Engineering plus X

Tech must ally with other disciplines in the Fourth Industrial Revolution

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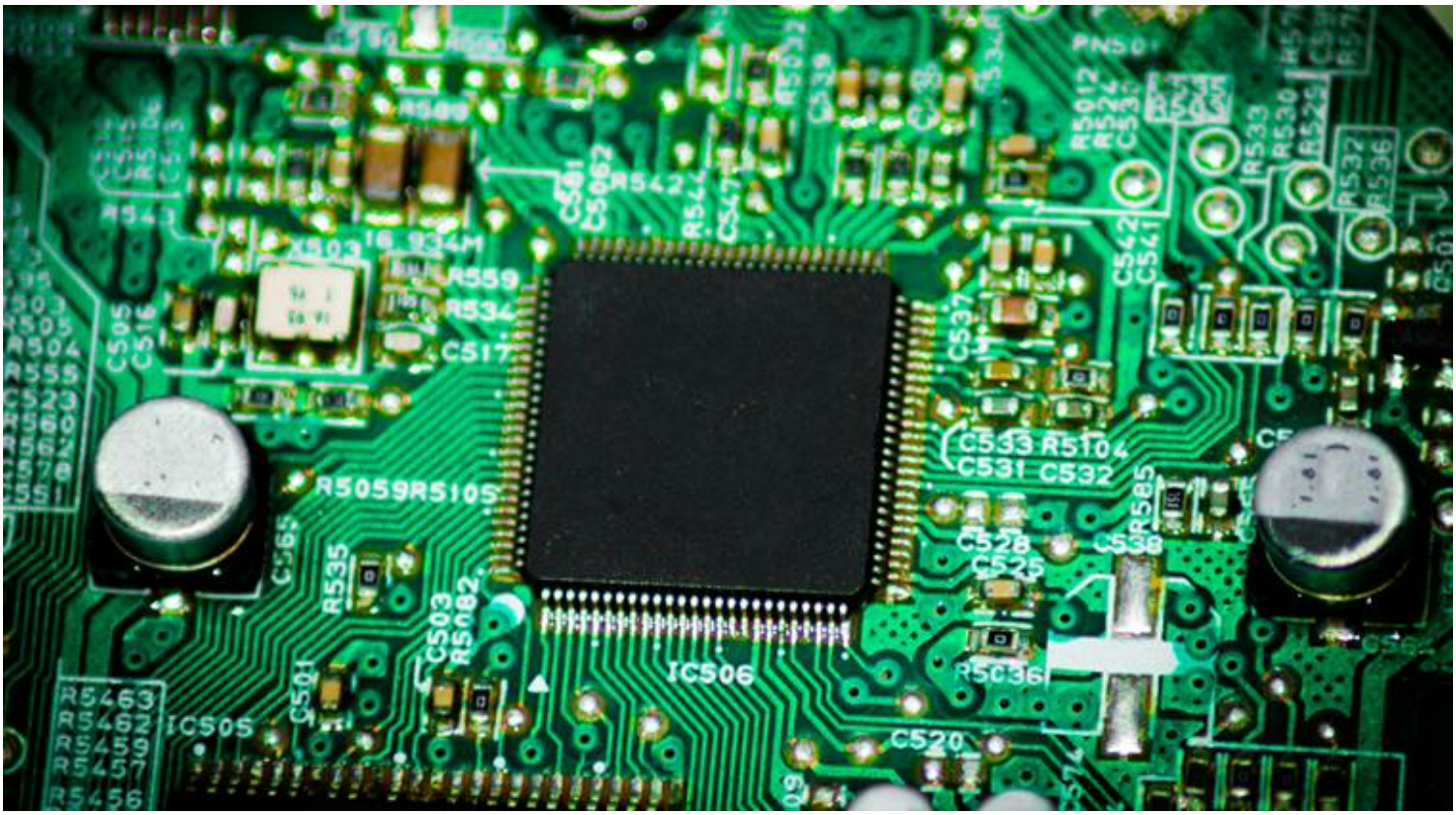

Representational Image

In the words of Chuck Vest, the late president of the US National Academy of Engineering, “we live in the most exciting era for science and engineering in human history.” We are in the midst of unprecedented, exponentially accelerating innovation that every day alters the way we work, live, interact and create. This innovation, fuelled by technology, encompasses practically every discipline, every aspect of our life, and promises to bring unprecedented prosperity and well-being.

Many, particularly the World Economic Forum, believe that we are entering a new era, that of the Fourth Industrial Revolution — the era of convergence where the physical, chemical, biological, behavioural and increasingly, the social world will be integrated in unprecedented

ways. Understanding that engineering, computer science and technology will be the enabling drivers, we have coined — for several years now — this convergence as “engineering + X” (X being whichever problem, discipline or arena in which engineers engage), and have endeavoured to practice it through interdisciplinary initiatives.

I find it most convenient to use James Maslow’s hierarchy to classify needs, opportunities and useful purposes. These are: Sustainability, health, security, and (in a collective basket of its own), the joy of life. Convergence and engineering + X are necessary to address needs and advance useful purposes in each of these categories. Consider sustainability, where, for example, technology will need to partner with the natural sciences; health, where it must partner with medicine and biology; security, where it must partner with policy and law; and the joy of life, where it must partner with education, entertainment, communications, social and behavioural sciences and the arts.

Such a Maslow inspiration also characterises the 14 grand challenges for engineering, announced about a decade ago by the US National Academy of Engineering to solve some of the world’s greatest challenges — these are universal problems experienced by human beings.

Useful purposes invariably have unintended consequences, which are increasingly powerful as technology reaches increasingly higher peaks. Nuclear power was intended to advance sustainable energy — but it has also been used for nuclear weapons. The internet and the communications revolution allowed unprecedented communication, self-empowerment, made the world a tighter-knit community and advanced mutual understanding and prosperity. But it has also enabled unanticipated behavioural changes through social media.

There are concerns that artificial intelligence and machine learning — fundamental pillars of this technological revolution — will be on a collision course with humanity. Or, that advanced manufacturing will lead to a very different future of work.

We believe that engineering, science and technology will lead the convergence of disciplines to solve to a great extent the fundamental questions of Maslow’s hierarchy, starting with the most essential: Sustainability, health and security. In the process, it will free human activity towards resolving societal challenges, promoting the joy of life and the pursuit of happiness in terms of personal and societal growth. A slew of emerging technological breakthroughs will underpin this transformation: From the Internet of Things to AI and machine learning, advanced manufacturing and biotechnology.

Challenges would need to be addressed at every step. We, at engineering schools, will need to redouble our efforts to produce students with skills that yield intelligent, legal and ethical decisions. This is where the X in “engineering + X” represents humanity, empathy, character, judgement and values, both for individuals and society at large.

Consider the work of scholars at USC where I work: Milind Tambe uses AI in partnership with social work (X=social work) to thwart the spread of HIV among homeless youth, or applies AI to deter wildlife poaching. Maja Mataric’s research focuses on social assistive robots to help the elderly, sick children or those with autism (X=medicine). Nora Ayanian facilitates multi-robot communication for disasters (X=communication and policy). Shri Narayanan uses machine learning to curb addiction, computer vision to assess gender inequity in the media in partnership with the Geena Davis Institute (X=digital media) and to help foster communication in interpersonal relationships (X=psychology). Pedro Szekely and Prem Natarajan use “big AI” — knowledge graphs, machine learning, natural language processing and computer vision — to combat human trafficking (X=security and social justice).

Today, problem solving and innovation are not the domains of one discipline or one people, one geographic area. For the best global, social and economic solutions, diversity of thought, opinions, education and experience are necessary. Higher educational institutions worldwide — as long as they are fuelled by vibrant, diverse engineering talent from all corners — will continue to be fertile places for new ideas, entrepreneurship and the embodiment of engineering + X for the benefit of our ever-closer world.

Engineers, scientists and technologists will increasingly be called to address new challenges in the expanding domain of convergence. Quantum physicist David Deutsch says, “There will always be problems. But all problems are solvable, through science and engineering.” It is this mindset that must characterise the new engineers.

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