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# PREPARING EFFECTIVE GLOBAL ENGINEERS FOR SUCCESS

BY PAUL GILBERT

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***Paul Gilbert***, a leader in the field of industrial business and management, has two decades of experience working with key customers and suppliers in North America, Europe, Asia and South Africa. As CEO in Quanser, Mr. Gilbert is responsible for the development and execution of the company's business vision. His mission is to expand the base of Quanser's systems into critical controls research and industrial applications, as well as educational institutions throughout the world.

*"The century ahead poses challenges as formidable as any from millennia past. As the population grows and its needs and desires expand, the problem of sustaining civilization's continuing advancement, while still improving the quality of life, looms more immediate. Old and new threats to personal and public health demand more effective and more readily available treatments. Vulnerabilities to pandemic diseases, terrorist violence, and natural disasters require serious searches for new methods of protection and prevention. And products and processes that enhance the joy of living remain a top priority of engineering innovation, as they have been since the taming of fire and the invention of the wheel. In each of these broad realms of human concern — sustainability, health, vulnerability, and joy of living — specific grand challenges await engineering solutions. The world's cadre of engineers will seek ways to put knowledge into practice to meet these grand challenges. Applying the rules of reason, the findings of science, the aesthetics of art, and the spark of creative imagination, engineers will continue the tradition of forging a better future."*[1]

This quote from the National Academy of Engineering website, Grand Challenges for Engineering succinctly captures the prevailing mood at the highest levels of Engineering Leadership. In my role as CEO for Quanser I have the immense privilege to be able to travel the world and meet academic leaders, and can assure the readers of this article that these sentiments are truly global.

Only a concerted effort to educate engineers to be effective in a global setting will enable future generations to become a miraculous hybrid of Global Citizens, business strategists, policy makers and of course innovative engineers.

Engineers are the worlds problem solvers, and these challenges we face suggest profound implications for higher engineering education. I don't believe there is a silver bullet that will provide all the solutions, as there needs to to be both systemic and organic changes made by governments, universities, engineering schools and individual professors. Thus, my intent here is to examine these points a little closer, then explore a few cost-effective strategies universities could adopt to help develop and graduate more effective global engineers.

These thoughts are from the vantage point of a small/medium size company. Business like ours represent about 20% of industrial R&D expenditure in North America, and are by nature innovative and forward thinking. Our main focus is to supply the academic industry with quality teaching and research platforms. On the other hand we employ newly minted graduates produced by higher-education system. That's why we feel to be in a unique position to discuss the issues.

## *Crossing Departments to Solve Problems*

Engineering disciplines can no longer work in vacuums. Whether it's developing the latest "i" product at Apple , rockets for NASA, or brakes for GM, real-world systems are too complex. Industry demand for mechatronic controls engineers has dramatically grown over the past decade. Today, industry is looking for a new kind of engineer, one with multidisciplinary and systems integration experience. It is becoming increasingly important for students to learn how electrical, mechanical, computer and control systems interact with one another.

This crossing of disciplines is already happening in universities around the world, but it's not enough. These emerging multidisciplinary engineers need to think even further – beyond engineering itself. They must understand the needs and demands of consumers and the world at large. They must be effective marketers, business thinkers and, critically important, communicators. This takes training. Whose responsibility is that?

Last year, Quanser co-hosted panel of practicing academics from engineering departments in American colleges and representatives from leading engineering firms. Among others, Terri Morse, Boeing's Director of Engineering, Operations & Technology, worried aloud that students still weren't getting enough cross-disciplinary assignments. "We mean 'interdisciplinary' between engineering, business, finance, marketing, supplier management, project management skills." She felt graduates need these "to be attractive to us to hire them into the company."

## *And Crossing the Globe to Solve Problems*

Impatient consumers, complex systems design and international collaboration has produced an attitude in business that is keeping us all awake, affecting the way we do business every day. We used to go to the Far East for cheap labor. Now the world is trading product ideas, development and production, back and forth. Faced with extremely short development cycles, our interconnected business typically has design teams passing work around the globe every eight hours as it literally works 24/7 to meet demanding customer schedules.

Consequently young engineers must be intuitive and effective upon entering the working world. Today a critical success factor is the ability to collaborate and communicate with a large network of technology providers, inventors, vendors, manufacturers and peers worldwide. Language skills and cultural knowledge are essential, as well as an ability to lead multi-national teams through challenging problems and a willingness to conduct late night conference calls with partners in all parts of the globe. We need to move beyond an appreciation and respect for differences to synergistic global collaboration to create a culture of success.

## *Yng Pple R Dgtl! B OK W It :)*

Unlike my generation, under-30s don't need to adapt to change. They're driving it with a digital fluency and innate technological awareness I could only have dreamed of. When they reach university they are extremely proficient with an enormous array of digital devices and applications, from the hand-held personal digital assistants to home entertainment systems and of course, social media. While many are not as intimate with the engineering behind these devices, they intuit them, learning how to use them on the fly, at their own pace.

This generational reality has some negatives, but I would argue academia must embrace the positives – of which there are many, and build on their natural capabilities. Thus I believe it is critically important to use technology wherever possible in the learning process to allow students to physically experience and enjoy engineering.

Much of the past 15 years of my career has been devoted to helping engineering departments throughout the world transform their programs to address these new realities of industry and on-demand culture. It starts with reaching out to students on their own level – without sacrificing theory. I believe the self-discovery capabilities of information technology can be a link to reaching this goal and to offering new opportunities for student growth in education.

## *A Generation that Cares*

Much has been said about the "Youth of Today", with many sentiments unreasonably negative (as they were when I was young). In spite of that, when talking to Professors and Deans around the world, one theme keeps recurring: the youth of today really do want to make a positive difference to the world.

I did a little research and found that this has indeed been captured by some academics. *"The recent expansion of experiential learning in many engineering programs is capturing our students' desires for an education that will enable them to contribute to the solution of problems of societal significance…. "* says the report "Creating a Culture for Scholarly and Systematic Innovation in Engineering Education"[2], published by the American Society for Engineering Education.

In essence this means that finding solutions to the Grand Challenges of today is really aligned to the motivating forces behind many entering freshmen. This is a good thing, and the fact that Engineers solve problems … which is cool ….. must be communicated to all students of all ages from kindergarten through grade 12!!

## *Strategies for Graduating Intuitive and Effective Global Engineers*

So, to make sure those motivated young minds entering University, stay motivated and graduate as innovative and effective Global Engineers, we need to modify traditional engineering teaching

approaches to reflect the realities of todays world.

Here are four strategies that I feel must be considered:

*Introduce Hands-on Learning Everywhere*: Humans are sensory beings. It isn't news that we learn through the visual, auditory and kinesthetic. 2,500 years ago, Confucius said: 'I hear, I get; I see, I remember; I do, I understand.' That's the very definition of kinesthetic learning: touching, feeling and experiencing the material at hand. Kinesthetic learners acquire information fastest when participating in a science lab, drama presentation, skit, field trip, dance, or other active activity. Because of the high numbers of kinesthetic learners in today's intuitive, digital hands-on generation, education is shifting more toward the tactile. Manipulatives and 'props' are incorporated into almost every school subject, from physical education to language arts. New technologies including the web, digital video, sound, animations, and interactivity have provided tools to make engineering education more effective. Quanser's business is founded on this reality. For over 20 years, we have created labs with hands-on experiments for universities around the world. Supplemented by pedagogical curriculum, these devices function for both undergraduate learning and speedier post-graduate research.

I am sure all engineering departments will agree that hands-on experience is important, but are they all able to provide a physical connection for students consistently throughout their undergraduate years? My experience shows that many Universities fall short of this objective, and point to budget restraint as the single most important reason for not buying the necessary equipment.

It is lamentable that many Engineering schools believe and are told that they are a "cost" to the Universities and administrators typically look to cutting those costs. I argue whenever I can, that ENGINEERING SCHOOLS ARE MAJOR ASSETS TO UNIVERSITIES. If they focus some attention on raising research funds, great things can happen. At every University I know that has a team of people supporting advanced research – significant budgets can be achieved, superb staff attracted, and surplus funds become available.

Why do I comment on this now – because with these funds, truly up to date and technologically relevant labs can be purchased and developed!

Add to that the concept of sharing lab facilities between departments, again a foreign concept to many, but to those who have embraced it a sheer miracle. These shared Labs (also called Integrated Learning Centers) can be well funded, professionally run and best of all exciting and meaningful for young minds.

***Promote International Learning*:** To face the challenges of a tiny 24/7 planet, we need to modify curriculum to allow for travel wherever possible. On a résumé, study abroad is now nearly as indispensable as good computer skills or proficiency in English. 16% of German students travel during their undergrad years, yet only 3% of Americans, why is that! We need to facilitate the mobility of students, graduates and higher education staff, and promote the learning of other languages.

Picture international collaborative lab teaching practices – including competitions between universities, which require skills beyond engineering – and culturally programmed courses. Travel and competitions develop professional skills, promote teamwork and improve vital communication skills.

At Quanser we've experienced firsthand the benefits of international cooperation. Our solutions are found the world over; we're represented in nearly every country. The first question I ask engineers I interview for work here is, "Do you have a passport?"

Of course, travel is not cheap, and if that is prohibitive for some schools – I say use internet based tools to ensure undergraduate engineers have some contact with students in other parts of the world. There should of course be a reason for this, so why not develop international undergraduate lab assignments ….. ? As leaders I believe the suppliers to academia and international leaders must put their heads together and provide frameworks where students are forced to interact with students from different cultures and time zones.

***Reach Out to Future Generations Early:*** Universities need to champion the importance of engineering in everyday life. From the water we drink to the cars we drive and the tunes we download, engineering solutions are ubiquitous. How do we bring that message home to kids?

At the risk of showing my age, we need to make engineering as cool as downloading music is. Get university and even high school students into competitions. Involve parents. It's not hard. Programs like *FIRST Robotics* have taken off all over the world. And let's evangelize our converts. Get older students to talk to young kids now. Build on the basic interest kids have with technology and build on their level of competences early. Kids now play digital games and progress through levels depending on competence. Why not teach that way? The digital generation is used to self-paced, intuitive learning.

Again, Quanser backs this philosophy with action. Our engineers visit local schools to get kids excited about engineering. Universities like Cornell use our experiments for outreach programs to local communities, enticing kids with experiments such as Quanser's Shake Table, a device that simulates earthquakes.

***Teach rapid prototyping*:** Emphasizing the important role of prototyping in industrial practices, engineers need a methodical approach to the development of mechatronic systems, from concept to production, using rapid prototyping technology. That starts in the classroom by teaching the theory and solidifying those concepts with hands-on experiments. State-of-the-art rapid prototyping tools and new engineering practices allow an engineer to take a design from concept to production using a variety of tools that all fit under the umbrella of rapid mechatronic prototyping.

Quanser rapid control prototyping tools and turnkey solutions combine hardware and software with lab materials. Don't feel that Quanser is the only solution either, there are a myriad of engineering tools that Universities could use more effectively in the Labs to enable students to grasp the core concepts of rapid prototyping … Moving from MODEL to SIMULATION to PROTOTYPE to DEPLOYMENT, using integrated software tool chains. Only by experiencing the value and current shortcomings of these tools will students really appreciate how they can affect change effectively.
By the way, most software companies provide these tools at very competitive prices to Universities …. Take advantage of that!

## *How Quanser Can Help*

All Quanser devices are designed with these four strategies in mind. To increase the numbers and quality of engineering students, we strive to make our experiments as relevant and desirable to them as downloading music. Supported by pedagogical curriculum, Quanser offer engineering departments over 80 experiments. They're versatile and robust enough for everything from undergraduate study to post-graduate research.

It's a good start. From basic motor control, to active mass damping, robotics, and haptics, these experiments bring the textbook closer to the real world, preparing students to be immediately effective engineers in the real world. I say this with confidence because Quanser also produces devices for very real-world industrial clients including NASA, McDonald Detweiller & Associates and Defence and Research Development Canada.

Tactile experiments captivate modern kinesthetic learners comfortable with technology. They motivate them to push themselves and learn more. Ultimately they help produce global graduates, intuitive and effective engineers comfortable with real-world problems – whether that's downloading billions of tunes in a few months or predicting the next severe earthquake.

By Paul Gilbert

Footnotes:
1. http://www.engineeringchallenges.org
2. Creating a Culture for Scholarly and Systematic Innovation in Engineering Education, published by the American Society for Engineering Education, 2009
http://www.asee.org/about/board/committees/EEGE/upload/CCSSIEE_Phase1Report_June2009.pdf