AC 2008-1477: A NEW ENGINEERING COMMUNICATIONS COURSE BASED ON A PROFESSIONAL COMMUNICATIONS PROCESS

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A New Engineering Communications Course Based on a Professional Communications Process

Abstract

Given the nationally recognized need to improve engineering students' communication skills, a new engineering communication course was developed by the Industrial and Manufacturing Systems Engineering department at Iowa State University and offered in the Fall of 2007. Initial assessment results provide insight into student learning needs related to specific professional communication skills. The course is characterized by a high degree of interaction and formative assessment of students along with a unique core professional communication process consisting of (1) Analysis, (2) Formulation, (3) Creation, (4) Delivery, and (5) Assessment. Students participate in multimodal communication exercises that require ongoing practice and application of this process. This paper describes why the course was developed, the premise of the course, course content and logistics, examples and assessment of student work and perceptions, and future plans for long term impact and course/curriculum assessment.

Introduction

Since 2000 when ABET identified outcome item (g) [*students will have an ability to communicate effectively*], academia has increasingly formalized its concurrence with industry that effective professional communication skills are necessary for the successful engineer. [1] As Shuman et al. have described, the set of ABET outcomes can be divided into "engineering" skills and "professional" skills, with professional skills including not only communication, but teamwork, ethics, professionalism, engineering solutions in a global and societal context, lifelong learning, and a knowledge of contemporary issues.[2] ABET prioritized these professional skills as relatively equal in importance to those of technical competence in its Criteria for Accrediting Programs, and in doing so, made it possible for engineering programs to not only recognize the importance of professional skills, but to teach them to their students. ABET's decision to formalize this priority reflects what industry has been emphasizing in its recruiting and advising for many years. Companies such as IBM and Boeing describe communication skills explicitly as a "foundational competency" and a "desired attribute of an engineer" respectively. [3, 4] Toyota and 3M list qualifications for engineering positions including "excellent oral, written, reporting, and problem solving skills" and "excellent interpersonal, oral and written communication skills," respectively.[5, 6] Recognizing the need to improve communication skills, educators have examined different approaches to increase communication skill emphasis in engineering courses and curriculums. [7, 8]

Programs that emphasize communication often identify the need for more "practice" or varied forms of practice for both written and verbal tasks, including portfolios, reports, email, presentations, etc.[7, 8, 9, 10] Yalvac et al. describe how an engineering course was redesigned to promote advanced writing skills by adding writing exercises based on the VaNTH taxonomy of core competency skills in writing.[11] Many educators and institutions recognize the value of increasing communication emphasis in a longitudinal manner throughout a student's academic program.[12, 13] While this emphasis is significant and necessary for developing efficient and effective engineering graduates, increased "practice" time and/or varied assignment formats are

not sufficient by themselves to accomplish this goal. Just as a successful engineering design is achieved through systematic application of the engineering method, effective communication is likewise achieved through the consistent application of a systematic process. The absence of instruction on the communication process severely limits students in their ability to understand how they must communicate to be effective.

While some engineering and business communications courses include discussion about analysis (e.g. Tranquillo and Cavanaugh; Norback, et al.) and formulation (Turns and Lappenbusch; Lord) for effective communications, most courses emphasize only the creation and delivery aspects of the process.[9, 14; 12, 15] There is evidence that some courses incorporate dialogue or feedback with and between students that might include the assessment process, i.e. the students checking for shared meaning, but the use of this process is never stated. For instance, Lengsfeld et al. describe peer editing workshops as part of their communications course including, "Engineering faculty help students develop complete and technically correct information, while English faculty help teams create concise yet persuasive arguments."[16] Mankin generically refers to a communication process, suggesting that "a good presentation does not necessarily indicate learning of the communication process."[17] In the paper, "What do Engineers Do?" Whittaker and Eschenbach note how important communication activities are to the engineer. They state that "It is not calculation or computing that engages engineers; rather it is a continuous round of conversations, phone calls, meetings, letters, site visits, quick words exchanged in the halls; it is correcting drawings, plans and specifications so that *they accurately communicate the engineer's intent* [emphasis added]."[18] To address this concern – the need to check for communicated intent – we have defined a complete professional communication process as the Engineering Information Exchange Process (EIEP) as described in Figure 1.

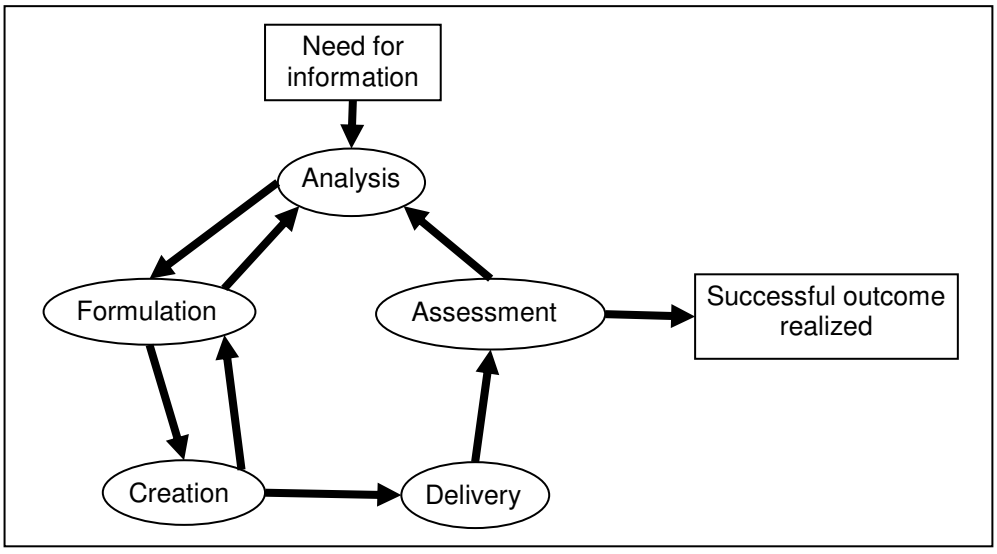

Figure 1. The Engineering Information Exchange Process

This process includes *five* critical steps. They are 1. Analysis; 2. Formulation; 3. Creation; 4. Delivery; and 5. Assessment.[19] A survey of numerous course descriptions and papers from

across the U.S. revealed that many courses include assessment *of* students by their instructors, peers, industrial partners, etc.[10, 17, 20, 21, 22] Tranquillo and Cavanaugh discuss the usefulness of revision in writing and self-reflection on presentations.[9] Likewise, Gunn describes courses that require multiple drafts of written assignments and the use of checklists by students to "check what they have done."[8] The VaNTH Communications Taxonomy includes the step "Get user (reader) feedback and revise."[23] Many educators discuss Bloom's taxonomy for cognitive learning, for which the highest level is classified as evaluation.[10, 20, 24] However, helping students learn to assess their own communication in a formal manner is not being addressed using current approaches. To accomplish this, students must be taught to assess themselves *immediately* after information exchange, and then *ask, answer, and determine the next immediate step* as a function of the question: was this communication demonstrably successful? Assessment must be included in the communication process as both the end *and the means to the end*. Jacquez et al. loosely compare the writing process to the engineering design process and discuss the use of writing "as a tool by which the individual creates meaning from experience, i.e., context."[10] However, they do not describe the cycle of assessment and improvement that must be conducted to achieve Lane's concept of communication as "shared meaning."[25] It is our contention that without checking for shared meaning, the student cannot complete the communication process. Students must be taught to develop criteria for evaluating shared meaning in each communication event, check for understanding after each communication event, adjust if necessary, and incorporate improved ways of sharing meaning in both immediate and future communication. This assessment step is a key part of the communication skill set.

Given the recognized need to improve communication skills by the engineering education community as well as curriculum assessments of our industrial engineering (IE) program (described by Potter, et al.[19]), we have developed an innovative communication course to address the skills gap. In this paper, we describe the new course and present assessment results from the first offering of this course during the Fall 2007 semester, including skill assessment, self-efficacy data, and qualitative feedback from students. Examples of student work and assessment processes are included. Finally, we describe short term changes to the course and long term impact expectations.

Course content and logistics

A new experimental course called Industrial Engineering Professional Interactions was offered through the Industrial and Manufacturing Systems Engineering (IMSE) department during the Fall 2007 semester. The 3-credit course was approved as a substitute for the regular speech communications course (which all IMSE students are required to take). The course format included three hours of class time per week (two 80 minute meetings), with a significant amount of those three hours serving as recitation time. The course is instructed by an IMSE faculty member and a graduate teaching assistant (TA) from the English department, with an undergraduate TA from the IMSE department managing logistics and resources. The IMSE faculty member and graduate TA from the English department worked together to develop the course plans and assessment activities based on the EIEP. Two textbooks were used, including *Business Communication: Process & Product 5th ed* by Mary Ellen Guffey and *Introduction to Engineering Communication* by Hillary Hart.[26, 27] Prerequisites for the course included 2nd, 3rd, or 4th year standing, and passing grades in the university's first-year composition courses,

equivalent transfer credits, or test-out credit for first-year composition. In addition to this, students could not be currently enrolled in or have previously taken the senior design capstone course. During Fall 2007, six male sophomore students with three different cultural ethnicities took the course; two of these students were non-native speakers of English.

By design, the new course was highly interactive and provided students with ample opportunities to demonstrate their ability to communicate in a variety of forms. Students completed multiple written and spoken assignments, with grades based on both individual and team efforts. The weighted importance of these assignments and tasks is shown in Table 1.[28]

Table 1: Assignments and their weight for overall grading

Basis for grading	Assignment/Event	Weighted percentage of grade
Individual	Exam #1	12.5%
Individual	Exam #2	12.5%
Individual	Email	5%
Individual	Mechanics	10%
Individual	Elevator speeches	15%
Individual	Other assignments	15%
Group	Capstone paper	7.5%
Group	Capstone presentation	7.5%
Group	Proposal paper	7.5%
Group	Proposal presentation	7.5%
	TOTAL	**100%**
Individual	Professionalism Evaluation	+5/-8%
Individual	Peer Evaluations	Up to 1/3 of a final letter grade

Lecture topics beyond the communication process included topics such as non-verbal communication, business and cultural etiquette, negative messages, data presentation, and constructive feedback. Exams required students to demonstrate internalized understanding of the communication process and how it impacted and/or was impacted by the many other topics discussed. Multiple email, agenda, mechanics, process, letter, presentation slide, and resume assignments were made throughout the semester. Likewise, elevator speeches were required multiple times with varying degrees of preparation allowed. Two formal group project papers and presentations were also required, providing team practice as well communication practice. In this way, written, verbal, and non-verbal skills were all practiced within the construct of the EIEP. Every assignment was based upon an understanding of and the use of the EIEP. For each paper and presentation, students were assigned the task of analyzing each need in terms of expected outcome, audience, and assessment for achievement. They were often given formulation requirements, but they had to synthesize these requirements with the desired outcome for any given assignment. Instruction was provided for creation and delivery, but the major focus for all assignments was the beginning and ending of the communication process: what needed to be accomplished, what stakeholders were present and what their needs and expectations would be, how to know if communication had been achieved (i.e. shared meaning), and determination of subsequent action depending on communication success. Appendices 1 and 2 show the questions that students were asked to address about each communication event

(analysis before each event and assessment after each event); students addressed these questions in writing, in small group discussions, and in classroom presentations. In addition to these assignments, students also addressed questions related to formulation, creation, and delivery which are not included in this paper.

While instructor evaluation of the students' ability to assess whether or not a communication exchange was successful was not graded as part of each communication event, it was an instrumental component of every discussion and was included in the overall assessment of each student's performance. An example of one assessment rubric used for elevator speeches (which served as both an 'end' (a grade on a given assignment) and a 'means to an end' (part of the on-going conversation, "Did you communicate what you intended to communicate?")) is shown in Table 2. The rubric grade addressed both content and delivery, because both are essential for shared meaning (timing, pace, enthusiasm, and non-verbals are essential qualities for getting a message to an audience; ignoring them means creating unnecessary barriers/resistance and preventing a successful exchange of information). The rubric then provided talking points for students to assess through conversation with the instructors and other students, and through written reflection, the information they had communicated and the barriers they had created which prevented their message from being shared completely and/or correctly.

Table 2: Elevator speech rubric which served as an assessment *of* the students as well as part of the assessment process *by* the students*

Name	Excellent	Good	Needs Some Improvement	Needs Major Improvement	Unacceptable	X %	Points Possible	Points/ 100
	100% ≥X≥90	90% >X≥80	80% >X≥70	70% >X≥60	60%>X≥0			
Content	1*		6*		11*		20	
Timing	2*		7*		12*		20	
Pace	3*		8*		13*		20	
Enthusiasm	4*		9*		14*		20	
Non-Verbals	5*		10*		15*		20	
Total Score								

*Where criteria achievement levels are defined as:

1. Content is clear, concise, appropriate, and logical. Information flows naturally with no rambling and no topic-skipping. Delivery is professional.
2. 1:00-3:00 minutes long; a good elevator speech has a definite length and isn't too short or too long.
3. Pace is not too rushed or too slow. Speech should sound conversational.
4. Speaker is enthusiastic about topic and energetic. Behavior and tone in voice are convincing and confident. Speech is memorable.
5. Non-verbals convey confidence and enthusiasm. Eye contact is solid, physical stance is confident, handshake (if appropriate) is well-executed. Non-verbals convey ease, appear natural, and support conversational tone. Mannerisms are professional.
6. Content is generally appropriate and delivered in a logical manner, but possibly one or two disjointed thoughts. Slight bit of rambling or choppy delivery.
7. 3:00<x<4:00 minutes long; you don't want to go on too long or you will lose your audience's attention.
8. Pacing is occasionally too fast or slow; pacing is uneven, but generally professional.

9. Speaker demonstrates basic competence when speaking, with rehearsed verbal and non-verbal aspects of presentation.
10. Mannerisms are generally professional, with one or two minor distracting non-verbals. Some eye contact but not consistent. Stance is generally okay, but some nervousness with shifting weight, etc. Handshake reasonably well executed but could be polished.
11. Inappropriate content for the situation. Delivery stilted, choppy, or a string of random thoughts provided in a rambling manner. Content and/or delivery is unprofessional.
12. x<1:00 or x>4:00 minutes long; too short is as bad as too long. If you don't have much to say, people will assume that you don't know or don't care.
13. Pacing is distracting; fast pacing that is notably difficult to follow, slow pacing that is tedious and makes concentration difficult.
14. Speaker is unenthusiastic, negative, or apathetic; speaker is visibly nervous to the point of distraction.
15. Non-verbal performance is consistently poor, conveying nervousness or poor preparation. Eye contact is almost non-existent. Stance is very nervous and/or closed. Handshake not firm, too long, or awkward.

In addition to emphasizing the communication process, unique contexts for assignments were also built into the course. For the capstone paper and presentation assignments, communication students worked directly for students in the senior capstone design course. The communication students accompanied the capstone design students on their initial industrial partner plant visit, and then generated useful information for the capstone design students regarding senior design projects. This exercise provided another opportunity to check for shared meaning. While it is not realistic for a student who has made a presentation to 29 senior design students to go back to each audience member individually and check for shared meaning, the senior design students were asked to provide constructive feedback on content (and the communication students provided the senior design students with feedback on the value of their critique). In this way, an exchange of constructive criticism between the two groups of students was facilitated, providing both with a better understanding of their success using the communication process.

Another unique aspect of the course was the solicitation and use of an industrial partner communication library. The library consists of working templates and examples of documents from various stages of the engineering process (from planning, through design, implementation, and testing, to project turnover) provided by members of the IMSE industrial advisory council. Some of the media forms include email, presentation slides, standard operations sheets, production studies (safety, quality, and capacity), meeting minutes, and internal memos. The library was used throughout the semester to generate homework assignments, exam questions, and discussion for lecture topics. For example, during the data presentation discussions, students were given real part production and forecasting data as presented and used by the industrial partner and asked to analyze it. This required them to consider all of the steps of the EIEP. They then emailed their analyses to an IMSE faculty member (other than their instructor), and discussed their results with him by conference call. These tasks gave them practice with the process, instruction on good data presentation, exposure to the challenges of communicating by phone/conference call, and provided a very interesting discussion on non-verbal communication.

All assignments throughout the semester were provided in a similarly concrete industrial engineering context, and many of them came directly from this library of "real world" examples.

Students' communication skills were evaluated both pre- and post-course. Written skills were assessed for qualities such as mechanics (punctuation, grammar, transitions, etc.), purpose, tone, clarity, etc. Presentation skills were assessed for qualities such as content, timing, pace, enthusiasm, and non-verbals. Intake data included an English mechanics skills pretest, an email introduction by each student of himself, an impromptu speech by each student introducing himself, and an impromptu written paragraph in which each student assessed his presentation. Initial surveys were also administered asking the students to score their skills, confidence, and enjoyment with respect to communication. Outtake assessments were made of planned and impromptu written prose, process internalization, and mechanics. Post-surveys were administered on skills, confidence, and enjoyment. Finally, ABET/IMSE outcome items (f) [an understanding of professional and ethical responsibility], (g), (i) [a recognition of the need for, and an ability to engage in life-long learning], and (p) [be able to provide leadership in multi-functional teams] were evaluated at the end of the semester using departmental assessment rubrics.

Results for Fall 2007 offering

Given the small number of students in this first offering of this course, the assessment results cannot be generalized, but they provide insight into student performance. Data from future offerings will help clarify the scalability of these results. The degree to which the low ratio of students to instructors contributes to improved student performance is unknown. The assessment data also provides an indication of potential value. Had the results of this six-student study been indifferent or negative, there would have been no need to offer the course a second time.

Written skills were assessed at the beginning, midpoint, and end of the semester, and focused on two types of assessment instruments: line item tests designed to assess students' knowledge of and ability to apply basic rules of grammar and usage in isolated sentences ("Place commas, as appropriate, in the following sentences") and freeform editing and composition tests designed to evaluate students' ability to complete writing tasks in practice. Pretest results suggested that students knew many of the rules of good composition: they successfully identified and corrected 73% of punctuation errors, 83% of usage errors, and 96% of tense/number agreement errors. However, students had difficulty applying that knowledge to editing and composition tasks: the average incidence of errors in their freeform written samples was 4.5 per 100 words, with an even distribution of errors in punctuation, spelling, syntax, usage, and register. (To place that result in context, the university's advanced composition manual, prepared by the English Department for use in upper-division composition courses, recommends grading penalties for student work with more than one major error per 100 words.)[29]

Over the course of the semester, students were provided with "Grammar Minute" workshops covering both orthographic correctness (punctuation, syntax) and principles of good composition and shared meaning creation (organization, structure, information choice, and transition/argumentation). These workshops were reinforced with assignments that required students to develop and exercise an editorial awareness of correctness and composition issues in

practice: for example, students were asked to identify the grammatical rule governing placement of each punctuation mark they included in certain assignments, or to identify, explain, and improve transitional elements in their own work and that of their peers. By the end of the semester, students had improved in their English mechanics skills, most dramatically in the correct use of punctuation: on average, students identified and addressed 92% of punctuation and usage errors on a grammar test, and displayed an average of 1.16 errors per 100 words in a 300-word freeform text. All students also displayed improved attention to register, idiom, and the ability to prioritize and organize information in written text.

Verbal skills were assessed frequently during the semester by classmates, instructors, 1st and 4th year students, IMSE faculty, and outside faculty. Video recordings of elevator speeches were made several times throughout the semester, and direct comparisons were made of speeches during the first and last weeks of the semester with students asked to assess each others' performance, both in terms of speaking skill and in terms of meaning creation. To a student, improvements were seen, though in different ways for each individual. One student was able to eliminate a significant number of filler words from his speech, reducing the incidence rate from approximately 6-7 per minute to 0-1 per minute. Another student improved his dynamics dramatically and went from an initial speaking voice that was very difficult to hear from mid-room to a fully projected voice that could be heard from the back of the room. Two students considerably improved the content organization of their speeches, going from disorganized and only moderately useful to well-thought out and appropriate content. All six students improved dramatically from a confidence perspective. They moved on a continuum from "very awkward" to "owning the floor."

One of the non-native English speaking students expressed concern early in the semester about his English skills and asked where he could get additional help with written and verbal tutoring. He was directed to two resources on campus: the writing center and the Intensive English program. Significant improvements were observed in both his written and verbal skills throughout the semester. At least some of that improvement came from the knowledge he gained and the practice time he had in the course. Some of his improvement was also attributed to his use of additional outside resources, which he sought after being motivated by the course.

As described previously, students completed many assignments that required multiple revisions. One of these assignments was writing their resumes. One example of clear improvement is seen by comparing Figures 2 and 3. Both figures are verbatim from the "Work and Leadership Experience" section of a single student's resume; Figure 2 represents "iteration 1" and Figure 3 represents "iteration 2."

Work and Leadership Experience	
LG Fence	Blue Valley West Basketball
4/2007-present, Owner	Summer 2007, Junior Varsity Coach
Performed scheduling, estimates, repairing and staining/resealing jobs	Performed all coaching, scheduling, and worked at summer camps

Figure 2: Example of one student's "iteration 1" work and leadership experience on his professional resume

Work and Leadership Experience
Owner-LG Fence. Summer 2007
Started fence maintenance company with another employee working directly beneath me. Significant restoration and staining done on over ten homes. Performed all estimates, purchasing and labor.

Basketball Coach- Junior Varsity Blue Valley West Basketball, Summer 2007
Coached 24 boys split into two teams at 20 league games and four tournaments in the Kansas City area. Scheduled practices and tournaments. Mentored over 60 boys at summer basketball camp.

Server-Jose Pepper's, Summer 2006
Served patrons of local Kansas City restaurant. Awarded for outstanding service by Jose Pepper's Corporate Group. Learned valuable lessons in teamwork, responsibility, and customer relations.

Figure 3: Example of same student's 2nd iteration for work and leadership experience section of his professional resume

While improvement opportunities still exist, it is our opinion that the 2nd iteration of this resume is significantly more useful than the first. The second iteration includes numbers that indicate the order of magnitude of this student's efforts and responsibilities, relevant qualitative information such as being recognized by his employer and learning valuable communication skills while on the job, and stronger attention to the persuasive rhetorical purpose of a resume. The improvements to this resume were made by the student after conversation with instructors and fellow students about the potential audience, what the audience might prefer to see on a resume, what the student wants to convey through his resume, and how to best accomplish these things. In a typical communications course, assessment of the initial resume would have been made by the instructor and the process for learning would have been "complete." In this course, constructive feedback was provided by multiple audiences and the student was asked to consider whether or not his communication attempt was successful, evaluate which aspects were and were not successful, and improve the whole in a second iteration. The student was then provided feedback a second time and encouraged to continue the process of assessment and improvement.

As a final example of task application and its results, three verbatim iterations of an "introduction" section of a proposal assignment are shown in Appendices 3-5. Using the same application of the EIEP to engage teams of two students in assessing their own work and making changes based on their assessments, we saw improvement demonstrated in many ways, including content relevance, transitions, flow and tone, and mechanical correctness. Again, while more improvement is possible, the gain in understanding and application appears to be very significant.

Pre- and post-surveys were given to the students with the intent of capturing any change in their self-efficacy as a result of the course. Survey questions were divided into four categories: belief in skill sets, confidence in application, perceived use of a systematic communication process, and enjoyment associated with communicating. The average scores as self-reported are shown in Figure 4.

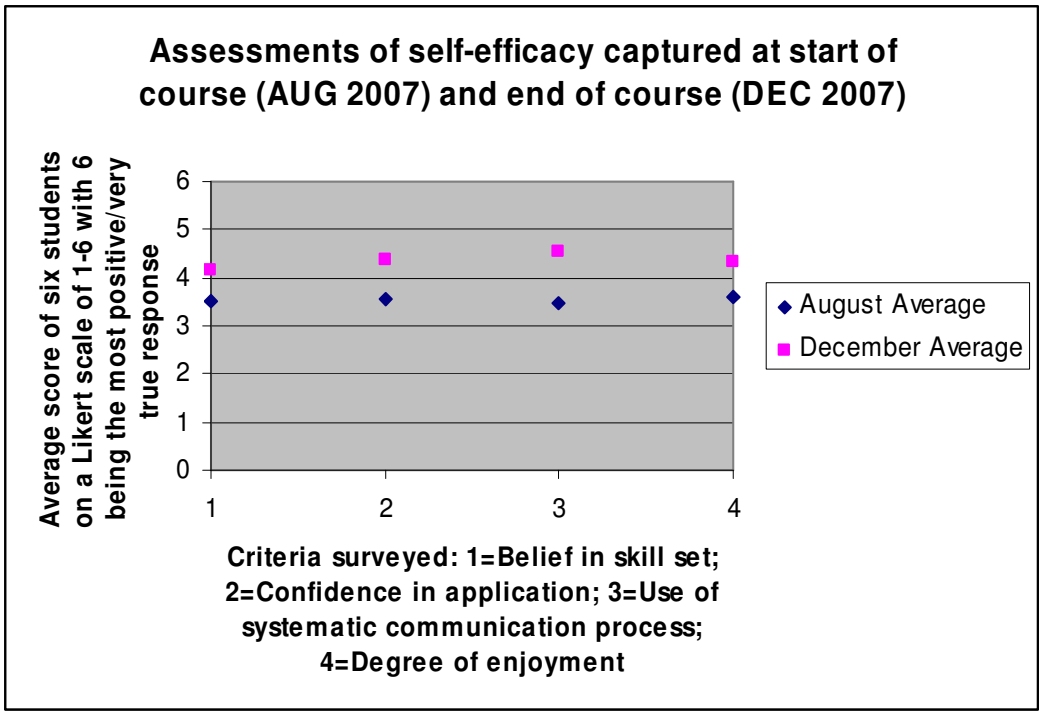

Figure 4: 'Before' and 'After' average self-efficacy scores as reported by experimental engineering communications course students

On average, the group of six students reported higher self-efficacy for all four categories of survey statements. Several of the questions had increased average scores of greater than 1 point on a Likert scale of 1-6. These specific statements are shown in Table 3.

Table 3: Self-efficacy statements with average score increases of more than 1 point over the duration of the course

Statement	Category	Avg Score Aug '07	Std Dev Aug '07	Avg Score Dec '07	Std Dev Dec '07	Δ Avg
Rate English prose skills (1=lowest, 6=highest)	Belief in skill set	3.17	0.75	4.50	0.55	1.33
I am confident about speaking in small groups (2-10 people) (1=Not at all true of me, 6=very true of me)	Confidence in application	3.83	1.17	5.33	0.52	1.50
I understand how to evaluate the success of my communications (1=not at all true of me, 6=very true of me)	Perceived use of systematic communication process	3.00	1.41	4.80	0.45	1.80
I analyze my audience before I communicate (1=not at all true of me, 6=very true of me)	Perceived use of systematic communication process	3.17	1.33	4.40*	1.14*	1.23
I organize my thoughts before I begin communicating (1=not at all true of me, 6=very true of me)	Perceived use of systematic communication process	3.83	0.75	5.00	0.71	1.17
*=sample size of 5 instead of 6; item wasn't answered by one student						

We note that every one of the twenty items surveyed showed improvement for the aggregate. Additionally, large changes were seen for individual students who provided us with identifying information. Significantly, one individual scored 3 for two of the "degree of enjoyment with respect to communications" statements (I enjoy writing=3; I enjoy speaking=3). The use of a 6 point Likert scale allows us to label these attitudes as negative. At the completion of the semester, this student scored these two questions both positively (I enjoy writing=4; I enjoy speaking=4). A course that can contribute to changing the attitudes of students about tasks that they have previously viewed negatively can have a profound impact on a curriculum.

Students were asked at the beginning of the semester to rate their personal satisfaction with how their Industrial Engineering undergraduate education has helped them with each of the ABET outcome items (a-k) and an additional five outcome items (l-p) specified by the IMSE department (Likert scale of 1-5, with 1=not satisfied at all and 5=very satisfied).[30] A list of outcome items (a-p) is included in Appendix 6. At the conclusion of the semester, students were asked this same question as well as how helpful this course has been for increasing their ability to accomplish each of these same outcome items (Likert scale of 1-5 with 1=not at all and 5=extremely well). For all but two of the outcome items, increases were seen in the students' perception of the value of their IE undergraduate education, indicating that the course, as part of their Fall 2007 semester classes, had a mostly positive impact. The average score for the aggregate increased from 3.25 (std dev=0.86) to 3.78 (std dev=0.77). Three outcome items saw increases of greater than one point. They are shown in Table 4. The two outcome items that saw decreases over the semester were (e) *identify, formulate, and solve engineering problems* and (i) *recognize the need for and to engage in life-long learning* (Δ=-0.50 and -0.17 respectively). This impact is interesting and will be addressed during the Spring 2008 semester. We do note that

one student commented on the difficulty of making this judgment since he had completed so few IE courses to date.

Table 4: Average personal satisfaction scores for how the IE undergraduate education has helped accomplish outcome items – changes of >1 point shown

ABET/IMSE Outcome item	Avg Score Aug '07	Std Dev Aug '07	Avg Score Dec '07	Std Dev Dec '07	Δ
(d) function on multidisciplinary teams	2.83	1.17	4.17	0.75	1.33
(g) communicate effectively	3.17	0.41	4.33	0.52	1.17
(m) able to integrate engineering and business processes	2.80	0.84	3.83	0.75	1.03

This data is interpreted as a general approval of the curriculum. The six students who participated in the experimental communications course were all sophomores in the IE curriculum, and were finishing their general engineering coursework (calculus, physics, etc.) as well as taking their first IE classes during the semester.

For the survey question, "How helpful has this course been for increasing your ability to accomplish each of these outcome items?" (1=not at all, 5=extremely well), the student responses indicated an interesting difference of opinion between themselves and the faculty. Students rightly evaluated outcome items as being impacted in varying degrees by this specific course. Comparing the course impact to the curriculum as perceived at the end of the semester, students indicated that (f), (g), (h), (j), (k), and (p) were more heavily impacted by the course than their curriculum-to-date. Prior to offering the course, faculty identified outcome items (f), (g), (i), and (p) as outcomes most relevant to the course. The comparison of these outcome items perceived as relevant are summarized in Table 5.

Table 5: 'Relevant' outcome items for the experimental engineering communications course as identified by students and faculty

Perceived outcome items impacted by engineering communications course	Outcome items						
Faculty opinion at beginning of semester	*f*	*g*		i			*p*
Student opinion at end of semester	*f*	*g*	h		j	k	*p*

While students and faculty consistently agreed on outcome items (f), (g), and (p) being impacted by this course, outcome item (i) did not register with the students. This will be one of the issues that will be addressed in the Spring 2008 offering.

Besides quantitative data, extensive qualitative feedback was collected from the students. On multiple occasions, students were asked to voice and/or write about their opinions of the material, structure, assignments, etc. Feedback was overwhelmingly positive, and included comments such as the following:

- Course is great!
- The material covered and gone over greatly improved my communication skills as a whole.
- I feel I was pretty good at this [knowing the audience and preparing to speak with different people] before, but I know this has improved greatly.
- It was more work than my friend's SP212 [regular speech communications course], but it was much more helpful.
- I became more confident at speaking, but also how to apply engineering problem solving techniques to communication.
- A better understanding of the entire communication process.

Short term changes and long term impact

Based on the initial results from the Fall 2007 offering, several short term changes were made to the course. Because the content offered in the initial course proved to be very effective, these changes were all fairly minor. An even stronger emphasis on analysis and assessment as part of the professional communication process was built into the syllabus. This was accomplished with formal revision cycles for both written and verbal assignments. The use of revision cycles requires the students to ask, "Was I successful in communicating what I intended to communicate?" and if the answer is "no," it requires them to adjust and incorporate. In addition to this, a requirement for students checking for meaning after communication delivery will be implemented in various assignments. Some changes were also made regarding classroom management logistics so that an emphasis on individual elevator speeches could be continued and yet provide scalability of the course material. Several assignments were slightly altered to facilitate more granular data collection for the areas deemed especially important to evaluate. The impact of the course on outcome item (i) will be addressed in the Spring 2008 course through increased emphasis on student achievement throughout the semester.

Long term impact will be evaluated at the completion of the second offering of the course. Its viability within the IMSE curriculum will be assessed by the faculty, and will essentially be a cost/benefit analysis. The course as currently configured requires significant overhead. Whether or not the cost of this course is worthwhile will be determined by comparing the expense of teaching it to both the perceived and actual benefits reaped from offering it. If by taking the course students are improving their communication skills and companies perceive that student communication skills have improved, then benefits may outweigh the costs. This will be initially evaluated at the conclusion of Spring 2008, with short term recommendations to the IMSE department made at that time. Not until all of the communications students have completed the capstone design course, however, will the full long term impact of this course be known. At that time, comparisons of ABET rubric assessment data will be made between students who took the experimental communication course and those who took the regular speech communications course.

Conclusions

Though the sample size was very small, student communication skill levels increased by the end of the new communications course. Particular attention was paid to the increase in verbal skills, resumes, and the general ability of students to share meaning through coherent, cohesive messages. All students in the course demonstrated measurable improvement in these areas and others, such as the correct usage of punctuation. We believe that these measurable improvements are directly related to two things:

- The instruction of a complete professional communications process (the EIEP), and
- The rigorous and repeated use of this process by students to analyze and assess their communications and react accordingly.

Besides demonstrating skills improvement, all of the students responded positively to the course in terms of confidence and attitude, despite the demanding workload.

The second offering of the course during the Spring 2008 semester will provide significantly more data for evaluation of the course validity and impact. Currently fifteen students are taking the course, ranging in seniority from 1st to 4th year students. This group of students will be assessed by the instructors using the same methods as during Fall 2007. All students from both semesters will be tracked through capstone design, and comparisons of communication skills will be made with students who took the regular speech communications course.

It is recognized that the small sample size does not support generalization of the results and that the low student to instructor ratio, while necessary to facilitate our data-collection method, also makes it difficult to conclusively differentiate improved student performance based on internalization of this experimental pedagogical model from improvement derived from increased contact with and feedback from instructors. We view the results and the success of this course as a whole – in terms of content, logistics, and outcomes – as a means by which recommendations will be made to the department about successful ways to incorporate communication skills, and particularly analysis and assessment skills, into the curriculum.

Based on these outcomes, the course could be adopted into the IMSE curriculum and required for all IE students. It could be added as an alternative for students who would prefer an engineering-focused communications course to the general, university-wide speech course. The course content, assignment format, and method could be disseminated and incorporated into other courses throughout the curriculum. Whatever decision is made, the results of this experimental course will be shared with the college of engineering so that other departments can learn from this experience and utilize the knowledge gained as it fits into their own sets of objectives. Final results will be reported after the completion of the second offering of this new course.

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Appendix 1 – Analysis checklist

IE320X ANALYSIS FALL 2007

1. What is the situation?

2. Is there a problem that must be addressed and if so, what is it?

3. What do I want to accomplish? (Remember: most communication tasks have multiple goals.)

4. How will a successful exchange affect the project or task at hand?

5. How will a successful exchange affect the organization?

6. Who is involved (peers, subordinates, supervisors, clients, vendors, public, etc? (Remember: most communication tasks have multiple participants.)

7. What are the current circumstances in play?

8. What are the existing personalities and established relationships and how do they impact this task?

9. What cultural or social factors affect this task?

10. Are there any other components to consider?

11. How do items 6-10 impact what needs to happen?

12. What barriers exist that could prevent a successful exchange?

13. What biases are present?

14. How and when should barriers and biases be addressed?

15. What time and resource constraints exist?

Appendix 2 – Analysis checklist

IE320X ASSESSMENT FALL 2007

1. What goals (from my Analysis) was I trying to accomplish?

2. What communication format did I use and why?

3. With whom did I communicate?

4. What transpired? (Describe in 1-2 sentences: How did my audience react? What was the actual outcome?

5. Did my audience get the main points? Yes / No

   - If yes, how do I know that? Based on this exchange, how can I improve future communication with this audience?

   - If no, why didn't they get the main points?

     -- What positive thing(s) happened during the communication exchange?

     -- What information DID get across to my audience and why?

     -- What should I do now?

     -- How will the next communication event be more successful (what will I do differently?)?

6. Based on the goals I established in my Analysis, was this communication successful?

7. What follow-up activities are required for this communication?

Appendix 3 – 1st iteration of student proposal introduction

Problem

There are not enough buses as well as seats on the buses available to compensate for the rise and change in density of the student population around Ames. This has caused customers to become unhappy about their Cyride experience. After our solutions are implemented, there will be increased bus and seat availability, leading to a rise in customer satisfaction.

Appendix 4 – 2nd iteration of student proposal introduction

Problem

Cyride has not been maintaining the satisfaction of the students who have moved off campus to new developments. The students of Iowa State fund Cyride and as paying customers their needs have to be met.

Cyride is one of the selling points that Iowa State has while giving visiting students a tour of campus. Having a bus system that services many areas of Ames is important to the student's that live there. If Cyride does not impress potential students then that is one less reason for them to come to Iowa State and fund Cyride. If more students come to Iowa State then Cyride will receive more funding and therefore be able expand to meet the needs of the students that are moving off campus as well as the citizens of Ames.

The new apartment complexes in Ames will be investigated and the areas that need to be serviced will be identified. Once these areas have been identified we will look at whether or not an existing route could be modified to service the area. Otherwise a new route will be drawn up to service that area. Once the new routes have been completed a new bus stop layout must be determined. New bus stops must be placed in the new service areas. In order for the buses to come into campus at convenient times old bus stops must be investigated and determine if there is still a need for them. There may be opportunity to remove an unnecessary or unused stop especially if there is another stop close by. With the new bus stop layout in place, a new schedule will be able to be drawn up based on the placement of those bus stops. The new schedule will service areas conveniently at the peak ridership times. This will allow the buses to stay on track completing the route and servicing the areas at the times they need to be.

After our solutions are implemented, the new bus routes and schedules will meet the needs of current as well as that of future student populations, leading to a rise and sustained customer satisfaction.

Appendix 5 – 3rd iteration of student proposal introduction

Introduction

CyRide is the city bus system for Ames, Iowa. It is a working partnership between the city of Ames, Iowa State University (ISU), and ISU's Government of the Student Body (GSB). CyRide exists to cater to the students of Iowa State University and also the general population of Ames. Customer satisfaction is a key driving influence on the company's success. CyRide has 10 fixed routes, as well as the Dial-a-Ride and Moonlight Express services. CyRide services approximately 75% of the city, as shown in Figure 1.

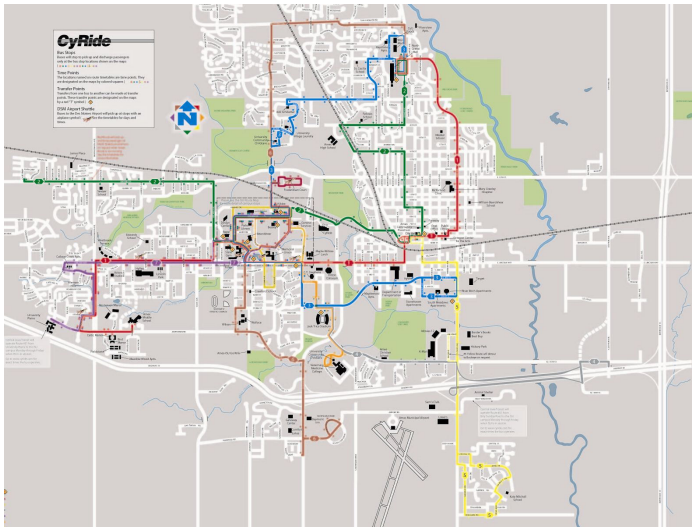

Figure 1: Fall 2007 CyRide bus routes

Their operating hours are from 6:30am to 12:30am on weekdays, with a reduced schedule on weekends. CyRide's fare for non-ISU students is $1.00, while ISU students ride for free with their ID card.

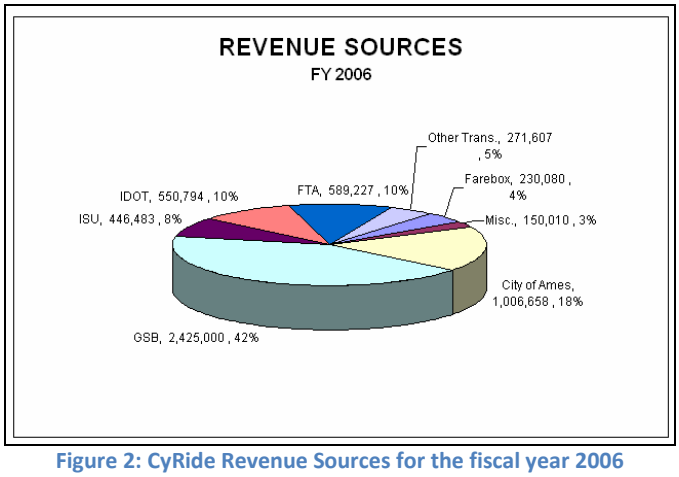

Figure 2: CyRide Revenue Sources for the fiscal year 2006

CyRide's main clientele is the student population. Recent revenue reports (see Figure 2) show that the GSB of ISU provides CyRide with over 40% of its revenue. As the GSB accounts for such a large percentage of CyRide's revenue, the needs of the students must thus be one of CyRide's priorities.

The population in Ames has been steadily increasing since the city's inception. Along with the rise in population, the density of the inhabitants too is changing. In order for CyRide to be a successful transportation provider, they must be able to adapt to these changes as they happen.

Specifically, the emergence of numerous new apartment complexes has caused changes in the density of the student population around Ames during the past few years. CyRide has not kept pace with these developments. Students, in particular, have complained about the lack of bus as well as seat availability near their living arrangements.

The typical distance between two CyRide stops is 0.25 miles. A bus runs between 10-25 miles per hour, and services 100 to 5000 people a day. There are 40 seats on a bus. Given that the students have expressed their dissatisfaction with the bus and seat availability, this implies that there are not enough buses and seats to accommodate the students.

This is a problem because CyRide's main purpose is to serve the student as well as the general population. Being unable to do so effectively negates their reason for being. If this continues, there is the potential consequence that the GSB may reduce or entirely cut funding to CyRide. This proposal details the process we will use to address these issues. Figures and information were obtained from CyRide's website www.cyride.com.

Appendix 6 – ABET and Departmental Outcome Items

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) be able to design, analyze, implement, and manage effective production and service systems
(m) be able to integrate the engineering and business processes of an organization
(n) be able to integrate processes involving people, material, equipment, information, and energy
(o) have a global perspective of enterprise
(p) be able to provide leadership in multi-functional teams