Trinity and the STEM Crisis

You may have heard that our education system is turning out too few Scientists and Engineers, and that, because of this, our economy will suffer serious consequences in the years ahead. A 2012 report by President Obama's Council of Advisors on Science and Technology claimed that over the next decade, 1 million additional STEM graduates and 100,000 new STEM teachers will be needed above the current trend. (STEM stands for Science, Technology, Engineering, and Math.) My son, Andre, a senior, is planning to study engineering in college, so these predictions make me confident that he will have immediate employment after graduation. At work, I also witness engineering companies having difficulty replacing their star engineers with new up-and-comers when the grey-beards retire or are lured away by a better offer.

I'm a member of the Institute for Electrical and Electronic Engineers (the IEEE). It is the largest engineering society in the world (almost 400,000 members). So, imagine my surprise when I picked up the September issue of the IEEE Spectrum and saw the lead article entitled, "The STEM Crisis is a Myth." Think about it. Here is the largest engineering society in America debunking the warning about a looming economic crisis due to our education system failing produce enough STEM graduates. What possible motivation could the IEEE have to discredit the push to educate more engineers?

First, the author examines supply and demand for a variety of STEM fields. He summarizes that, on average, there are about a 150,000 more STEM associate, undergraduate, and graduate degrees produced each year in the United States than there are STEM job vacancies. So, no supply problem here. He also argues that engineering salaries have stagnated over the last decade – another sign that demand is not outstripping supply. These figures are not encouraging, and in fact, they felt like a bucket of cold water on my future aspirations for my son and for me.

After this analysis the author steps back to examine STEM education in general, and to probe the qualities needed to be a highly successful scientist or engineer. The following quote really caught my attention:

> "Emphasizing STEM at the expense of other disciplines carries risks. Without a good grounding in the arts, literature, and history, STEM students narrow their worldview—and their career options. In a 2011 op-ed in The Wall Street Journal, Norman Augustine, former chairman and CEO of Lockheed Martin, argued that point. "In my position as CEO of a firm employing over 80,000 engineers, I can testify that most were excellent engineers," he wrote. "But the factor that most distinguished those who advanced in the organization was the ability to think broadly and read and write clearly."

In essence, the author is saying that a STEM-centric education is not needed: first, because the STEM economic crisis doesn't exist; but, second, and most importantly, because a broad based education with a good foundation in the arts, literature, and writing is what helps produce a successful scientist and engineer. This statement led me to reflect on my own experience and on Trinity's curriculum.

Let me begin with a little personal history. I started Notre Dame as an Electrical Engineering major. I did fairly well in my engineering classes freshman year, but at Notre Dame, all students, including STEM majors, are required to take courses in literature, composition, philosophy, and theology. Through these classes I experienced a real intellectual awakening. I was exposed to questions about the essence of God, of life, and of human society. This awakening led me in my sophomore year to switch my major to Math, and to use my many new electives (that I didn't have as an engineering major) to study more history, literature, philosophy, and theology along with some computer programming and higher level math. Well, God was in this choice, and I ended up being hired by a telecommunications research center, full of Ph.D.'s in Electrical engineering. They wanted me because I was a Math major with a diverse background, who could write computer programs to simulate new technologies. They didn't hire someone with a straight Computer Science or an Engineering degree. I eventually went on to get my Ph.D. in Electrical Engineering, but I am so grateful I decided to broaden my education when I had the chance, to make up for what I didn't get in my large public high school (but what our kids now get at Trinity).

So, let's examine again the premise of the second part of the article: that what enables a scientist or engineer to be successful is the ability to think broadly and read and write clearly. I've seen this played out in many different ways over the course of my career. Recently, I spoke with a colleague of mine who has a high position in Mitre Corporation. One of their top engineers left, and they've been searching for over a year for someone who could think abstractly and direct new developments in signal processing and communication theory. Finally, my friend went to a highly respected professor at MIT who is famous for producing students who become top-notch entrepreneurs in technology companies. He said, "Professor, do you have any graduate students for me who could fill this vacancy?" The Professor replied, "No, we don't produce students like that anymore. We only produce kids who program apps and want to make millions, but they don't think on a higher plane."

I talked to another colleague of mine, who, a few years ago, was voted by the IEEE society as the runner up for the young engineer award. This award is given to the engineer under 35 who has made the biggest contribution to the field. I asked him, "What are the most important qualities found in a really good engineer?" He said, "In my opinion, being able to clearly define the problem is the highest skill. The young graduates can execute and implement, but they

don't know how to abstract and define the problem. Being able to communicate the work is the second most important skill." Notice that he placed these two qualities above the technical skills needed to execute the work. This man, for whom English is a second language, is continually frustrated by how much time he has to spend teaching young engineers, educated in the US, how to communicate and collaborate with their fellow workers. This has led him to emphasize the thinking and communicating far above the technical prowess.

I'll provide one more illustration. Over the course of my career, I've witnessed or have been privileged to be a part of more than 40 inventions when they occurred (most of them were not my own). You may think that inventions happen in an ivory tower, by someone who removes him or herself from reality and has a "Eureka" moment. Well, I don't think any of these inventions happened that way. All the inventions I witnessed happened in the midst of conversation! They occurred amidst the back and forth, clarifying, questioning, striving to understand, abstracting, theorizing, testing, and saying "what if" that happens in human collaboration. In many of these inventions, it was extremely difficult to determine who actually came up with the novel concept or technique. The discovery came from the collaborative, communicative, inventive process formed by many minds working together.

So, this brings me back to Trinity's curriculum and the need for a broad-based education to become highly successful in a STEM field. Trinity's math/science curriculum, with two years of calculus and higher math, two years of physics built upon an understanding of chemistry and biology, all integrated and applied using MATLAB is a great technical foundation for any future scientist or engineer. What I also want to stress is this. Trinity's broad-based education, where art, music, drama, literature, history, language, and writing are integrated with math and science is exactly what will allow our children to succeed in STEM fields. The humane letters seminar may be the most important class for a future STEM major! Every day our students wrestle with some of the most influential works in Western civilization. They strive to understand the essence of what the author is saying, how what is said relates to reality, and the students have to enter into a conversation with their peers to explain, convince, refine, and communicate their understanding. This process, combined with an exceptional math/science curriculum, is providing a great foundation for future success. So, I'm not worried about a STEM crisis or a lack of one: I'm just grateful that our children are being educated so well, in a wonderful Christian environment, with all the tools they need to be successful in the future, in whatever field they choose to study. You might find a more concentrated, high tech, math/science program elsewhere, but I'm convinced that the balanced emphasis we give to sciences, humanities and arts is what will enable our kids to think critically, probe deeply, and be inventive scientists and engineers. So, I am full of hope for the future prospects of our Trinity educated kids.