Back to the Future:
John Galbraith's Vision for Engineering Education

"The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."

Edward O. Wilson, Sociobiologist - 1998

The engineering profession is experiencing drastic changes. The demands imposed by society are quite different and more stringent than ever. Technology is changing at a dizzying pace, innovations have led to increasing complexity, companies now do business around the world, concern for sustainable development is at a peak, and our ability to make sense of devices that are supposed to simplify our lives is falling sorely behind. Consequently, universities need to graduate engineers with a different set of talents. In seeking to shape the future, it is sometimes useful to look to the past for inspiration.

Historical Context: Galbraith's Vision

John Galbraith was the first engineering professor at the University of Toronto (1878) and the first Dean of the Faculty of Applied Science and Engineering (1906). He laid the foundation for engineering education in Canada. I recently read Richard White's history of engineering at U of T (*Skule Story*, Faculty of Applied Science of Engineering, 2001) and Catherine Moriarty's biography of Galbraith (*John Galbraith: Engineer and Educator*, University of Toronto Press, 1989), and found that Galbraith's vision of engineering education has stood the test of time surprisingly well.

Galbraith believed that engineering education should be based on an awareness of social problems, go beyond technical excellence, emphasize communication skills, and provide students with critical thinking skills. In 1909, he stated: "The engineer never can hope to be in the position of not requiring to study non-engineering things. The training to be given in the engineering schools should deal more with subjects which are not engineering than those which are, the reason being that the time for such training is short whereas that to be devoted to engineering is long. Above all, the curriculum should be educative, the student should be training in clear thinking and in clear expression. When he graduates he should have acquired a sufficient knowledge of his geography to have some idea of where he is in the world in general and in the engineering world in particular". Despite the fact that it is almost 100 hundred years old, Galbraith's vision is just as valid today. We must take strides to achieve this vision.

Societal Context: Engineers as Leaders or Followers?

Despite tremendous technological progress, society is facing a number of pressing problems that are in dire need of solutions. These problems come from all sectors, including: energy, health care, education, transportation, water supply, and sustainable economic development. Galbraith believed that social problems of this type fell squarely under the purview of the engineering profession: "Who should be better qualified for the task of stimulating and guiding this public opinion than the engineer?"

However, the world of the early 21st Century is markedly different from that of the early 20th Century. Social problems are more complex in nature, increasing the burden on the engineering profession. Many believe that engineers are not up to the task. For example, Maurice Strong — a Canadian who has held high-level positions in the United Nations system – has questioned whether the engineering profession is capable of leading society in solving some of its most pressing problems: "We can use our human technological ingenuity to good advantage; indeed, we must. But we also need wisdom beyond the purview of the engineering schools. Technology can assist or hinder political solutions, but it is politics and its motivating values and priorities that are the keys to how we use technology to shape the human future". This perception is widespread and has affected students' career choices. According to a 1999 report from the U.S. National Research Council, bright students do not see careers in science and engineering as a way to reach positions of leadership in society. Both society and the engineering profession suffer as a result because those in leadership positions have little knowledge of science and engineering. Thus, the engineering profession is at a critical crossroads. One path is to change the nature of engineering education to meet the needs of society's most pressing problems. This option corresponds to Galbraith's vision, where engineers would play a strong leadership role in society. Another path is to sit back and continue with the status quo. This option corresponds to Strong's vision, where people trained in other disciplines, such as business and law, lead the way in making decisions about how technology will be used to shape the future of humankind. I believe that it is possible – indeed, necessary – to achieve Galbraith's vision.

Professional Context: Beyond Technical Excellence

Many of the problems currently facing society have a strong technological component, but they cannot be solved by technology alone. These problems also involve human, organizational, and environmental considerations. As Galbraith recognized, to better meet these needs, the engineering profession must become broader in scope: "A properly educated graduate ought to be able by his own reading to adapt himself to any situation wherein he may be placed. A broad education is the best preparation for specialization in … life".

The need for breadth is stronger than it has ever been. To use the words of Tom Brzustowski, President of Canada's Natural Sciences and Engineering Research Council, engineering curricula need to go "beyond technical excellence" by providing students with a much broader education than they currently receive. University of Toronto President, Robert Birgeneau, expressed a compatible view, stating that "leaders must know where they come from (history), who they are (psychology) and what impact they have (economics and social science)". This view is shared by U of T Provost, Adel Sedra, who stated that we need engineering curricula "that include significant exposure to humanities and social sciences".

Currently, undergraduate engineering curricula provide very little opportunity to take humanities and social sciences courses. A more extensive exposure to such courses could provide engineering students with a better understanding of the social context in which their future technical designs would reside. They could appreciate that attention to human factors and to the environment would become an integral part of "good design", not some isolated, specialist considerations that you worry about at the end of a project, if you have any time and money left over. Broadening the curriculum could also bring engineering students into contact with arts & science students, and expose them to other ways of thinking. The world is not made up entirely of people who think like engineers, a fact that some students only encounter after they graduate. Humanities and social sciences courses could also provide engineers with a more stringent opportunity to develop their writing and communication skills. Such skills are essential to success in the profession, but are not very well fostered by specialized remedial English courses just for engineers. Finally, a broader education could also enhance engineering undergraduates' tolerance for ambiguity. Students need to realize that, in engineering practice, decisions do not just have one correct answer that can be found by looking in the back of a textbook.

The importance of these insights is well captured by Professor D. Allan Bromley, Dean of Engineering at Yale University: "I have become increasingly aware that in the average engineering project, the first 10 percent of the decisions made effectively commit between 80 and 90 percent of all the resources that subsequently flow into the project. Unfortunately, most engineers are ill-equipped to participate in these important initial decisions because they are not purely technical decisions. Although they have important technical dimensions, they also involve economics, ethics, politics, appreciation of international affairs, and general management considerations. Our current engineering curricula tend to focus on preparing engineers to handle the other 90 per cent, the nut-and-bolt decisions that follow after the first 10 percent have been made. We need more engineers who can tackle the entire range of decisions".

Of course, a price would have to be paid to adopt the changes I am advocating. A few technical courses would probably have to be dropped from current curricula. John Galbraith would argue that such a trade-off is more than justified, and I would agree. Engineers in the 21st century need to go beyond technical excellence; they must be exposed to history so that they can learn from the past; they must be exposed to human sciences so that they have a better understanding of the relationship between people and technology; and they need to be exposed to social sciences so that they know what impact they can, and should, have on society. This new breed of technically-competent, yet socially-aware, engineers could lead society in helping solve some of its most pressing problems.

Engineers of this type would be invaluable because they could factor technical knowledge into important social decisions, something that decision makers trained in other disciplines are not prepared to do because they do not possess the requisite education. The importance of this technical knowledge was eloquently captured by the Nobel Laureate physicist, Richard Feynman, in the context of the fatal 1986 decision to launch the Challenger space shuttle: "for a successful technology, reality must take precedence over public relations, for Nature cannot be fooled".

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