

it possible for engineers to show more social responsibility or to do more for social justice is itself a social undertaking, not something usefully assigned to an individual engineer. Those who want engineers to be more socially responsible or to contribute more to social justice should focus on providing engineers with better tools for that work. Engineers can certainly use help in carrying out their professional responsibilities. No engineer practises alone.

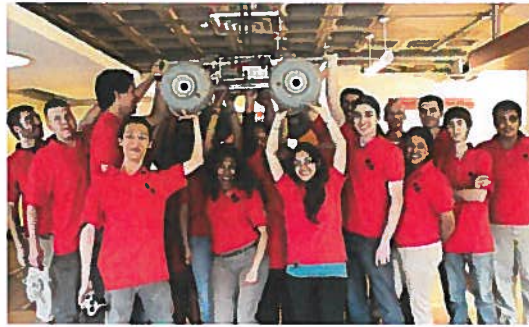
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BUILDING AN ENGINEERING RENAISSANCE IN ONTARIO

By Janusz Kozinski, PhD, P.Eng., and Eddy Evans



The multi-disciplinary undergraduate and graduate students that make up York University's Rover Team hoist the rover that they entered into NASA's Lunarobotics Mining Competition and Mars Society's University Rover Challenge.

ENGINEERING EDUCATION should expand technical knowledge, facilitate interdisciplinary learning and foster creative thinking. In Ontario and Canada, we have been successful, and we continue to make significant progress, in the first challenge. However, we have neither broadened the engineering curriculum enough nor given students adequate opportunity to express their creativity.

The engineering education system is not producing the type of graduates Canada needs to compete on the world stage. And it's losing some of the best and the brightest, particularly women, to rival disciplines, such as medicine or bio-

technology, that offer a clearer path to changing lives for the better.

Thomas Jefferson drafted America's Declaration of Independence from the comfort and convenience of the swivel chair he created. Like renaissance women and men before and since, Jefferson's extraordinary abilities did not simply coexist in his mind. Benjamin Franklin read Jefferson's drafts and looked out onto the horizon for inspiration with the help of the bifocal lenses he invented. Another great North American, Canada's Sandford Fleming was cut from a similar cloth as his renaissance cousins south of the 49th parallel. One of the first truly global Canadian engineers, Fleming created the time zones that bind us together in order and harmony, and applied his artistic talents to the design of Canada's first postage stamp, as familiar back then as the Apple logo is today.

It's no coincidence that many engineers who change the world possess not just a technical brilliance but also an acute understanding of what it is to be human, gained from their pursuit of knowledge of all aspects of life. An inquisitive and sophisticated engineer will be a better engineer, and one best placed to succeed in conquering the challenges we face. Yahoo! CEO Marissa Mayer is a remarkable role model for entrepreneurial engineers regardless of gender. She's also an accomplished ballet dancer who performed the Nutcracker while studying engineering at Stanford. Canadian astronaut and engineer Julie Payette speaks six languages, and is also a pianist and singer, performing with the Montreal Symphony Orchestra and Placere Vocale de Bâle in Switzerland.

We must offer engineering students an academic timetable that integrates extracurricular activities rather than forcing them down a rigid academic path that may restrict their creative opportunities.

[POLICY ENGAGEMENT]

“The Macintosh turned out so well because the people working on it were musicians, artists, poets and historians—who also happened to be excellent computer scientists,” Steve Jobs once told *The New York Times*.

CORE SKILLS

At the turn of this century, “The Future of Engineering Education” (Rugarcia et al., 2000) proposed seven core skills that engineers will need to master to flourish in a constantly changing world:

1. independent, interdependent and lifetime skills;
2. problem-solving, critical-thinking and creative-thinking skills;
3. interpersonal and teamwork skills;
4. communications skills;
5. self-assessment skills;
6. integrative and global-thinking skills; and
7. change management.

Similarly, in their 2009 article, “A global engineer for the global community,” Adrian Chan, PhD, P.Eng., and Jonathan Fishbein led an effort to define the global engineer:

1. superior communication skills and understanding across different cultures and languages;
2. a facility for multi-disciplinary and interdisciplinary teamwork;
3. a well-developed sense of social responsibility and ethics, with due consideration in his/her personal and professional activities;
4. being entrepreneurial; and
5. an ability to deal with complexity and systems thinking.

Both these studies describe the modern-day renaissance engineer. The engineers of the future—renaissance engineers—need to not only be able to adopt new scientific discoveries, but also to be innovators, entrepreneurs, integrators, stewards of the environment, agents of change and excellent communicators. They must be culturally sensitive and socially responsible as well.

We must be conscious of the tough choices required to realize this bold vision and to recognize that it must include women and people of every background.

SYSTEM NOT KEEPING PACE

The engineering education system is not keeping pace with rapid societal shifts. While the world has changed faster than expected, engineering education reform has moved at a snail’s pace. We risk falling further behind if we do not act.

Engineering education remains rooted firmly in the 20th century. We remain hunkered down in an educational model that’s increasingly not fit for purpose. In our pursuit of technical excellence we have allowed the postsecondary engineering pedagogical model to become too narrow and too unresponsive to the needs of both students and employers.

This is not a message that is coming from within some kind of academic bubble. Last year, Google’s Eric Schmidt spoke about the need to apply the lessons of the 19th century when the disciplines of engineering, science and art weren’t rivals but were driving progress in unison.

“[The Victorian era] was a time when the same people wrote poetry and built bridges...Lewis Carroll didn’t just write one of the classic fairy tales of all time. He was also a mathematics tutor at Oxford. James Clerk Maxwell was described by

Einstein as among the best physicists since Newton—but was also a published poet,” Schmidt told a conference in Edinburgh last year (MacTaggart).

Leaders in engineering education have a choice. They can make piecemeal changes toward a broader curriculum and hope it will be enough—the quiet life option. Or they can embrace a radical overhaul of engineering education.

As Rugarcia et al. pointed out: “Although their content has changed in some ways and the students use calculators and computers instead of slide rules, many engineering classes in 1999 are taught in exactly the same way that engineering classes in 1959 were taught.” Today’s students use iPads and 3D printers, but we have not moved on—or nearly enough—from the 1959 model.

As educators, we must take risks and exercise our responsibility to make tough choices about how we approach education.

The Lassonde School of Engineering was created at York University to be the home of this renaissance. We call it Renaissance Engineering and we’ve trademarked the term. This sets the bar high and makes a statement about the scale of our commitment and our reputational investment. This is our response to the challenge of recrafting engineering education. While this has been talked about in symposiums for years, we want to make it happen.

The government of Ontario is supporting this vision with a \$50-million investment in a new facility to be built around the concept of Renaissance Engineering. This builds on a transformative gift of \$25 million from mining entrepreneur Pierre Lassonde, matched by an investment of \$25 million from York University. We are embarking on a campaign to raise a further \$150 million from the private sector to create a new engineering school with an overall investment of \$250 million.

NEW PRIORITIES

To implement our vision of renaissance engineers we are focusing on three initial priorities: admissions, curriculum content and curriculum delivery.

Admissions policies for engineering faculties unnecessarily shut out some of our most creative minds and narrow our talent pool. At the Lassonde School we plan to have applicants draft a statement or submit a video explaining why they want to join us. This will help us distinguish between the top applicants and give us the chance to consider those who may be just below the grade cut-off but have creative minds and the potential to flourish in the right environment.

We're not the first to take this step. Other Ontario universities have also committed to creating a more sophisticated admissions system for engineering courses while maintaining fair selection procedures.

If we are to credibly expand the talent pool to include more students with breadth and depth of talent, we must be prepared to take risks with our entry criteria. Reaching out to students with diverse demographic and academic profiles is essential. We must also invest time and resources in a process that is receptive—not resistant—to well-rounded applicants. In return, we must offer them an academic pathway that broadens rather than narrows their thirst for enquiry.

We must also recognize that drop-out rates in engineering are too high. In some cases, it's not that students are not cut out for engineering, it's just that they may not be cut out for the learning experience we offer them. Too often, we may be forcing a round plug into a square hole by imposing a one-size-fits-all model.

This brings us to the second element of our challenge: changing the curriculum to focus on interdisciplinary learning.

The Lassonde School is forming strategic academic partnerships with Osgoode Hall Law School and the Schulich School of Business at York to enable students to acquire excellent technical and scientific training while gaining sophisticated business skills and a deep knowledge of relevant legal subjects. This is not a case of adding in a few lectures, guest lectures or extra courses here and there. This must be and will be fully integrated into the curriculum.

Students at the Lassonde School will take business and law courses in their first year and continue to study these disciplines so that they have the option after graduating with an engineering degree to add a law or business degree with two years of additional study. As well, students will be exposed to transdisciplinary learning that reaches out beyond the confines of the campus to involve not just other faculties but also industry, government and the community.

SHIFTING CURRICULUM DELIVERY

Thirdly, there needs to be a radical shift in curriculum delivery. Many engineers may not look back fondly on the hours they spent in lecture halls hurriedly making notes as a professor engaged in a monologue at the front of the room. We cannot justify this teaching method on the basis of some kind of rite of passage unless we can prove it is the best and only way to impart knowledge.

The "classroom flip," as we call it, turns tradition on its head. Students will be able to choose when and how they view lectures and study materials—at home, in a café or in one of our specially designed workspaces in our new building. In this model, students will be familiar with the material before they come to class, where they will discuss the concepts they have learned, absorb ideas from each other, and engage with professors and industry mentors. This student-centric approach will be integrated into the design of our new building to optimize this new type of learning

model, including a focus on breaking down barriers between students and professors to create a truly interactive environment.

This freedom involves a huge investment in students, who will have to take responsibility for their learning. The pursuit of knowledge will require a high degree of commitment from students. To become renaissance engineers, students will have to be entrepreneurial about their learning and career development.

We have been stranded at a crossroads in engineering education for too long, knowing that we need to change but being unable—and at times unwilling—to chart a different course. We can continue to talk about a new engineering education system or we can start the journey.

Qui audet adipiscitur. He (or she) who dares, wins. Ontario needs to be bold to win the future for engineering in our province.Σ

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