Introduction: Four Carrots and a Stick

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This special issue on Communicating Across the Engineering Curriculum addresses a topic that, although critical to the success of individual engineers as well as their organizations, has received far too little emphasis in our schools of engineering.

My experience, as both faculty member and dean, in monitoring the professional progress of our students beyond graduation makes it clear that engineers who are adept at communications have a considerable advantage over those who are not. Too many times have I seen engineers, whose technical skills are superior, fail to communicate their ideas effectively and find that their ideas do not receive the attention they deserve.

Such failures to communicate not only can hinder the careers of engineers, but invariably compromise the quality and even the very success of the project on which they are working. Conversely, superior communicators are more likely to become leaders, both in engineering groups and in the broader organization. Quite often, these leaders also possess those technical skills that will lead to success for their company or laboratory. But of course, when they do not, the result can be lowered quality and even failure of the entire organization. Communication for engineers is very important, but of course it is not the whole story.

Thus, this special issue is particularly significant, because it can help faculty ensure that their students graduate with communication skills to match the quality of their technical education.

As a preface to this issue, there are several general principles that I would highlight.

• First of all, new communications technologies, especially the Internet, represent an unprecedented opportunity for both faculty and students to communicate engineering principles and achievements more broadly and effectively. Many in our society, including many engineers, do not yet realize that the Internet and its burgeoning multimedia capabilities allow anyone to become a global publisher of print, images, video and audio.

Such powerful new capabilities are particularly important to engineering, because we are members of a “high-impact, low-drama” profes-

sion. Even though the products of engineering constitute the very technical and economic foundation of society, those products are not viewed by many to be as glamorous as those of some of our fellow professionals in medicine or law.

For example, a new advance in treating an exotic cancer often makes headlines, even though it will benefit a relatively small segment of our society. The very word "cancer" plays on our fears about our health, dramatically capturing our attention—which is one reason why the television series ER is among the most popular on the air. On the other hand, an engineering advance that produces a five percent improvement in fuel economy for our automobiles — or even an advance that speeds progress toward alternative fuel technologies—invariably receives far less media attention, though the benefits to our entire society through both lower fuel costs and cleaner air are enormous.

Moreover, engineering has a profound impact on the very health care dramatized on ER. Thanks to bioengineers, physicians now have access to powerful new computer systems and instruments for diagnosis and treatment. Bioengineers have also given medicine new fundamental insights into the functioning of the human body that are leading to dramatic new clinical treatments. Again, these engineering stories are not being told as effectively as they could be.

However, with new communications technologies, engineers can begin to tell their own stories to the world, a potential that will only be realized if engineers are taught both the techniques and importance of communication.

• Which leads to another principle I believe important to teaching communication skills among engineers per se, namely this communication should not be narrowly defined as communications among engineers in a specific discipline. Students must understand that, even when they are presenting a talk to fellow engineers, not all of the audience will be in their own specialty area. Thus, a mechanical engineering student giving a talk or developing a web page to present technical information must understand that to an electrical engineer he or she may be speaking a foreign technical language.

Given that so many engineering projects are multidisciplinary and with each discipline having its own "dialect," students must learn to be adept at reaching across engineering disciplines in their communication.

Yet I would go even further and urge engineering faculty to help their students learn to communicate with the world at large. Students should be prepared, not only to do a finite element analysis, but also to testify before Congress, write a newspaper op ed article, or give a talk at the local civic club. I realize that this opinion may be considered heretical

by some, because many of us who are faculty believe that learning an increasingly complex engineering curriculum is demanding enough on students, much less asking them to learn journalism and public speaking. Certainly, some faculty have expressed skepticism about the wisdom of our engineering colleagues who have decided to commit time to writing popular books or exploring the history of their field. My own view is that the works of David Billington, Samuel Florman, Henry Petroski and Walter Vincenti, for example, have been notable and distinguished contributions to the dialogue among engineers as well as with opinion leaders and the general public. And it is my hope that more engineers will follow their pioneering efforts.

However, while I expect few engineering faculty to launch a "Journalism for Engineering" course, I do hope many will help their students broaden their communications horizons, e.g. by encouraging them to take a journalism course, write for the student newspaper, or pursue other activities that will prepare them for the demands of being an engineer in a new era of communications. And faculty can take advantage of the many day to day opportunites for enhancing their students' communications skills through better prepared and critiqued lab notebooks and reports, proposals and progress reports as well as oral presentations.

• A third important principle is that students should not only be prepared to communicate across engineering disciplines, and with the public, but across cultures as well. Engineering is now a global discipline and engineering training must reflect that reality. At Duke, for example, we offer a special seminar for international graduate students, which provides them both formal training and informal activities such as dinners and conversations with mentors and peers that help them better understand American culture. Importantly, we offer them mentoring and a buddy system with American students, which serves as a two-way educational opportunity that also helps American-born students better understand the cultures of our international students. Such a program not only prepares all our students for their professional life in a global economy, but also and more immediately, it helps those international students who are likely to become teaching assistants to do a better job in the classroom.

• A fourth important principle — implied in the first three — is that engineering faculty must recognize their central role in fostering their students' communication abilities. For we are role models in ways we often do not realize. A student in an engineering class is not only learning a particular engineering subject from the teacher, but is also observing how the teacher communicates that subject. Thus, a faculty member has a responsibility to hone his or her presentation techniques so that students will benefit, not only from learning the content of an engineering topic, but also from the communication skill of the faculty member.

What's more, in this new era of new communication technology, faculty have a responsibility to incorporate into their teaching such techniques as e-mail, web pages, chat groups and multimedia. Admittedly, it is often difficult just to keep up with the breakneck pace of the communications revolution, much less understand how to incorporate these new technologies appropriately into teaching. Engineering faculty in particular, because of their acute awareness that technological change often makes old systems obsolescent, may be especially skeptical of the value of new communications technologies to their teaching. And indeed some new communications technology may be more notable for its novelty than its utility.

However, faculty will often find adapting the appropriate new communications technologies to be necessary, if for no other reason than to keep up with their students, who have grown up with the Internet and will otherwise outpace their teachers in its use.

Importantly, faculty should not be left to fend for themselves in learning these new technologies. For example, at Duke we offer faculty short courses in web technologies and multimedia that will make it easier for them to incorporate such technologies into both their coursework and their research.

Faculty should understand that the content of their lectures can reflect an attitude that broad-based communication is important. Their teaching of even the most technical engineering topic can include information that places the topic in a broader perspective. Doing so conveys to our students that we place value on such a broader perspective and on communicating it. And importantly, such a perspective helps motivate our students to learn the topic and retain that knowledge. Too often, as faculty we may believe that students should accept the importance of a topic for classroom discussion without any background motivation, but simply because we deem it important enough to include in our lecture.

However, students who graduate with a broader understanding will better know why, when presenting information to their colleagues or writing a popular article, they must also communicate the overall importance and context of their topic, and explain why their audience should be interested in it.

Besides having a positive attitude toward communication, engineering faculty should also emphasize in the formal organization of coursework the importance we place on communication techniques. For example, I teach a graduate mechanical engineering seminar in which I ask the students to prepare for and give the lectures. My role is in part to make sure they cover the technical content, but I am also there to help them hone their presentation skills.

Distance learning over the Internet may well turn on its head the traditional relationship between teaching and research in determining faculty career incentives. Until now, achievements in research, published in journals and presented at conferences, have been the principal path to national recognition for faculty, and thus to tenure. However, beginning with the rise of distance learning, teaching will for the first time become an activity that offers national and even international visibility. Thus, for today's faculty, as well as those who will follow us, communication ability, as reflected in an engaging and effective presentation style, will become a far more important professional skill.

• So far, I have emphasized the "carrots" that encourage teaching and learning communication skills. A fifth, and final, important point is that there also exists a "stick" in the form of the new ABET criteria for accreditation of engineering schools. These criteria emphasize the importance of communication skills for engineering graduates and will require each accredited engineering program to demonstrate that its curriculum helps students develop those skills. If it does not, then that program will be at a serious disadvantage in seeking accreditation.

A significant issue now is that the ABET criteria are not particularly specific about the communication skills to be demonstrated or how they should be documented. Over the course of time, as accreditation reviews proceed, these elements will no doubt be brought into focus, and we will better understand what constitutes a desired skill level and its demonstration.

But until then, engineering programs need to prepare themselves for accreditation review by mounting an active effort to teach our students communication skills and ensure that the products of that learning experience whether web sites, multimedia presentations,video tapes or written materials are rigorously reviewed and rewarded.

We must also ensure that all our students have more opportunities to make formal research presentations and write research reports, not just those who engage in independent study. And, we must actively develop courses and seminars that help students advance their oral and writing skills, as well as their abilities to use multimedia to communicate information and ideas.

Most importantly, we must understand that if we graduate engineering students who have a full complement of communication skills, we will better prepare them to be more effective professionals as well as highly valued citizens. Clear communcation and clear thinking are mutually reinforcing. Together they are a powerful combination that will serve well the individual, our nation and world in the exciting years ahead.

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