The Grand Challenges for Engineering from the National Academy of Engineering

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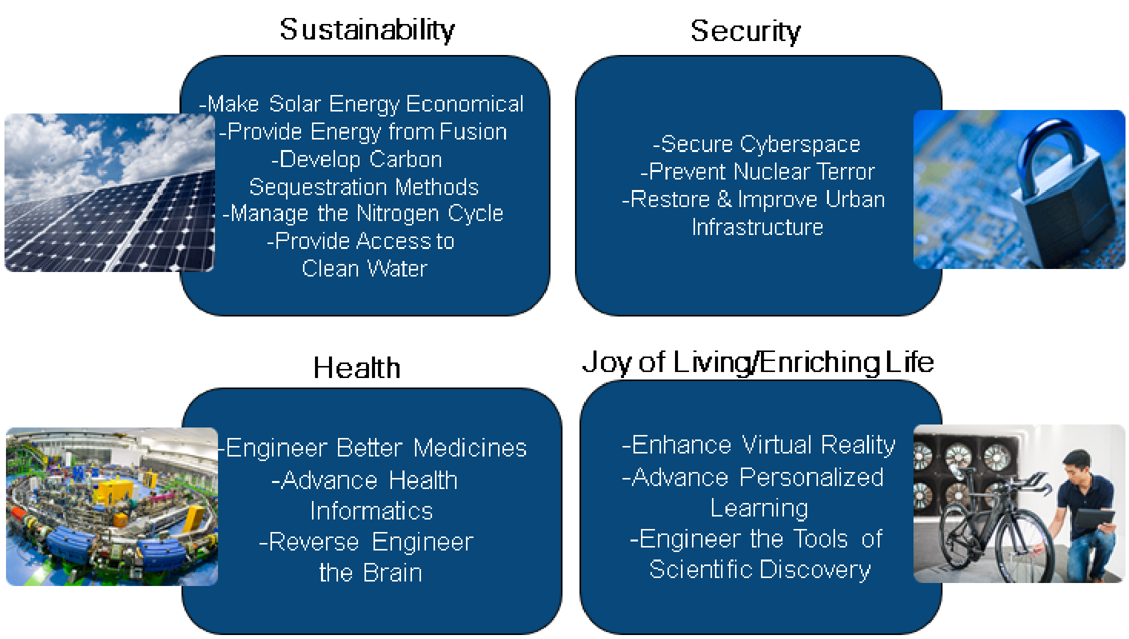
A total of 14 challenges for engineering in the 21st Century has been defined and proposed by the National Academy of Engineering (NAE) [1]. It all started back in 2008 when a committee was set out to identify some of the "most important, tractable engineering system challenges that must be met in this century for human life as we know it to continue on this planet" [2, 4].

The committee received and collected feedback and ideas from thinkers around the world and determined the list of 14 Grand Challenges for Engineering (GCE) which were presented on a report. The committee's report was then reviewed by more than 50 subject-matter experts, making it among the most reviewed of Academy studies.

The 14 GCE can be grouped into four main themes:

- Sustainability
- Health
- Security, and
- Joy of Living/Enriching Life



The University of Houston's Dean of the Cullen College of Engineering, Dr. Joseph Tedesco was part of a large number of engineering deans from leading U.S. universities who accepted the challenge of educating engineers to meet the GCEs [3]. This initiative recognizes and accepts the fact that in order to achieve these challenges, one of the priorities is to prepare engineering students with the "skillset and mindset" through education; the commitment from these academic institutions (including UH) is to integrate the following key elements into the engineering curriculum and/or activities [3], even in K-12 programs [6]:

- A creative learning experience connected to the GCEs
- Authentic experiential learning with clients and mentors that include interdisciplinary experience
- Entrepreneurship and innovation experience
- Global and cross-cultural perspectives
- Development of social consciousness through service-learning

From the engineering stand point, most if not all of these challenges require a trans/cross-disciplinary, system level, collaborative approach with a strong participation from industry, government, communities and the academic sector. For the electrical and computer engineering (ECE) profession, these challenges represent an immense and unique opportunity to have a direct impact on society as a whole and the future of planet earth, requiring a holistic approach to ideate, create, develop and deploy solutions outside the lab, in the real-world.

In order to tackle and meet the GCE, awareness and knowledge among students and faculty has to be increased. This requires proactive actions from both, faculty and the leadership at universities (and industry). For example, every lab in the Department of Electrical and Computer Engineering could at least have one project on the GCEs; the same applies to classes, lectures and courses that somehow touch the topics covered by the GCEs.

For example, the "Make Solar Energy Economical" challenge may be seen by ECE students as a problem that has already being solved (according to its wide spread adoption and the rapidly decreasing prices in solar panels and related technologies) or that it may not require more research or innovation; nothing is further from the truth. The reality is that solar (energy) technology is still far from being truly economical (especially if subsidies are eliminated or reduced); it is also not reliable enough and needs to be easier to install and maintain. Equally important, the lifespan of solar panels have to be extended, and its conversion efficiency increased to more than 20% in an economical way. In addition to all this, solar technology is tightly integrated with other technologies such as batteries/energy storage and power electronics; the former is indispensable for solar power to be successful as it is intrinsically and intermittent source of power (only works during the day, affected by cloudy skies, etc.) and the latter has to do with its integration with the power grid and AC power conversion (DC-AC conversion, power grid interconnect, etc.). Both of these (batteries and power electronics) are topics of research and development in the ECE domain and represent additional opportunities for ECE students and faculty to innovate and find solutions that have a direct impact in the real world. Other factors, not discussed here, are also important. For example, some of the materials used on solar panels nowadays are not as "green" as we may think [5]; some of them can be considered highly hazardous and toxic and have to be properly handled and disposed of when taking out of service (the same applies to batteries used in residential solar panel installations). As engineers, we want to make solar energy technology sustainable and safe; today, silicon Photo-Voltaic (PV) cell production involves many of the same materials as in the microelectronics industry (you may see PV technology as a microelectronic technology) thus presents the same challenges and hazards, and are subject to the U.S. Occupational Safety and Health Administration (OSHA) standards and procedures. All these challenges represent huge opportunities to make solar energy economical by adding innovation and ingenuity to the engineering process.

In a similar way, there are many other examples that we could describe in this article but given the space constraints they are left for future editions of the ECE Dept. Newsletter. On the next edition, we will discuss fusion energy, what it is, and how it can become a reality in the next two decades or so with the help of a new generation of engineers prepared and willing to take on this challenge. In the meantime, we would like to hear about your ideas on how solar energy can become more economical while meeting the associated challenges discussed above. Please feel free to provide your feedback and project ideas to consider for student and lab projects in the ECE Dept.

References:

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