Looking into the future

As electrical engineering professionals, we would all like to have a better understanding of the directions in which 21st-century engineering might evolve. As human beings who watched disaster in South Asia shake the world at the beginning of the New Year, we all wish to find ways to predict catastrophic events and prevent or minimize human misery.

While we cannot predict all natural or manmade disasters, we can look to the past as a basis for our predictions to guide our projections into the future. We can also examine present trends in engineering and forecast how they might play out and how they might affect our decisions as engineers and stewards of our profession.

A National Academy of Engineering webpage lists the twenty most important engineering achievements of the twentieth century (http://www.greatachievements.org/). The world our Western society takes for granted, outlined in this Top Twenty list—electrification, automobiles, airplanes, water supply and distribution, electronics, radio and TV, agricultural mechanization, computers, telephones, air conditioning and refrigeration, highways, spacecraft, Internet, imaging, etc.—is a world envisioned and created by engineers and, it could be argued, powered to a significant degree by the innovation of electrical engineers.

Some of the key twentieth-century achievements mentioned on this site will continue to shape our future. Finding renewable sources of cheap and clean energy for transportation, industry, home use and other needs remains one of the most pressing problems of our world. Energy consumption and its fallout effect on the environment are of utmost concern. Engineers will continue to be pressured to develop new products, systems, materials and methodologies to improve efficiency, safety and sustainability.

For example, the unabated demand for alternative energy sources has resulted in innovative efforts to reclaim the energy in wastewater and garbage, changing our thinking to view both, not as discards, but as potential resources. The need to provide affordable private, commercial and public transportation, coupled with environmental concerns, has also spurred the search for alternative fuels for diesel and gasoline-powered vehicles—alternatives that can be grown or renewed.

My colleagues at the University of Toronto are doing leading research in these and related areas. Just two examples will serve. A study, published in the August 2004 issue of the *Journal of Energy Engineering*, by civil engineering professor David Bagley and Ph.D. candidate Ioannis Shizas, was the first to measure the energy content of the raw municipal wastewater in plants in the Toronto area. The research revealed that the wastewater contained enough organic material to potentially produce 113 MW of electricity, or close to 990 million kWh a year. With a 20% recovery of that potential energy into electricity, it is thought that wastewater treatment plants could produce enough electricity for their own operation, and that any recovery of potential energy above that requirement could be returned to the grid.

A second example is the pioneering work of Professor David Boocock, of our Department of Chemical Engineering and Applied Chemistry. Dr. Boocock has invented new technology to transform the production of biodiesel, making it faster, more efficient and less costly to produce than traditional methods, which prevented biodiesel from being an economically viable alternative to petroleum diesel. His new approach to converting agricultural seed oil, recycled cooking oils, vegetable oils and waste animal fats into biodiesel—a renewable, biodegradable and sulphur-free replacement fuel—will be commercialized in a new Canadian plant with the capacity to add 50% to North America's total biodiesel production. Biodiesel fuel can be used in any unmodified diesel engine and will greatly reduce harmful emissions compared to traditional fuel.

Looking to current trends in engineering, it is clear that biomolecular engineering, nanotechnology and megacomputing are the current "hot" areas of research, likely to continue as the pre-eminent trends for the foreseeable future (http://www.spectrum.ieee.org/wfbonly/resource/jan04/). Beyond these emerging developments, the crystal ball is less clear. The final outcome will depend on political decisions and scientific breakthroughs that we cannot predict with any accuracy. Will it be space exploration, Star Wars, or attempts to undo the damage to the environment that will capture our imagination and resources in the coming decades?

How then to advise a young North American aspiring to be an engineer and wondering how best to be educated for the future? The question is especially pressing given that engineering jobs seem to be shifting to India and China. As educators and industry mentors, we should renew our efforts to preserve and redefine excellence if our young people are to find high-level jobs in North America. Another alternative that many bright students are already pursuing is to make themselves into citizens of the world, seizing opportunities to travel and work abroad in preparation for a career away from home.

When faced with planning an engineering education now, for a future determined by factors that are yet unknown, my conclusion is that developing fundamental skills for a high degree of overall mental fitness will best answer the need. A broad education will enable the engineers of the future to be the most nimble and agile in their responses to as yet unknown challenges.

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