept use of tables, figures, and bulleted and numbered lists further enhances clear and succinct information delivery. Sentences are complete and grammatically correct, and spelling and punctuation errors are few and minor.	Approaching "A" quality, but room for improvement in most areas listed.	Reads like a rough draft. Sentences are relevant but often difficult to follow. Arguments may be weak, and details may be misplaced. Sentence constructions are sometimes awkward and/or wordy. Numerous opportunities exist to present information more clearly and concisely through effective use of tables, figures, and bulleted and/or numbered lists. Grammar, spelling and/or punctuation errors detract from message clarity.	Sentences are irrelevant and difficult to understand. Supporting evidence is incomplete, ineffective, and/or misplaced. Text contains a great deal of repetitive verbiage, information redundancy, unhelpful or confusing tables and figures, and/or other types of unnecessary verbal and visual "padding." Grammar, spelling and/or punctuation errors abound.	Large sections of text are incomprehensible.
ORGANIZATION	Clear visible structure and effective textual signposting make writing easy to follow. Chapters, sections and subsections begin with introductory set-up text. Information is presented in a logical sequence, and transitional language is used adeptly to direct and control idea flow. Within paragraphs, topic sentence defines content and focus, and all other sentences directly relate to the specified topic. Details fit where placed, and lengthy supplementary information is placed in appendixes when appropriate.	Approaching "A" quality, but room for improvement in many of the areas listed.	Report is difficult to follow in places. Some chapter, section, and/or subsection introductions are missing. Logic of information sequencing and detail placement is not always clear, and transitional language may be missing. Paragraph structure exists, but topic sentences are often missing. Appendix use could be improved.	Structure and logic of report flow is difficult to follow. Chapter and section introductions, if present, are weak. What may look at first glance like paragraphs are simply arbitrarily divided blocks of text that address multiple topics. Transitional verbiage is consistently absent, and details rarely fit where placed.	Large portions of the text are almost impossible to follow. Chapters and sections lack introductory text. No apparent logic to information sequencing and no effective paragraph structure.

<table>
<tr><th>Grading Category</th><th>A/A+</th><th>B</th><th>C</th><th>D</th><th>F</th></tr>
<tr><td>CONVENTIONS
Writing shows control of standard writing conventions, and text appears to have been proofread.
• Passive constructions used appropriately but not overused.
• Verb tense choices are appropriate.
• Same-level headings and items within a given bulleted or numbered list have parallel structure.
• Acronyms are spelled out at first mention (except when universally familiar).
• Formatting of numeric data conforms to technical writing conventions.
• Proper nouns are capitalized and all other nouns are lowercased.
• Tables and figures and appendices are properly constructed, captioned, and cited in text.</td><td rowspan="2">Always or almost always yes to all.
A+ is faculty level / journal quality.</td><td rowspan="2">Usually yes, no obvious errors</td><td rowspan="2">Usually yes, but some obvious errors</td><td rowspan="2">Occasionally yes</td><td rowspan="2">Rarely or never yes</td></tr>
<tr><td>CITING SOURCES
Writing demonstrates proficiency in locating, evaluating, incorporating, and citing borrowed information.
• Supporting information from external sources is skillfully incorporated at the appropriate points.
• Choice of supporting sources enhances report and author credibility.
• Except in Section 1.2, information drawn from other sources is paraphrased, not directly quoted.
• All borrowed information (including tables and figures borrowed or adapted from other sources) is properly cited.
• In-text citations and Reference List items conform to ASME format.
• Reference List includes all sources cited in report body and no additional sources.</td></tr>
</table>

Appendix C: MIME Capstone Communication Inventory

(Administered through Blackboard and to be completed during first week of the course)

DESCRIPTION

As its name implies, MIME Capstone Design is a place to synthesize and showcase everything you've learned so far as an engineering student. This includes not just technical knowledge, but also your skills in oral, written, and visual communication, team collaboration, and project management—all of which are key to success and professional advancement in the engineering workplace.

For many of you, MIME Capstone Design is also one of your final opportunities to fine-tune these engineering skills before entering the job market.

The following inventory is a 20–30 minute exercise that will help you take fullest advantage of this course for polishing your engineering *communication* skills. The questions prompt you to think about where you are now as an engineering communicator; where you want to be on your first job; the gaps between these two places; and strategies for bridging them. Based on this reflective thinking, you'll set some communication goals to work on during the next 3–6 months.

The information you and your classmates provide in this exercise will also assist the College of Engineering in developing an integrated engineering communication curriculum. Thank you in advance for your help with this effort.

Note: The Capstone Communication Inventory is being administered through the Blackboard Test function solely for tracking purposes (i.e., so we can give you credit for completing it). Despite what the Blackboard heading says, this inventory is NOT a test, and there are no right or wrong answers—just honest and considered ones

INSTRUCTIONS

1. Review the purpose of the Capstone Communication Inventory (CCI) in the assessment description. To get the most out of the CCI, you need to understand why you are completing it.
2. Complete the CCI by selecting or typing the applicable response(s) to each listed question. It's a good idea to save your work occasionally by clicking the "Save All Answers" at the bottom of the document (button (next to the "Save and Submit" button). **Note:** To receive credit for this assignment, you must answer all of the questions. You can submit the CCI only once, so be sure you have answered *all* of the questions before doing so. Also, if you need to navigate away from this page while you are still in the process of completing the CCI, be sure to save the questions you've answered thus far by clicking the "Save" button at the bottom of the document.
3. Submit your completed CCI by clicking the "Save and Submit" button at the end of the document.
4. Upon submitting the CCI, you will receive a "Test Submitted" confirmation message. Click the "OK" button in the confirmation message box.
5. Blackboard now displays your CCI responses.
6. You will be asked to revisit your CCI responses at the beginning of MIME 498 when you do your mid-course communication goals review and at the end of ME/IE 498 when you prepare your capstone experience memo. Your completed CCI will continue to be available to you on Blackboard, but for easier retrieval and reference we recommend that you save and print your responses now (for example, by using your web browser's Save and Print functions or by copying and saving the responses in a Word document) and keep them with your course materials.

In the event of an Internet interruption, power fluctuation, or other anomaly that causes a premature time-out of your attempt to complete the CCI, you will need to ask your instructor to *reset* the self-assessment for you. For help with other technical aspects of using this questionnaire, contact either of the following:

- OSU Computer Help Desk at (541) 737-3474 or http://oregonstate.edu/is/tss/och/
- Technology Across the Curriculum (TAC) Office at TAC@oregonstate.edu

PART I UNDERGRADUATE PREPARATION

The Capstone Communication Inventory begins with a series of questions about your undergraduate preparation as an engineering communicator.

To start off, select from the statements below all that are true for you about the course you used to satisfy your first-year writing requirement (WR 121 or the equivalent).

I took WR 121 at OSU.
I fulfilled my first-year writing requirement through coursework at another 4-year college.
I fulfilled my first-year writing requirement through coursework at a community college.
I fulfilled my first-year writing requirement through a pre-college course.
I have not yet fulfilled my first-year writing requirement.

Q2 **From the following statements, select all that are true for you about the course you used to satisfy your technical writing requirement (WR 327, HC 199, or the equivalent).**

I took WR 327 ("Technical Writing") at OSU.
I took HC 199 ("Honors Writing/Engineering") at OSU.
I fulfilled my technical writing requirement through coursework at another 4-year college.
I fulfilled my technical writing requirement through coursework at a community college.
I fulfilled my technical writing requirement through a pre-college course.
I have not yet fulfilled my technical writing requirement.

Q3 **From the following statements, select all that are true for you about the course you used to satisfy your speech requirement (COMM 111 or 114 or the equivalent).**

I took COMM 111 ("Public Speaking") at OSU.
I took COMM 114 ("Argument & Critical Discourse") at OSU.
I fulfilled my speech requirement through coursework at another 4-year college.
I fulfilled my speech requirement through coursework at a community college.
I fulfilled my speech requirement through a pre-college course.
I have not yet fulfilled my speech course requirement.

Q4 **Please list any additional college courses, *both inside and outside your major,* that in your opinion have substantially furthered your engineering communication skills. If you had no such courses, write "None."**

Q5 **In your opinion, which of the college courses you've taken thus far did the most to advance your engineering communication skills?**

Q6 **In what ways did the course(s) cited in Question 5 advance your engineering communication skills?**

Q7 **Please list any extracurricular activities in which you've participated as an undergraduate (e.g. clubs, competitions, internships, international exchanges, etc.) that have strengthened/extended your engineering communication skill set. If there were no such activities, write "None."**

Q8 **In your opinion, what is your single-greatest current *strength* as an engineering *writer*?**

Q9 **In your opinion, what is your single-greatest current *weakness* as an engineering writer?**

Q10 **In your view, what is your single-greatest current *strength* as an engineering speaker/presenter?**

Q11 **In your view, what is your single-greatest current *weakness* as an engineering speaker/presenter?**

Q12 **From the following statements relating to peer review of writing assignments in your *engineering* courses, select the one that is true for you.**

I have no prior experience with either providing or receiving peer feedback on writing assignments in engineering courses.

I have provided and/or received informal peer feedback on engineering writing assignments (for example, with friends or roommates), but none of my engineering courses has included formal instruction or guided practice in peer review.

I have received formal instruction and guided practice in peer review in at least one engineering course.

Q13 **From the following statements about writing feedback *offered to* other engineering students, select the one that corresponds most closely to your own experience.**

When reviewing other students' engineering writing, I can almost always provide constructive suggestions for improvement.

When reviewing other students' engineering writing, I can sometimes provide constructive suggestions for improvement.

When reviewing other students' engineering writing, I'm usually at a loss for suggestions on how to improve it.

I have never had the opportunity to review other students' engineering writing for the purpose of providing feedback.

Q14 **From the following statements about writing feedback *received from* other engineering students, select the one that corresponds most closely to your own experience.**

My engineering writing almost always improves as a result of feedback from other engineering students.

My engineering writing sometimes improves as a result of feedback from other engineering students.

Rarely, if ever, does my writing benefit from feedback from other engineering students.

have never received peer feedback on my engineering writing.

Q15 **If you would like to make any additional comments or observations about your experience of giving or receiving peer feedback on engineering writing, please do so here. Otherwise, simply write "N/A".**

Q16 **From the following statements about collaborative (team) report writing, select the one that is true for you.**

I have received formal instruction and guided practice in the collaborative report writing process In at least one previous engineering course.

I have never received formal instruction or guided practice in collaborative report writing in an engineering course.

Part II: CAREER ASPIRATIONS/EXPECTATIONS

The second part of this inventory asks about where you're headed after you complete your undergraduate program.

Q17 **First, do you plan to pursue a master's degree prior to entering the job market?**

Yes

No

Not sure

Q18 **Do you plan to pursue a doctoral degree prior to entering the job market?**

Yes

No

Not sure

Q19 **Please list the career you intend to pursue after completing your degree(s).**

- If you are targeting a specific job position and/or employer, feel free to include this information in your response.
- If you haven't yet settled on a career field, write "I don't know."

Q20 **In the kind of job you expect to pursue after graduation, what percentage of your workday, on average, would you expect to spend on communication-related tasks?**

Very little (<10%) of an average workday

Maybe 25%, give or take, of an average workday

Closer to 50% of an actual workday

Most (75% or more) of an average workday

I have no idea

Q21 **List three qualities that you'd expect most employers in your chosen field to place highest on their list of "good communication skills."**

1.

2.

3.

Part III: **REPORT-WRITING PROFICIENCIES**

Q22 The engineering communication proficiencies listed below are elements of effective technical report writing, and most pertain to oral presentations as well. After reviewing this list, please select any you're unsure about or think you need more practice in.

Identifying audience and purpose. *Careful analysis of the audience(s) for a report and your goals in writing it (i.e., what you want your audience to think or do after reading the report) will help you gauge how much background information to provide, how simple or complex your explanations should be, what tone and writing style to adopt, etc., in order to meet audience expectations and achieve the desired outcomes.*

Discerning the credibility of online sources. *Not all online sources are created equal. Can you differentiate between those that will strengthen your report and those that could undermine its (and your) credibility?*

Incorporating and citing borrowed information. *Information pulled from other sources must be seamlessly integrated and properly cited in your engineering reports, both at the point of inclusion in your text and in the reference listing. Direct quotations are virtually never used in engineering writing; so to avoid plagiarism, you must be proficient at paraphrasing. Borrowed visuals usually also require citation, whether in documents, on posters, or in presentation slides.*

Assembling and incorporating visual information. *Visual information (tables, charts, photos, etc.) can certainly be worth the proverbial thousand words, but only if these "pictures" are clearly introduced and easily parsed and their function and relevance to surrounding text clearly explained.*

Assembling and incorporating supplementary information. *The ability to differentiate between information that is integral to a technical report and that which can be moved to an appendix and to correctly format and reference appended information is another important technical writing skill.*

Composing effective executive summaries, introductions, and conclusions. *An effective executive summary presents the key information and action items contained in the larger report. An effective introduction quickly and clearly describes the report's content and organization, allowing readers to quickly determine whether to read further and/or where to find specific information. An effective conclusion reviews key findings and other important document content, while also pointing readers toward any relevant "next steps."*

Keeping readers oriented as they move through your engineering report. *You can help keep report readers on track both through visible structure (such as headings and bulleted lists) and through verbal "road-mapping" signals and cues.*

Designing comprehensible paragraphs. *A paragraph is information that has been defined, limited, and arranged into a comprehensible unit. It systematically and seamlessly moves the reader from "known" to "new" information.*

Making effective transitions. *The clarity and strength of an engineering report is enhanced by (and sometimes even hinges on) the use of effective transitions –"connecting" words, phrases, or sentences that show the relationship between successive ideas or topics and provide logical flow from one sentence, paragraph, or section to the next.*

Crafting strong and succinct sentences. *Sentence strength hinges on selecting strong verbs and positioning them for impact, clearly identifying the subject, using appropriate vocabulary, and matching sentence length to purpose.*

Reviewing and revising effectively. *As with engineering design, creating an engineering report that meets all customer requirements involves multiple iterations as you systematically move toward your final version. The process tends to be most efficient when each iteration focuses on a different set of editorial concerns.*

Part IV: PERSONAL COMMUNICATION GOALS FOR THIS COURSE

Q23 **The first part of this inventory addressed your development thus far as an engineering communicator. The second part addressed your career aspirations and some communication-related aspects of your chosen profession. The third part inquired about typical stumbling blocks for emerging engineering communicators; and your collective responses will help us determine the instructional foci for this class. In the fourth and final part of the CCI, you'll pull all of this thinking together and identify two engineering communication-related goals that you want to work on during this WI course. Identify these goals as follows:**

1. Think for a few moments about the kinds of communicating you expect to do in your first engineering job after graduation. Think, too, about the kind of communicator you want to be in that job.
2. Next, think about the biggest gaps between your current repertoire of engineering communication skills and the skills that might be expected in your first job. To close these gaps, what needs to change?
3. With these thoughts in mind, identify two goals for communication skills improvement that you will commit to working on over the next two terms, with the following caveats:
   - The first goal must involve a **report-writing skill that will come into play in creating your capstone project report**. Any of the proficiencies listed in Question 22 would be appropriate, for example.
   - The second goal can involve either another **report-writing skill or a skill related to oral presentation preparation and delivery**.
   - Both of your goals must be sufficiently **relevant, realistic and specific** that (a) you'll be able to show evidence of following through on them in this class and (b) others will be able to provide feedback on your efforts. (See below for examples of goals that do and do not meet these criteria.)
4. Record your two goals in the space below. For quick reference, record them on your syllabus or in your engineering notebook as well.

PERSONAL COMMUNCATION GOALS:

1.

2.

Examples of relevant and specific goals that are achievable within the timeframe of this course:

- *Find credible sources of information and properly cite all references.*
- *I would like to strengthen my transitions from paragraph to paragraph and topic to topic.*
- *I would like to be able to craft stronger sentences in my reports.*
- *Develop a good mix between what is on a note card and what is memorized that mostly reduces my stuttering and struggling for what I am going to say for oral presentations.*
- *My reports would benefit from having multiple revisions. My goal is to finish written pieces with sufficient time that I can do at least one rough draft before pieces are due.*
- *I need to become better at drafting an executive summary. Specifically, I want to be better able to identify the important areas and aspects of a report/project that need to be included.*

Conversely, here are some examples of inappropriate (non-specific, irrelevant, and/or unrealistic) goals:

- *I want to ace this course.* (Not specifically communication-related)
- *I need to get better at writing.* (Too general)
- *I am going to do at least 5 full revisions of each report draft and get advisor feedback on each of them before generating the final version.* (Unrealistic)
- *I want to refine my five-paragraph essay-writing skills.* (Irrelevant to this course.)

Q24 Without follow-up, the goals we set quickly morph into wishful thinking. Therefore, the last step of this exercise is to consider exactly how you intend to follow up on the two goals you just specified. What strategies will you use for accomplishing them? What tools and resources can you harness for these efforts? Consider not only approaches that have worked well for you in the past, but also new ones you could experiment with.

In the space below, record several strategies to start out with. As the weeks progress, you may well identify additional or alternate paths to goals accomplishment. But in order to make real progress on their achievement, you need to assume full responsibility for their achievement.

Q25 Thank you for completing the CCI. If you would like to share any additional thoughts on MIME Capstone Design, the communication component of this course, and/or the CCI, please enter them in the box below. Otherwise, simply enter "N/A."

Reminder: After you complete this last question,

1. Look back through your CCI to make sure you haven't missed any other questions. To get credit for this assignment, all questions must be answered.
2. Then submit your CCI and click the "OK" button to display your responses. (Remember: The various Blackboard scoring notations next to your responses have absolutely no bearing on the CCI or whether you will be credited for this assignment, so please disregard them!)
3. Finally, for easy retrieval and reference later in the course, we recommend saving and printing your CCI results (for example by using your browser's Save and Print functions or by copying and saving the results in a Word document). **In any case be sure to keep a copy of your communication goals for reference throughout the course.**

Appendix D: MIME Capstone Mid-course Communication Goals Review

In this exercise, you will review your progress on the communication goals you set in your Capstone Communication Inventory and either (a) recommit to the goals as originally written, (b) refine the original goals, or (3) set some different goals for the second half of MIME Capstone Design.

1. **List the two communication goals you specified in your CCI (still accessible on Fall Blackboard site), and briefly recount any steps you took to achieve these goals during the first 10 weeks of MIME Capstone Design.**

GOAL 1: _____

Efforts toward achievement:

GOAL 2: _____

Efforts toward achievement:

2. **For each of your goals, assess your progress thus far in the specified skill area. Then, cite any material evidence that could be used to substantiate your assessment** *(e.g., assignment grades, reviewer feedback, comparison of original/revised versions of report sections, etc.)***.**

   OR, if you feel you did NOT make demonstrable progress on the goal, why do you think that is? *(For example, did you perhaps forget to work on the goal? Was it too broad or ambitious? Was it irrelevant to course assignments? Other reasons?)*

GOAL 1

Self-assessment of progress made: _____

Material evidence of your progress on the goal, or reasons for lack of progress on this goal:

GOAL 2

Self-assessment of progress made: _____

Material evidence of your progress on this goal, or reasons for lack of progress on this goal:

3. **Since establishing your CCI communication goals last term, have you noted any other issues with your writing or presentation skills that you might prefer to focus on during the coming term?**

4. **Based on your responses to the previous questions, choose from the following options to identify your intentions for the second half of Capstone Design.**

   — During the second half of Capstone Design, I will continue working on both of my existing goals as originally written.

   — I will refine one or both of my original goals in order to make them more specific, achievable, and documentable during the second half of Capstone Design.

   — I will change out one or both of my original goals in order to focus on another set of report-writing or oral presentation skills during the second half of Capstone Design.

5. **Complete this exercise by recording the two communication goals you plan to pursue in ME/IE 498. (At least one should relate to report writing.)**

   Additionally, name at least one strategy you plan to use for pursuing each goal and at least one form of evidence for demonstrating your efforts and progress in that area.

   *Remember: Both goals must focus on improving a **specific** aspect of your report-writing and/or oral communications skills.*

   GOAL 1: _____

   Strategy/ies for achieving GOAL 1 in ME/IE 498:

   How do you expect to document/demonstrate your progress on this goal at the end of the term?

   GOAL 2: _____

   Strategy/ies for achieving GOAL 2 in ME/IE 498:

   How do you expect to document/demonstrate your progress on this goal at the end of the term?

Appendix E: 2013-14 MIME Capstone Experience Memo

To assess your growth as an engineering team member and communicator during MIME Capstone Design and to aid us in future course planning, compose a succinct 1–2-page formal memo responding to the questions posed below. Submit the memo on Blackboard in either Word or PDF format. Use the following as the memo header:

To: J. Calvo, J. Parmigiani, and T. A. Robinson
From: *Your name and project team #*
Re: 2013–14 MIME Capstone Experience Memorandum
Date: *Date of memo submission*

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1. **Communication skills development**
   After reviewing your CCI (available on Blackboard) and mid-course communication goals review (returned to you on 2/24), assess the progress you made on your CCI personal communication goals and note any other areas in which you have progressed as an engineering communicator during this class.

2. **Teamwork skills development**
   Assess the collaborative aspect of your project experience by addressing the following questions:
   - How have your skills as a project team member improved during MIME Capstone Design?
   - What teamwork challenges did you encounter while completing your design project and how did you overcome those obstacles?
   - To what uses did you put the team charter (e.g., for setting the tone for team collaboration, preemptively addressing potential sources of conflict within the group, enforcing agreed-on policies and procedures, and/or other purposes?

3. **Professional development beyond MIME Capstone Design**
   Based on what you have learned in MIME Capstone Design about yourself and your current strengths and limitations as a practicing engineer, what two or three goals would you set as the most important "next steps" in your professional development? Please be concrete and specific in your response. This question is included as much for your benefit as for ours.

4. **MIME Capstone Design as a culminating experience**
   By definition, a capstone design experience involves knowledge and skills acquired in earlier course work. To verify this linkage in your MIME 497–98 experience, please list any prior engineering courses that helped position you for success in your capstone project, noting the specific area(s) in which each of those courses prepared you. (To refresh your memory on names or numbers of previous engineering courses, refer to the IE, MfgE, and ME listings at http://mime.oregonstate.edu/academics/courses

5. **Course infrastructure vs. project experience**
   Separating out the two aspects of MIME Capstone Design (infrastructure and project) for a moment, which infrastructural elements of this course (e.g., design lectures, project website, status reports, communication sessions, ethics presentation etc) did you find the most and least useful, and why? On a scale of 1 (low) to 10 (high), how would you rate your design project experience, and why?

6. **(Optional) Any other feedback on the MIME Capstone Design experience that you might like to offer**