

What does it mean to be an engineer? The 2001 Challenge to Engineering Educators

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Abstract

Dean Kamen's keynote speech at the 2001 ASEE National Convention in Albuquerque, New Mexico asked some tough questions of engineering educators. Primarily, Kamen questioned what we are doing to represent engineering as a viable career choice in comparison to the widespread appeal of lucrative sports careers, which promise to pay young people extraordinary amounts of money. His conclusion was that we are not really doing very much at all, and he predicted dire consequences for our society at local, national, and international levels if such negligence continues.

In response to Kamen's challenge to engineering educators to take proactive steps, four faculty members from two large urban universities decided to investigate the situation at our own universities and in our own communities:

- Were we failing to reach out to students and potential students in our communities?
- Were these students indeed expecting sports careers with the commensurate salaries?
- If so, as engineering educators, what did we have to counteroffer?

What started as a casual inquiry evolved into a formal survey designed to determine who our engineers-in-training today are, why they are seeking engineering education, and how they believe engineering fits into Kamen's "big picture". The first step in characterizing the perception of our profession was to obtain a view of the students. We surveyed over 300 engineering students, most of them aspiring civil engineers, at different stages in their education to learn about their motivations, perceptions, and knowledge of the profession. This paper presents our findings along with an example of our survey instrument in hopes of extending this project to other institutions.

Introduction

How many keynote speeches does anyone actually remember? Don't most people attend keynote activities because they usually offer free food and a conference agenda? Dean Kamen's 2001 Keynote speech to the ASEE National Convention in Albuquerque, New Mexico was quite decidedly a keynote speech to remember.¹ Whether you agree with Kamen's assessment that engineering educators are doing little to nothing to ensure the future of engineering as a viable professional choice or not, there is little doubt that anyone who heard Kamen's speech could

forget it. It was a powerful speech, supported by Kamen's own testimonial FIRST program and supplemented with video clips and photos of its power in action.

As engineering educators working diligently in the underfunded states of Tennessee and Kentucky, we listened to Kamen's dire predictions regarding the future of the engineering profession with mixed reactions: while we appreciated Kamen's words and his active participation in encouraging engineering education, we disagreed with parts of his predictions. In discussing his points, we responded with even more questions, and these questions called us to go directly to the source for current information about engineering students: the students themselves.

As with any academic research, we addressed the basic rhetorical questions first. Our purpose for the research was to test Kamen's prediction by asking students why they decided to pursue engineering educations:

- Were our engineering students expecting sports-star-type salaries?
- What factors brought them to us in the first place?
- What did they perceive as their future places in engineering and society in general?

These answers are important to us as engineering educators because their feedback helps us to help them. It is also important to note that helping students directly helps engineering as a profession, which is exactly what Kamen implied we were not doing. Our results suggest otherwise.

Background

It seems relevant to note that this is not a new topic in engineering, nor one that engineering educators are under-prepared for. In fact, in his research, Denton describes an engineer's interest in educating others as a natural fit for engineering educators: "engineers excel at the design, analysis, and improvement of complex systems" and documents cases of engineering professors contributing outside the realm of the traditional classroom to enhance and enrich the perception of engineering as a viable career choice.²

An important source for designing our work was Besterfield-Sacre et. al's extensive quantitative and qualitative research project across 17 engineering institutions that also investigated the factors that propel students into or out of engineering careers.³ In "Gender Ethnicity Differences in Freshman Engineering Attitudes: A Cross-Institutional Study," the researchers report that gender and ethnicity differences are critical determining factors in how students make choices to study engineering or not. Across the institutions, males reported higher scores than females in "Perception of How Engineers Contribute to Society" sections, and also rated their self-confidence levels in basic engineering knowledge and skills higher than female students, but what is important to us is that all groups of students reported acceptable levels of preparation/skills, etc. in all but 5 of 13 attitude and self-assessed confidence measures.³ We interpret this to suggest that in at least 17 institutions, the students are arriving ready to learn. Yet this extensive inquiry did not examine student expectations, particular student expectations concerning salary.

Additional research reveals that engineering educators really do seem to be interested in both recruiting and retaining engineering students, and they do these things in a variety of ways.

Strong evidence of this concept is presented in by Wankat's in-depth search of one of the primary sources of information for engineering educators: *The Journal of Engineering Education*. Wankat's review reported that in a 5 year survey sample of 20 issues, approximately 60% of the articles were related to topics of teaching methodology, assessment ideas, and suggestions for curricular improvement, indicating that these are indeed areas that engineering educators are aware of.⁴ Furthermore, many of these researchers are able to combine research interests with curricular improvements AND please university administrators at the same time by documenting their efforts for ABET review.

Besterfield-Sacre et al's 1998 presents a plan for using ABET criteria in conjunction with assessment of student feedback and evaluation data to improve/tailor/customize teaching.² These examples are just a few examples of projects and papers in progress in engineering programs everywhere.

Still not convinced that we're out in our communities spreading the word about engineering careers? Perhaps Kamen should have attended Session 3453 at ASEE's National Convention in Albuquerque, New Mexico. If he had (and he didn't--we looked) he would have seen examples of just the sort of people he'd described in his wish-list for the future of engineering. He would have seen Chandler and Fontenot from Texas Tech University's College of Engineering speak of a community-corporate-university program designed to target entire families of middle-school and high-school students and provide them with tools necessary for learning the skills required in engineering⁶. Unlike Kamen's FIRST program, this program is funded largely through the throw-away computer parts of several Texas-area computer companies, relies on volunteers such as computer repair technicians working with university volunteers, and meets most often according to the convenience of the families served instead of the volunteers: afternoons, nights, and weekends. A similar program was described by Leo Hanifin from Detroit Mercy that involves students and industry leaders from The Ford Company, where Ford not only donates money and material, but they send their employees as mentors and resources as well.⁷

In light of these examples and countless other ones all engineering educators know up close and firsthand, we believe Kamen's suggestion that we're underprepared as professionals to promote our profession is unfounded. But what about our students? Was he right about our students? The following sections detail our findings.

Methodology

Our survey was designed as a hybrid resulting from ideas borrowed from Besterfield-Sacre's 2001 cross-institutional study combined with and customized for our own questions.² The one-page survey was divided into 4 sections: demographic information, background/motivation for choosing engineering educations, knowledge of professional engineering practices, and intra-disciplinary knowledge. The survey questions called for a combination of both quantitative and qualitative data with a mix of open-ended narrative questions and several "check-as-many-as-apply" questions. A copy of the survey is included in Figure 1.

The survey was distributed at The University of Kentucky, College of Engineering, and The University of Memphis, College of Engineering, on the first day of classes in the Fall 2001 semester. We had initially planned for a greater cross section of intra-disciplinary departments

Introduction

Welcome to the Fall 2001 semester. This class is part of an educational research project, with the primary purpose of improving engineering education, and your responses to the following questions are important. All answers and information obtained from this survey and subsequent research are confidential, and participation in the research is voluntary. Your professors are available today and throughout the semester to answer any questions about this survey or the intended research, and may be contacted at 859-257-4816 or ukce441@aol.com.

Demographic information

University: _____ Dept: _____ Course: _____ Academic Status: __ FR __ SO __ JN __ SR __ GR
Age: _____ Gender: _____

Please answer the following questions:

I hope to be a: __ Civil Engineer __ Mechanical Engineer __ Electrical Engineer __ Agricultural Engineer
__ Chemical Engineer __ Mining Engineer __ Computer Science __ Other (_____)

I chose this particular field largely due to: (check as many as apply)

- ☐ financial compensation/security
- ☐ family/friend experience in the field
- ☐ high school guidance/advisor urging
- ☐ a personal interest in the field
- ☐ work environment
- ☐ other: _____

What are three things you believe professional engineers do at work?

- 1.
- 2.
- 3.

How do you believe engineers contribute to society in general as professionals?

What are the differences between the following engineering specialties?

Engineering Discipline	Materials used	Products Designed
Civil Engineering		
Mechanical Engineering		
Chemical Engineering		
Computer Science		
Mining Engineering		
Electrical Engineering		
Agricultural Engineering		

Figure 1: Sample Student Survey

to represent all engineering departments, but in our administration of the pilot survey, a large proportion of surveys were distributed to Civil Engineering students only in both universities. Greater control and planning measures were used for collecting class-based data, however, and students from all levels of engineering education (freshmen, sophomore, junior, senior, graduate) were surveyed. All student participants were informed that the survey was voluntary and confidential. To ensure complete coverage, the survey was handed out in the various classes over the course of a few days, but never in the same course twice. To minimize the possibilities of duplicate sampling, students were instructed not to fill out a survey if they have already done so.

Results

After distributing the survey at the beginning of the Fall 2001 semester at The University of Kentucky and The University of Memphis, a total of 320 students responded to some or all of the questions. The sampling included a wide range of students at different educational levels and engineering backgrounds. At the time of the survey, 59 respondents were not affiliated with any specific department, meaning that they were not officially tied to a specific discipline. However, the first question ("I hope to be...") related to the students' engineering aspirations. Of the 310 students that responded, 240 were aspiring Civil Engineers. Unfortunately, the sample turned out to be heavily weighted toward Civil Engineering. Table 1 shows the various career desires of the respondents. While it may be heavily weighted toward Civil Engineers, we did achieve a diverse cross-section of educational class level. Of the 318 students who revealed their classification, the majority were seniors (136). Table 2 shows the classification of the students. Finally, of the 309 respondents 260 were males and 49 were females; 11 respondents did not indicate gender.

When describing the recruiting pitfalls of engineering students, Dean Kamen used the analogy of professional sports. Namely, young men and women are attracted to sports because of the money involved. He then inferred that engineering doesn't compete financially with major league sports. While this is undoubtedly true, was it also true that our students were seeking large amounts of money? To find out, we asked the students why they chose their particular field of engineering. We listed 5 specific things (see Figure 1) and the students were allowed to check all that applied. All 320 people responded, and as it turns out, financial consideration was not their primary motivation (132 out of 320 listed financial considerations). The primary motivation was personal interest (252/320). Figure 2 shows the details of the students' motivation. Combined, the work environment and family/friends had as much influence as money.

In order to survey students' perceptions of what they'd be doing in their careers as engineers, we asked several practical questions including: "What are three things you believe professional engineers do at work?" This open-ended question resulted in a vast array of answers. Most of the respondents listed at least three things and only seven respondents left the question blank. The answers were grouped into common themes--one or two word answers that described the actual response. Figure 3 shows the results of what students believe engineers do at work. This graph reveals that an overwhelming number of students believe engineers design things (products, structures, or processes). They also believe that engineers problem solve and manage people and/or projects. It is interesting to note that students generally answered the question with

a concept rather than a specific task. There were a host of miscellaneous reasons, but very few had reoccurring responses. Of these miscellaneous non-reoccurring responses, many were related

Table 1. Students' desired profession

Career Desire	Number of respondents
Civil	240
Mechanical	60
Agricultural	7
Electrical	3
Chemical	1
Other	7

Table 2. Student Classification

Classification	Number of respondents
Freshman	79
Sophomore	33
Junior	53
Senior	136
Graduate Student	13

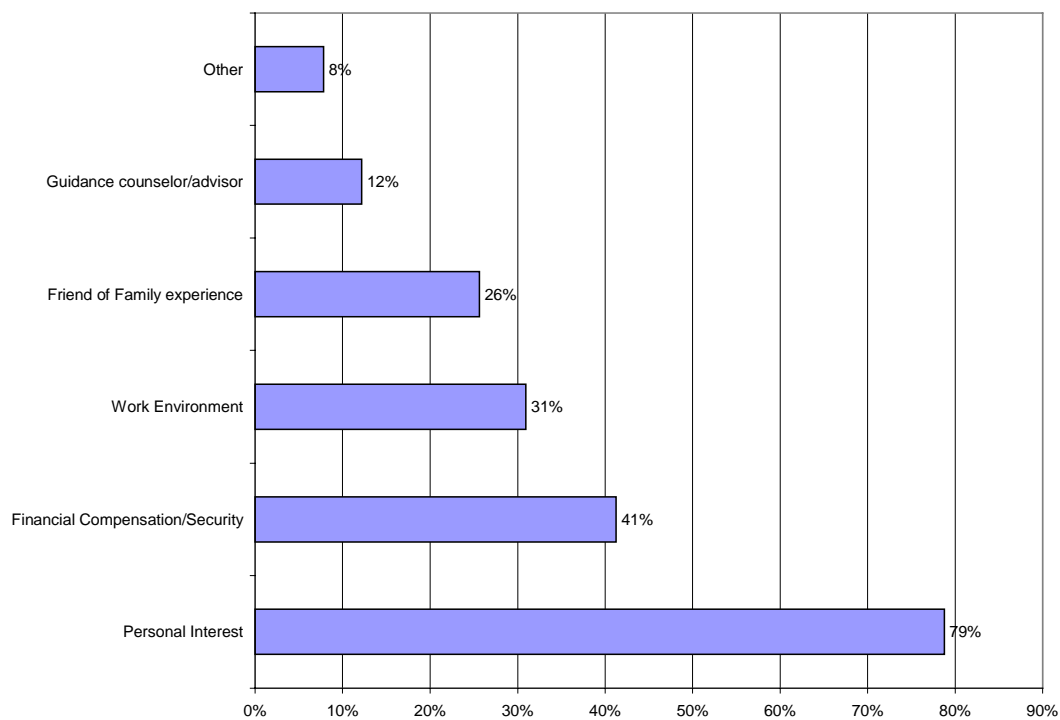


Figure 2. Students motives for pursuing Engineering Career (totals will not equal 100% due to multiple motives).

to specific tasks.

Finally, concerning the question "How do you believe engineers contribute to society in general as professionals?", there were many students with no response what so ever (66/320). This was a significant number when compared to the general questions where only a few students did not respond. This might indicate that some students do not know exactly how engineers impact and/or contribute to society. Still, of the majority of students who did answer, the responses can be summarized as engineers make society better by improving the standard of living and increasing the levels of safety for the products/services we use.

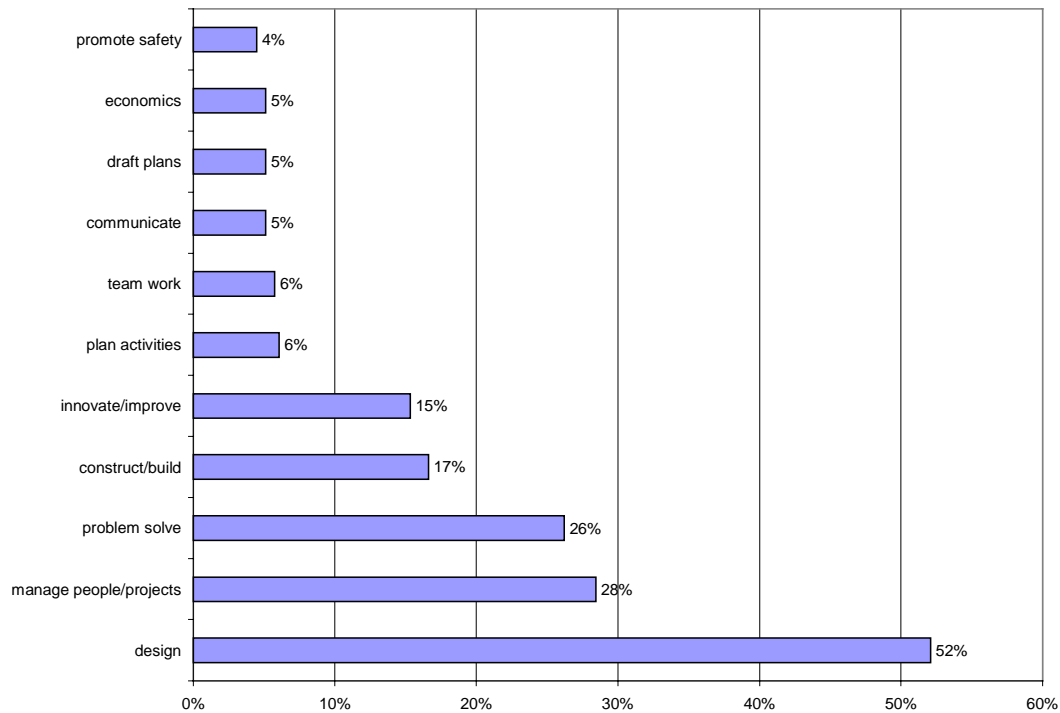


Figure 3. Student responses to what engineers do (totals will not equal 100% due to multiple answers).

Discussion/Call to Action:

Clearly, our survey represents only approximately 300 students' opinions, but their collective responses were reassuring to us. Although most of our students are aware that engineering careers aren't comparable to sports star careers, they still find value in seeking engineering educations for other reasons. And although, as engineering educators, we're obviously not motivated by sports-star-money, many of us are doing quite a lot of work to promote and extend engineering as a viable, rewarding career choice. We would like to challenge other engineering educators to replicate our survey, find out more about the students in their programs and what they expect both from the programs and the profession. And finally, we hope our colleagues share this information because in these respects, we agree with Dean Kamen, we believe these students are our future.

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