Craig Gunn, Michigan State University

CRAIG JAMES GUNN Craig James Gunn is Director of the Communication Program in the Department of Mechanical Engineering at Michigan State University. In this role he directs the integrated communication program in mechanical engineering while providing help to the cooperative engineering education division of the College of Engineering. He serves as editor for the CED Newsbriefs and MCCE Co-op Courier.
Overview

With the changes in accreditation through the current ABET criteria, providing adequate writing, graphic, and speaking skills can easily become the second most important issue for engineering departments next to the teaching of the technical skills themselves. As more and more departments are seeking accreditation under the new rules, it is vital that varying methods of addressing skill acquisition be viewed. The engineering student's already extensive list of requirements, in most cases, can not be burdened with more credits, though. This creates a dilemma that can only be solved by providing communication skill instruction in as many engineering classes as are feasible within the constraints of the institution. These skills coupled with technical information create for the student an atmosphere of interest within which communication skills can easily be incorporated and emphasized. Careful planning and coordination can provide needed instruction in the communication skills within the department. These ideas are developed in a structured plan that incorporates communication instruction and evaluation into all engineering classes offered by the Department of Mechanical Engineering. The plan shows the development of communication skill awareness in the freshmen year through the senior design experience.

There will always be a need for communication skill awareness. Students seem to forget the important elements of their previous education and focus only on what they assume to be important at the time. Within engineering, the areas of mathematics, chemistry, and physics will hold a greater place than the written document or the grammatical correctness of that document. Students will need to be continuously reminded of the importance of writing and speaking in a professional manner. If those reminders are performed on a regular basis by faculty who really do influence the lives of the students, then communication will be integrated into the life of the engineer and never be forgotten.

In an earlier paper I wrote the following words.

When considering a diverse group of individuals and the issues that are most often discussed in regard to their educational development, one concern about the failure of education rears its head at almost every gathering. First and foremost is the ever present inability of our students to communicate adequately in the English language. High school graduates happily enrolled in the colleges of their choice take the full brunt of the critical axe when they fail to perform at the levels expected of them by the professors and the public alike. Engineering students fare just as badly as others in the continuous barrage of negatives on Why Johnny can't READ, WRITE, SPEAK, etc.

At Michigan State University, the required university dictated writing classes for most engineering students encompass only one semester of freshman Writing, Rhetoric, and American
Culture instruction and one term of more specialized engineering writing in the junior or senior years. After these courses in the educational structure, little or no formal training is offered or required. The Department of Mechanical Engineering decided almost twenty years ago to address the problem of communication through a change of focus from single course requirements to multiple experiences in a variety of courses.

I believe that there has been a marked change in the quality of student writing in the Department of Mechanical Engineering at Michigan State University since that decision was made. Words repeated by a number of individuals in 1987 spoke of widespread opinions in industry that the United States was graduating engineers who excelled in their technical skills but were missing many of the important skills, including being able to communicate, that were necessary for success and advancement in the industrial world. As we look at what has been accomplished over the past twenty years, we see that those earlier negative comments have been reversed by engineering departments and accreditation agencies that see the need for increased emphasis on issues outside of the focused technical material. One of the principal reasons for an increased awareness is the requirement by ABET that engineering departments address the communication skill of their engineers.

The current focus of engineering faculty and corporate leaders over the lack of communication skill expressed by engineering undergraduates has merit when we look at many of the documents produced by young engineers in their early engineering courses before they have been indoctrinated into mechanical engineering communication.

These poorly prepared documents become early examples of poor text production that is seen in the upper level engineering courses. Poor training in and attitudes toward the production of technical documents and a lack of concrete connections to the technical world in early writing classes have created a weakness in the communication system in many engineering departments. It is necessary, therefore, to address and correct this problem in any manner that will bring about improved communication skill. Many avenues have been suggested to do just this: writing across the curriculum, writing intensive courses, tutors. The list is extensive. Another method may be useful in addressing the typical problems shown in the text produced by the average engineer.

As we think about text production and the need to improve it we have to realize that the goal of any engineering course is to produce technically competent engineers. We also need to be aware that they must be able to produce written text that is free of mistakes in both the technical content and the presentation of that material. If communication skills are to be scrutinized in the engineering classroom by the engineering faculty member, it is necessary to provide information on specific areas of concern along with ways to address these concerns. By focusing on problems that are generally encountered in engineering text, the faculty member does not have to assume the role of English teacher. They become guides to better text production instead of being forced to function in areas to which they may be uncomfortable. There will only be a necessity of directing the attention of the students to a very specialized list and requiring that the student address the concerns.
Background

In the fall of 1986 Dr. Clark Radcliffe, a professor in the ME Department at MSU, addressed these needs by revamping his measurements class, ME 446, to incorporate the draft reading of student papers to judge the students' ability in technical communication skills. Students were given instruction in writing skills, available time for consultation, and extensive suggestions on how to improve their written communication. The form of their communication in this class was the formal report. This form provided practice in the writing of abstracts, introductions, analysis, results, conclusions, and the equipment and procedures needed to conduct an experiment. This class, although a senior course, was an apt place to start because it gave the soon-to-be graduating seniors a last look at their writing before they entered the world of industry.

With this course as an impetus, three more classes were targeted for technical writing skills work. The 332/333 series fluids lab classes under Dr. John Foss gave the junior engineering students a chance to look closely at the writing that they were doing in the form of memos and later in formal reports. The 422 Design Projects class emphasized the added skills needed in group work on a much larger scale coupled with the presentation skills needed to explain and champion the proposed designs.

In an effort to continue and expand this course of action, a writing class was designed in the summer of 1987 especially for and contained within the Mechanical Engineering Department. The articles read, the communications prepared, and the papers presented all contain information relevant to the mechanical engineering field. Using the format of already created writing labs, the Mechanical Engineering writing class takes the student/engineer through memo writing, letters, proposals, short and long formal reports, and presentation skills while targeting the use of language in the proper conveyance of information. Since the engineer is usually unaccustomed to writing for a variety of audiences this skill is also addressed. Quite a lot to condense into fifteen short weeks, but again it is another vital building block in an overall scheme to make writing an integral part of the engineering program.

At this point in time, though, bits and pieces were being offered to bandage a large and growing wound in the educational body. A few lab classes were servicing some of the needs of the engineering population. Committees met to discuss possibilities for the future, while students passed through the door of graduation unprepared for the massive communicative task ahead of them.

Avenues for Improvement

After investigating almost ten years of text produced by junior and senior mechanical engineering students, five common areas of concern were found to be most prevalent: the problems involved in simply beginning the production of a text, specific grammatical mistakes, difficulty in creating text that flows, awkward wording, and a lack of direction in editing. If every engineering professor made an effort to direct students to focus on these concerns, the text production in engineering courses would improve.
After receiving enough comments on communication concerns by faculty, students, and industry representatives alike, a survey was created to delve below the surface of “Can’t write/Can’t speak,” and discover what were the actual concerns of students and faculty. In this survey, faculty and students in the Department of Mechanical Engineering were asked to participate in two separate surveys on their opinions on communication. Seventeen faculty members participated, distributing questionnaires to 28 classes. The seventeen faculty completed their own survey while the students filled out their own. The two separate surveys produced a variety of interesting results, especially the similarity of concerns from both faculty and student alike. Since the surveys focused on the need for specifics and not the general attitude that “engineers can’t communicate, it was important to gain insights about where the actual concerns lay.

The principal areas of concern for both groups were the issues of grammar, punctuation, and spelling. These concerns were followed closely by lack of organization skills, unclear expression of ideas, poor verbal skills, difficulty with writing introductions and conclusions, and weak logic. The rankings for each group were as follows:

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grammar</td>
<td>Grammar</td>
</tr>
<tr>
<td>Verbal skills</td>
<td>Expression of Ideas</td>
</tr>
<tr>
<td>Organization</td>
<td>Organization</td>
</tr>
<tr>
<td>Expression of ideas</td>
<td>Support of ideas</td>
</tr>
<tr>
<td>Poor introductions and conclusions</td>
<td>Verbal Skills</td>
</tr>
<tr>
<td>Logic</td>
<td>Poor introductions and conclusions</td>
</tr>
<tr>
<td>Support of ideas</td>
<td>Logic</td>
</tr>
</tbody>
</table>

The two groups also had similar responses to the questions that dealt with how to improve the communication skills of engineers. They both felt that more written assignments with increased feedback would help immensely. This applied equally to the verbal skills where more presentations were suggested with a more concerted effort toward providing constructive feedback. Class analysis of technical papers, providing equal grading for both technical and the way the material is presented, more practice, and the teaching of presentation tools such as PowerPoint were all listed as aids to improving the communication skills of engineers. Samples of the surveys are included in the Appendix.

Departmental Changes

As the previously described survey information was collected and analyzed, required courses in the Department of Mechanical Engineering were viewed in respect to the communication skills that were being introduced or reinforced. With this investigation, the following was decided concerning inclusion of communication activities in the courses.
<table>
<thead>
<tr>
<th>Year</th>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>ME 101– Freshmen Design –planning stage</strong></td>
<td>The beginnings of technical communication in the students’ lives. Short papers related to their studies. Reviews of their abilities and reinforcement of communication as engineering</td>
</tr>
<tr>
<td></td>
<td><strong>EGR 291 – Residential Option for Science and Engineering Students</strong></td>
<td>Resumes, email, short engineering focused reports, engineering writing demands, problem solving, speaking, ethics, and orientation to the university/college/majors</td>
</tr>
<tr>
<td>Soph. Year</td>
<td><strong>ME 201 – Thermodynamics</strong></td>
<td>Student communication survey, refresher for past grammatical expertise Tools: MS Word, Email, WWW</td>
</tr>
<tr>
<td></td>
<td><strong>ME 332 – Fluid Mechanics</strong></td>
<td>Laboratory Reports: (Approx. 9 @ 4-6 pages each) Brief narrative of procedure, measured data, deduced and analyzed data, plotted results with discussion and conclusions.</td>
</tr>
<tr>
<td></td>
<td><strong>ME 371 – Machine Design I</strong></td>
<td>Short Technical Reporting Design Analysis Reports (2 @ 4-6 pp. + App., Individual); Technical Analysis, Economic Analysis, Recommendation for Action Tools: EES,Powerpoint</td>
</tr>
<tr>
<td>Junior Year</td>
<td><strong>ME 391 – Mechanical Engineering Analysis</strong></td>
<td>Reading, thinking, and teamwork Tools: Matlab</td>
</tr>
<tr>
<td></td>
<td><strong>ME 412 – Heat Transfer</strong></td>
<td>Design Project Documentation: Formal Report (1 @ 10 pp. + App., Individual) Memo Reports ( 7 @ 2 - 5 pages App., Individual) Tools: MS Word, Excel</td>
</tr>
</tbody>
</table>
Means of Assessment

Since the inception of the Communication Program in the Department of Mechanical Engineering, there has always been a great concern with providing students with every opportunity to write and receive positive and critical comments on their text production. While we do not follow all students and chart their progress through the curriculum, we do monitor the overall improvement of their collective text production. We also provide them with a multitude of opportunities to practice their communication skill and receive feedback in both written and verbal experiences.

From the earliest forms of writing that take place in the EGR 291 course, we begin to build the foundation for the competent engineering communicator. In the early days of the program, two individuals read first drafts, provided feedback, read final copy, and graded that copy. This provided a technical reading along side a reading for proper communication. As more and more courses were added to the list of classes that required written text that would be graded on the communication side, it became necessary to bring into the program readers. These readers were simply the on average 20 existing teaching assistants each semester. They obviously read for technical content, but they could easily tell an undergraduate additional areas of concern that included flow of the text, logical wording, level of vocabulary, and enjoyment of what they read.
In ME 332, 451, 461, 412, 371, and 481, all rough drafts are read and suggestions are made on ways to improve the communication of the text. These rough drafts go back to the students for rewrites and are graded by the teaching assistants. The grades reflect both facets: the technical and the communication.

It is also felt that it is important to empower students to make decisions on their own concerning their own writing. One way of doing this is to continually provide them with the means to check what they have done and use as much of their own talent to modify text before it is handed in rough draft and in final form. One of the ways of doing this is in using checklists. One of these checklists follows. It focuses on a particular course – ME 451, Controls.

A significant benefit of the method that is to be described is that it works to improve the students' written and spoken capabilities without adding classes to the curriculum, requiring no great influx of new money and allowing the department to dictate and control material for the needs of its own students.

If we envision change progressing at a slow and evolutionary pace in the overall curricula of today, it becomes apparent that concerned collegiate departments must take the initiative to formulate within their confines a means to rectify the unaddressed problems of communication and forge ahead with improved skill techniques. It is time for the collegiate ranks to realize that individual departments must shoulder the responsibility in the reeducation of those students who have failed to grasp, who failed to have been taught, or who have simply ignored the English language and its written counterparts. A reappraisal of responsibility will also help the multitudes of foreign students who have learned the rudiments of the English language and now need a greater grasp of the American tongue to move ahead in the realm of academia and industry.

A great deal of movement in this direction stems from the needs expressed by industry, emphasized by the words of Jack Withrow (Chrysler Corporation)

Communication for an engineer cannot be overemphasized. . .It probably comes second only to technical skills. . .If you cannot express yourself, both verbally and in the written form, then you cannot communicate adequately the thoughts that you have relative to any given problem or solution or project or whatever it might be that you are working on.

Most universities (trying to provide adequate instruction in communication skills for their students) require freshman composition classes that are quickly taken and even more quickly forgotten. Instead of thinking of writing as a useful tool in the engineering field, writing becomes both a required freshmen activity (more an initiation rite to suffer through) and a process that must be endured throughout the rest of the engineer's undergraduate years. Students are heard to complain that the biggest problem concerning their lab work is not the time, work, or long hours in discussion, but the process of writing the terrible report at the end of the lab itself. The report, for the most part, is never seen, read, or utilized after it has been graded. The writing carries no continuum into any other classes. It is simply a task of drudgery. The evolving communication program within the Mechanical Engineering Department at Michigan State University offers a means by which the engineering students can improve upon
their skills through a promising unit of in-house writing designed especially for the engineering
department and student alike. It was imperative to consider how this program could be
implemented without creating a hardship upon the professor and the student alike.

It is clear that faculty need to be involved in the learning process of communication skills by their
students. Engineering students need to be told to let text flow from the knowledge that they possess.
They need to sit down and brainstorm the information that may or may not be included in their
writing. Telling students to make an effort to generate as much text without a concern for order or
grammatical correctness produces a wealth of material that a student can then organize into a
coherent document. By producing copy with as much information as the student can generate, a
clear indication of gaps in necessary material will also be evident. Suggesting that outlines should
be produced from this early writing will allow the student to see the direction in which the text will
move, a movement that will result in a much more competent production.

That common concern among faculty readers - the level of poor grammatical skills expressed by
student writers – needs to be addressed in engineering courses. But where does one start in a fluid
mechanics or in a vibrations course to address these concerns. The unfocused feeling expressed by
faculty is probably the same as the students who have no idea where to begin their reports when
they have only the blank computer screen in front of them. There needs to be a basic list upon which
to focus. After looking at a wide range of technical reports, a common set of errors came to light.
These errors were in the use of tense: especially present and past. A simple request to look at the
tense usage in text may be enough to correct some of these mistakes.

Another area that seems to appear in many pieces of student text is incorrect documenting of
sources both in the text and in the way bibliographies and reference lists are created. A great deal of
complaint is raised, but if examples are given in the early days of a class, the problem might simply
disappear. The last broad grammatical problem area concerns simple punctuation mistakes:
punctuation with equations, both before and internally; where to place commas; the use of the semi-
colon; punctuation with lists; and where does the punctuation go in figures and tables. A few
grammar rules presented in the context of technical documentation to an engineering course at the
beginning of each semester or quarter will, in most cases, eliminate many of these mistakes.

A third concern among readers of student text is the flat, dull quality that comes from much of the
text that is produced by students. This quality reflects a lack of flow in the wording, a condition
similar to reading a list that indicates no apparent connection among the various parts of the list.
This lack of connection makes a reader quickly begin to wander, sometimes becoming lost in
personal thoughts far from the actual text. The three items that may help improve all student text are
a focus on outlines, a review of simple paragraphing with topic sentences and supporting
information, and an overview of the transitions that can be placed in a piece of writing to make the
text flow. These relatively easy elements in writing can make a great difference in the quality of a
student’s text.

Another problem that is seldom mentioned to an entire class of students (but appears at some time
or another in the text that they write) is awkward wording. Students are never shown examples of
text that absolutely makes no sense; sentences that are so long that the reader loses contact with the
core meaning; and word choices that are can be inappropriate, ambiguous, or redundant. Faculty
who during the course of a semester or quarter give an overview of the kinds of text that do not convey concise meaning provide students with a clear indication of what their own text should avoid.

Many papers also look as though the writer made no effort to read the paper after it was completed. Students sometimes feel that the final click on the computer to print the document is sufficient for a quality piece of text. But does anyone really spend time in giving students an indication of how they should approach their text to proofread and edit the copy. A simple process is to instill in students a need to first look at the content and make sure that they have supplied all the information required. They can then approach the issue of clarity. Is the wording clear and concise? In the third step they review the text for grammatical correctness. The last two steps require students to evaluate their own writing for its ability to present the text in the least number of words and to investigate their own particular style. These efforts will lead to a much better production and fewer concerns over the finished text.

Conclusions

Students enter and leave programs of engineering taking with them a myriad of skills. It is hoped that at least the technical expertise needed to survive in the real world will be present, but we have come to a point in our history that more than just technical skill is needed. Departments of engineering must provide guidance to their students when it comes to the communication skill they possess or the lack of that skill. By taking a close look at the particular needs of one's students, a department can start the process of making communication an integral part of the engineering program. Surveying the faculty and students as to their needs and concerns, providing a plan to approach communication skill acquisition, and necessary aids in this acquisition will go far in providing young engineers with the tools to enter the workforce.

Bibliography

Appendix

Student Technical Communication Survey

An area that is of great importance to an engineer but in which there is little formal training or attention paid is technical communication. To help correct this problem; more emphasis is being placed on determining deficiencies for both the student and the system. This survey hopes to identify those areas of concern and possible solutions to this situation. Your participation is greatly appreciated.

You are:

___ Grad Student   ___ Senior   ___ Junior   ___ Sophomore   ___ Freshman

You have worked at (please mark all that apply):

___ an internship   ___ a co-op   ___ a job within the engineering field

Please list any classes that have dealt specifically with the subject of developing communication skills through any means that you feel have been valuable.

_________________________________________________________________
_________________________________________________________________

What types of communication have been discussed or examined in your courses (please mark all that apply).

___ Formal presentations
___ Short oral presentations
___ Demonstrations
___ Essays
___ Projects
___ Formal Reports
___ Lab Reports
___ Other (memos, progress reports, feasibility studies, correspondence),
    Please specify

Please list below communication problem areas for yourself and possibly other students as well (please use 1 for Major problem area and 2 for Minor problem area).
Please list below any suggestions as to what you think should be included in a technical communications course to improve these skills.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Please list below any issues that never seem to be raised in this kind of course that should be raised.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

If you have worked at a co-op, internship or within the engineering field, please indicate, what if anything, the industry has taught you about the needs of communication that would be valuable in a communications course.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Please list below any ideas on how to educate students on the various areas of concern.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Other comments or concerns
________________________________________________________________________
Thank you for your time and cooperation.

Faculty Technical Communication Survey

An area that is of great importance to an engineer but in which there is little formal training or attention paid is technical communication. To help correct this problem; more emphasis is being placed on determining deficiencies for both the student and the system. This survey hopes to identify those areas of concern and possible solutions to this situation. Your participation is greatly appreciated.

Please list any classes where you have dealt specifically with the subject of developing communication skills through any means that you feel have been valuable.

What types of communication have been discussed or examined in your courses (please mark all that apply).

___ Formal presentations
___ Short oral presentations
___ Demonstrations
___ Essays
___ Projects
___ Formal Reports
___ Lab Reports
___ Other (memos, progress reports, feasibility studies, correspondence), Please specify

Please list below communication problem areas for yourself and possibly other students as well (please use 1 for Major problem area and 2 for Minor problem area).

___ Grammatical, spelling, and punctuation
___ Organization of paper or presentation
___ Expression of ideas
___ Logic
___ Support of ideas
___ Lack of technical comprehension
___ Introduction or conclusion
Please list below any suggestions as to what you think should be included in a technical communications course to improve these skills.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

Please list below any ideas on how to educate students on the various areas of concern.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

Other comments or concerns
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

Thank you for your time and cooperation.

**Report Checklist**

The following items make up the elements that will be evaluated in the formal reports for ME 451 from the composition side. Teaching assistants will comment on the inadequate elements, and you will have to address those comments.

**In order to make this a smooth running operation, it will be necessary to number in the first submission where each of the following items is addressed in your text.**

**TITLE PAGE**

1. Title of paper
2. Course
3. Date due
4. Section time
5. Name
6. DRAFT OR FINAL COPY
SUMMARY

7. Overview of the lab

8. Why was the lab performed?

9. How was the lab performed?

10. What was discovered, achieved, or concluded

11. Recommendations

12. Past tense used

13. Reference to experiment not paper

14. No personal reference (I, We)

15. It is before the Tale of Contents

TABLE OF CONTENTS

16. All sections represented

17. Abstract and Table of C not listed

18. Lab Observations as a heading - Analysis, equip, procedure, results - sub headings

19. All columns lined up

MOTIVATION AND OVERVIEW

20. Ample motivation for the experiment stated
   20A. yours
   20B. Whirlwind

21. Sufficient information to orient reader to the substance of experiment

22. Sections to follow mentioned

23. Any terminology that reader will need to understand the text.

THEORETICAL BACKGROUND
24. Mathematical model used to predict system behavior presented with ample explanation and lead in

25. Equations numbered
26. Punctuation with equations
   (: with follow/s/ing only)
27. Equations have space

**EXPERIMENTAL SETUP AND PROCEDURE**

28. Schematic of equipment used
29. Figures/Tables correct
   (Figure 1. Title)
30. Figures oriented correctly
   Clearly labeled and referenced

31. Highlights of equip. used
32. Highlights of the procedure (not specific steps)

**RESULTS AND DISCUSSION**

33. Data presented with clear indication of what data applies to
34. Reader will understand what this data refers to
35. Trends in data stated (then to be discussed in the discussion section)
36. Clear indication of what reader should see in the data
37. Complete discussion of the results appears
38. Connection of data and Whirlwind is clearly stated
39. Comparison to similar experiments is shown
40. Strong points of study given
41. Weak points of study given
42. Statements are specific
43. Logical progression to support conclusions that follow
CONCLUSIONS AND RECOMMENDATIONS

44."The following conclusions are supported by this study:"

45. Conclusions are numbered

46. Conclusions are concise and highly specific

47. Vague statements do not exist

48. Conclusions directly flow from discussion