# "It's Just So Darn Hard…"

The title of this message is taken from an article that was published in *The New York Times* on November 4, 2011 (see http://www.nytimes.com/2011/11/06/education/edlife/why-science-majors-change-their-mind-its-just-so-darn-hard.html?pagewanted=all). The article's full title was "Why Science Majors Change Their Minds (It's Just So Darn Hard)" and provides data showing that "roughly 40% of students planning engineering and science majors end up switching to other subjects or failing to get any degree." In fact, engineering fares particularly poorly in this respect: reportedly, the fraction of all engineering bachelor's degrees granted in the United States has dropped from a high of 9.9% in the early 1980s to 5.4% in 2010.

*The New York Times* article includes a number of interesting observations. For example, the data show that the attrition in engineering students mostly occurs not among those with poor academic backgrounds but actually involves high-achieving students in highly ranked schools apparently overwhelmed by stiff competition and demanding coursework. In some cases, students switch to majors in the humanities and social sciences where it is easier to get good grades. In other cases, however, it is the structure of science and engineering courses that is turning students off. A typical student quote is "I was trying to memorize equations, and engineering's all about the application, which they really didn't teach too well." In the 1990s, the National Science Foundation tried to tackle this problem by funding efforts to develop new courses making use of interactive projects. However, once the funding ceased, so did most of this effort. This is not surprising, given that pure lecture courses are simpler and cheaper to support, not to mention the familiar fact that top faculty concentrate on research, not teaching. The article also mentions a few examples of prominent U.S. universities where first-year courses have been enriched with design components and summer internship programs have been developed to help students gain some practical experience at a very early stage of their time in college.

I don't think this type of news comes as any major surprise to most of us involved with academic programs in systems and control. However, there is, I believe, one new disturbing element in what is reported in *The New York Times* article: the problem of attrition in engineering is not attributed to inadequate preparation at the high school level but rather to the structure of coursework at the college level. We have all often commented on our frustration with freshmen who have a poor mathematical background to the point that their first college year is spent mostly in remedial math courses trying to build up enough knowledge to tackle an introductory circuits course, let alone one in signals and systems. Now, however, it seems that a greater challenge we face involves well-prepared, bright students who are already motivated to pursue an engineering discipline, but they simply hit a wall when they take college-level courses. If one were to identify a list of courses that are indeed "so darn hard," I suspect that those we offer in systems and control would easily make the top ten in such a list, mostly because of the highly mathematical nature of our field. It is not likely that this will change, at least not while differential equations, Laplace transforms, and stochastic calculus remain key ingredients for the rigorous analysis and design of control systems. But the real question is this: Can we not enrich our courses (more generally, our academic field) with hands-on projects and meaningful problems that today's students can relate to? Can we not go beyond the dry lecture style that apparently turns students off and disillusions them from their own vision of engineering?

The IEEE Control Systems Society Executive Committee at work during its November 2011 meeting.

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It's not that these questions have not been already posed. What prompts me to bring them back to the forefront is the article's message that the key issue may not really lie with high school education after all. It has been easy for us to dismiss the problem by arguing that it's not ours: give us better prepared freshmen, and we'll deliver armies of well-qualified systems and control engineers! Now, however, we are told that it is *the top students* who are jumping ship, not the ill-prepared ones. Maybe they are to be blamed for thinking that engineering should be "easier" or maybe we are to be blamed for having ignored that every generation has new expectations and new viewpoints. Either way, this is our problem to solve, whether it is by better educating the students in terms of their (unrealistic?) expectations as to the level of difficulty they have to face or by adjusting our educational methods to reach their intellectual soft spots.

At the level of the IEEE Control Systems Society (CSS), the tool we have been using over the past ten years or so is that of outreach activities such as organizing workshops for high school students and their teachers to familiarize them with the power of control principles and their use in daily life and everyday technology. Could it be that we have done too good a job? Have we contributed to motivating high school students who go to college with high expectations and ambitions, only to find that they may have better options in social sciences to pursue careers that are both financially satisfying and intellectually rewarding? The Society has launched yet another initiative for "outreach" in the last two years, and this one targets all educational levels and forms of activities. Perhaps it is one vehicle that, in its own limited way, contributes to experimentation with new ways to build up new course structures for our field, including new types of laboratories and exciting, innovative projects.

Therefore, I close this column by not only pointing you to the somewhat surprising conclusions of *The New York Times* article that provide some food for thought but also reminding you that our CSS Outreach Program is available for all members to submit ideas that may be relevant to this problem and contribute to its solution, at least in our own discipline. For more information on the CSS Outreach Program, you may visit http://ieeecss.org/general/control-systems-society-outreach-fund.

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