# AC 2007-2246: INDUSTRY-BASED CAPSTONE DESIGN PROJECTS: YOU CAN'T SELL THE SOLUTION IF YOU CAN'T COMMUNICATE

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## Industry Based Capstone Design Projects: You Can't Sell the Solution If You Can't Communicate

#### Abstract

Industry-based capstone design projects have been used by Industrial Engineering departments since the 1960's. The format for the project varies from institution to institution. In some cases, a course in simulation or facility layout may be the "project course", while in other institutions a separate one or two semester course may be devoted to the capstone project. One of the constant considerations in all industry-based capstone projects is the need for the project team to clearly communicate their results to the client in writing and orally. A team may have a good solution to the client's problem, but the quality of the written and oral presentations to the client may lack the professionalism that is required to convince the client of its validity. This paper presents an approach to improvement. Examples of some final presentations that have resulted from this approach are included.

#### Background

An ability to communicate effectively is ABET criteria (g.) for all programs accredited by ABET-EAC<sup>1</sup>. Managers rated the "ability to communicate ideas and plans effectively in front of an audience" as the most important career skill<sup>2</sup>. Recognizing the importance of good oral communication skills and actually putting good oral communication skills into practice are not synonymous. How often have you watched a presentation given by a professional engineer that consisted of words copied from a written report? The speaker may have included a graph or a chart, but most of the presentation consisted of words that you could read in the report. Furthermore, the presenter often turns his back to the audience and reads the screen to the audience. Although this is a common occurrence, it is not effective oral communication.

As stated by Burnett<sup>2</sup>, an oral presentation can have several purposes: inform, persuade, demonstrate, and train. These can occur separately or in combination. Every presentation should include these major points: purpose statement, outline, preview of the presentation, clear transitions, periodic summaries, emphasis and examples for particularly important points, and a conclusion that reviews the major points and indicates the preferred action of the audience. Burnett also states that "Visuals are extremely valuable during an oral presentation. Visuals that illustrate or reinforce your information can increase most people's retention by approximately 20 percent."

A review of the ASEE proceedings from the past 8 years reveals a large number of articles that address oral technical communications. Among the more significant approaches to help capstone design students become good technical communicators are the efforts at Georgia Tech<sup>3</sup> and at Utah<sup>4</sup>. Louisiana State has made a significant effort to integrate oral communications into the entire engineering college<sup>5</sup>. To support these efforts, the institutions usually employ one or more full-time staff or faculty members who are communication specialists. At smaller institutions, lack of resources may prevent engineering colleges from hiring such individuals. In

that situation, communication consultants from Speech/Communication departments are often asked for help.

Despite the availability of many published guidelines for technical oral communications, a member of Bradley's Department of Communications who is working with capstone design students in another department in Bradley's College of Engineering and Technology recently stated that she spends the first of three sessions working on an overview of their speaking skills, assisting with some basic organization and use of visual aids before their first presentation. The remaining 2 sessions are spent on organization and practice prior to each of their other two presentations<sup>6</sup>. These sessions are valuable to the students, but do not result in the students having professional level presentations skills.

Capstone design course teams need go no farther than the web to find guidelines for oral presentations. A recent Google® search by the author revealed more than 1.5 million entries for "Oral Presentation Guidelines". A random sample of these reveals that most of these guidelines address the following: the need to adhere to a time schedule, to use correct grammar, to be concise, to develop good visuals and to practice the presentation. Some of the better guides do attempt to address visual information. With some examples, these could be good guides to follow. An example of such is the Oral Presentation Guidelines found on the American Heart Association web site<sup>7</sup>. This set of guidelines includes suggestions for keeping the wording clear and simple, keeping the design consistent and appealing to the eye, keeping graphs, charts and diagrams simple, and some hints for pointer use and eye contact with the audience.

All of these are good guidelines, but even following them can result in a poor presentation if the presentation is not well organized or if appropriate information is not presented in an easily understood visual form. This statement is true whether the presenter is a recently-graduated engineer or an experienced veteran. In many cases, the experienced veteran is not as good a presenter because making a good presentation requires the use of modern technology and may require the veteran to change his way of making presentations.

## **Oral Presentation Coaching**

At Bradley University, the Industrial and Manufacturing Engineering and Technology (IMET) department has approached the problem on a more personal basis by incorporating sessions on oral communications and multiple practice and critique sessions into the capstone design course. The goal has been to help the student take the results of their capstone projects and sell them to their clients. Since all projects are externally funded, the client has "paid" the department for a solution to their problem. Being able to clearly present the problem, the alternatives considered, the proposed solution, the costs and benefits, and the plan for implementation are important to both the student team and the client. For the students, the experience gained in putting a good technical presentation together is a transferable skill that they can use in their careers. For the client, understanding what the team is proposing and how to implement the proposed solution helps them solve the problem.

Although good visuals do not always result in a great presentation, having good visual information certainly makes developing and delivering a high quality presentation much easier.

Furthermore, being aware of the characteristics of a good oral presentation gives the student some idea of what components need to be improved. This paper presents the guidelines for a professional quality oral presentation that have been developed over 17 years of collaboration between the two authors: one who is the project course coordinator and the other a visual communication specialist.

Prior to the midterm presentation, the "speech coach" spends an hour going over the expectations for the midterm. His presentation covers the following topics:

- Establishing a goal/purpose statement,
- Analyzing the audience/situation
- Organizing information to be presented
- Preparing the introduction and conclusion
- Honing delivery skills
- Preparing good visual information

He also talks about the major criticisms from prior midterm presentations:

- Excessive "and" and "ums"
- Lack of eye contact with the audience
- Reading off the computer screen
- Use of informal language
- Lack of a conclusion
- Lack of adequate visual information
- Misplaced slides (good information wrong location)

The students are also given a copy of the oral evaluation form (Table 1) that is presented later in this paper. This form can be used by the students as "good presentation guidelines". By providing these guidelines, the time that might have to be spent on basic ideas for improvement during the practice sessions at the end of semester is often reduced. Each team meets with the speech coach for three 1- 1.5 hour sessions prior to the on-campus presentations. The on-campus presentations are then followed by the off-campus client presentations.

## **Practice Sessions**

In each session, the team is required to bring copies of their slides to be used by the speech coach for feedback. For each session, the team members are required to stand in front of the room and give their portion of the presentation as they will be doing in front of their clients. The first session is usually the longest and is often followed by an extensive reorganization of the presentation. The second and third sessions are usually opportunities for the team members to improve their visual material and to become more confident with the material they will be presenting. Each of these sessions is followed by verbal and written feedback to each member of the team. Slides are critiqued on a slide by slide basis in order to point out ways that the slide can be improved.

Over the past 17 years of collaboration, the authors have developed the following areas on which to evaluate presentations and provide feedback to the students. Although this process has been evolutionary and generally not rigidly structured, this paper has provided an opportunity to

develop a formal scale for providing feedback to student teams. This scale is currently being used for the 8 spring semester project teams.

What are these key concepts that will help students improve their presentations? The following table and associated point values allow teams to use the feedback to improve their presentations.

 Table 1. Oral Presentation Evaluation

	I. Organizational Considerations		
Pts.	A. Organization of material for multifaceted problems		
1	Parallel construction- covers one aspect (e.g., definition) of all problems		
	before going to subsequent aspects (e.g., analysis) of all problems		
3	Sequential construction - covers all aspects of one problem before going to		
	next problem		
	B. Organization of material		
1	Logic leap, missing steps, missing slides		
2	Some attempt at organizing material for flow/assimilation of material by		
	audience; right slidewrong place		
3	Important steps/milestones/logic included; anyone with basic		
	understanding of presentation could present this material		
	C. Presentation Organization		
1	No preview of presentation, speakers not identified, roadmap not provided,		
-	no clear introduction; problem not identified early		
2	Attempt at an overview of presentation, problem definition misplaced		
3	Good roadmap of presentation, clearly identified speakers, good attention		
	getting introduction and identification of problem early in introduction		
	II. Textual Considerations		
	A. Textual Information Presentation-Size		
1	No visual information, word wrap, more than 7 lines of 7 words,		
	sentences, font too small to see, unnecessary punctuation		
2	No sentences, extra textural information, need to cut out words		
3	No word wrap, only essential words, key words		
	B. Textual Information Presentation Amount		
1	Too much (information overload)/not enough information at once audience		
	reads ahead (need to make progressive); audience bored, too much detail in		
	information (need to round off numbers); multiple ideas on one slide		
2	Some use of progressive slides, more needed; some rounding still		
2	necessary		
3	Amount of information appropriate for ease of understanding/keep		
	audience with presenter (good use of progressive slides); one idea-one slide		
	III. Visual Material Aspects		
	A. Information (photos, graphs) Presentation-Size		
1	Hard to read/see; too small or too large		
2	Slide visually cluttered; used tables instead of graphs		
3	Photo/graph size appropriate for ease of understanding		

	B. Graph/Table
1	Important information lacking
2	Important information lost in sea of information; too much detail
3	Important information highlighted to easily target/draw attention
	C. Visual component of slide aids audience in understanding concept
1	Unrelated, distracting, unnecessary
2	Neither adds nor distracts audience; just occupies screen space
3	Value added visualassists audience in comprehension
	D. Important Aspects of Graph/Photo
1	Poorly conceived, lacks detail, too much detail/information to discern
	what's important
2	Good information, not presented in fashion for ease of assimilation
3	Important aspects easily ascertained
	E. Number of Slides
1	Less than1 per minuteslide up too long, nothing to reinforce verbiage;
	more than 4 per minuteflying through slides, not enough time to
	see/understand visuals
2	Some uncertainty of what to say about slide
3	Two slides per minute, verbiage equals screen time
	F. Slide Creation
1	Little contrast in visuals from background to text/ dark text on light
	background; poor color choices for projection
2	Some contrast in visuals; colors don't project well, wash out
3	Good contrast between dark background and light colored font; colors
	project well
	IV. Presentation Aspects
	A. Use of Language
	1 - Includes too informal/pedestrian (dudes); too ambiguous (I think, I
	feel, maybe); includes red flags (cheap little sprinkler)
2	Includes some informal, ambiguous language or red flags
3	Generally free of informal or ambiguous language and red flags
	B. Grammar
1	Improper word usage, tense, subject verb agreement
2	Generally correct usage of grammar and pronunciation, minor errors
3	Good grasp of English language
	C. Verbal presentation
1	Includes many vocalized pauses (10+); too soft to hear/cannot hear; rate
	too fast to comprehend material; too slow—boring
2	Includes some vocalized pauses (>5); volume could be louder; slow
	down/speed up a bit
3	No or few vocalized pauses (1-2); loud enough; good rate
	D. Eye contact
1	Looks at computer monitor, reads from notes, looks at, reads from screen
2	Attempts to look at audience, needs to get away from notes/reading off of
	monitor

3 Looks at audience, included everyone in audience	
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## Example slides

Slides from one of the better recent final presentations were analyzed. Compared to presentations usually given by guest speakers who are professional engineers, the first practice session presentation was already good, but was still improved significantly as a result of the practice sessions. An <u>overall</u> content analysis of the slides in the first session and the final presentation is summarized below.

	Practice Session 1	Final Presentation
Number of slides	42	34
Text Only Slides	21	3
Graphs/Tables	16	21
Photos	5	11
Ave. # words/slide	29.2	18.8
slides with text & visuals		
Ave. # words/slide	32	23
slides with text only		

Table 2. Content analysis – Practice Session 1 vs. Final Presentation

As a result of the practice sessions and feedback from the presentation coach, the slides contained more visual content and contained fewer words. The outline and summary slides were the only slides that were text only slides. The increase in the visual information and the corresponding decrease in the number of words on the slide also resulted in the presenter being more comfortable as he was not trying to read the slide or remember the exact wording on the slides.

Example slides dealing with two parts of the presentation – Current Process and Label Researchare shown below. For the Current Process, the scale developed above was used to compare slides from the first practice session with the corresponding slides in the final presentation to evaluate the effect of the feedback provided during the practice sessions on a presentation that was already fairly good.

First Practice Session	Final Presentation
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First Practice Session	Final Presentation



By increasing the visual content of the slides, the presenters were able to explain or "show and tell" and therefore did not read the slides to the audience. By decreasing the number of words on the slides and concentrating on the pictures, the presenter was also able to explain the concepts to the audience much more clearly. After the client presentation, one engineer experienced in warehouse operations stated that the three slides the team developed to explain the current process helped him to understand the warehouse labeling scheme for the first time in his 25 years with the company.

To illustrate the application of the evaluation scale, the factors defined in Table 1 were applied to the Current Process slides from the 1<sup>st</sup> practice session and the final presentation. Note: Only the <u>content</u> of the slides were evaluated. The <u>presentation</u> aspect was not evaluated for this example.

Rating Factors from Table 1	Current	Current
	Process	Process
	1 <sup>st</sup> Practice	Final
I.A – Organization – Multifaceted Problems	3	3
I.B – Organization of Material	2	3

I.C – Presentation Organization	2	3
II.A – Textual Information – size	1	3
II.B – Textual Information – amount	2	3
III.A - Information Presentation - size	2	3
III.B – Graphs/Tables	2	3
III.C – Visual Component - idea	2	3
III.D – Important Aspects of Graph/Photo	2	3
III.E – Number of Slides	2	3
III.F – Slide Creation	3	3
Totals	24	36

The changes in the presentation resulted in a 12 point or increase from 66% to 100%. Although the scores are given only for selected slides, the increase from 66% to 100% is a fairly accurate representation of the overall increase in the quality of this presentation.

## **External validation**

Does using a presentation coach and having multiple coaching sessions result in better presentations? The feedback from our clients says "yes". One of the questions on the final evaluation given to the client at the end of the project relates to the quality of the final presentation. On a scale of 1-4 where 3 is defined as "More than I expected from a team of engineering seniors" and 4 is defined as "At least as good as a professional consultant", the average score for projects over the past 5 years has been 3.9. Clients have consistently commented about the quality of the final presentation. One recent client commented that the final presentation he attended was "the best presentation he has seen in the 30 years he had worked as a professional engineer." Not coincidentally, all of the recommendations made by the team working on this particular project were implemented by the client at an annual savings of more than \$300,000.

## Summary

Being able to <u>clearly</u> articulate and <u>visually</u> present the problem, analysis, alternatives considered, recommendations, a plan for implementation and costs and benefits is the first (big) step toward selling a solution to the client. Engineers can become good communicators (and good salespersons) when they have a concept of what constitutes a good presentation and have some good coaching and feedback. A good presentation may not sell a bad solution, but a good presentation makes selling a good solution much easier.

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