
4. IMPENDING PARADIGM SHIFT IN ENGINEERING SCIENCES & FUTURE CHALLENGES

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“Engineering is an activity other than purely manual and physical work which brings about the utilization of the materials and laws of nature for the good of humanity.”

Engineer - R. E. Hellmund

Yes, said very truly, lending the helping hand in growth of the human society and keeping it in harmony with laws of nature has been the initial goal of the Engineering Sciences and Technologies (EST). In fact, undoubtedly, these have always been the catalysts in progress and development of the human society. The EST have been the only reason, in bringing the human society to a stage where it stands firm today, seeking the most benefits of the current technologies and making the daily living, a wonderful experience of living the life. Definitely yes, only developed countries of today's era, are focusing on the use of the EST for betterment and preservation of the most important component of us as living beings, the **NATURE!!** The global environmental problems we are facing today, is the most dominant proof of the fact that while marching on the journey of excellence, the EST s have deflected from their initial goal, as stated above, somewhere causing the imbalance in nature! And this imbalance has raised a set of various engineering challenges, that today's engineering community has to face!

The quote from some famous U.S. engineer and architect reads, “When I'm working on a

problem, I never think about beauty. I think only how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong.” Do the engineers of today's era preserve this vital, necessary mindset when they do invest their valuable energy, time and money in getting solutions of the various technical problems? Yes, they might be preserving this mindset, now, when we have to face the challenges like global warming. However, in case this mindset would have been preserved throughout the development process, we would not have been the victims of the global environmental problems of today! However, now we, as the engineers, have to find solutions for the resolution of future challenges that stand in front of us today!

Let us look into various scenarios that have caused this paradigm shift in EST. Obviously all time rising world population and its daily needs of living a comfortable life, have been the major reason of this paradigm shift. Let us discuss the major disciplines of engineering sciences that faced this challenge of coping with rising population. We will also discuss some other challenges that relate human beings with the technology.

The classic example of the **Civil Engineering** discipline in this population context is the development of the Palm City, Dubai! This engineering discipline achieved the highest of its glories when civil engineers succeeded in building the beautiful artificial

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islands in Dubai. This was the **paradigm shift** when with the help of civil engineering science, human could conquer the oceans. However, the artificial islands and offshore luxury townships coming up in the Persian Gulf are potentially vulnerable to natural hazards like earthquakes and tsunamis. According to the reports, the massive development projects in the United Arab Emirates (UAE), Qatar and Bahrain, are susceptible to both geological and atmospheric hazards. According to the scientists, tropical cyclones and the resulting oceanic surges are the main possible atmospheric hazards that can strike this region at any time in the future. "The danger of earthquakes would be higher in reclaimed islands and their tall buildings because reclaimed land is potentially more susceptible to liquefaction and slope failure," the report warns. Liquefaction is a phenomenon where soils suddenly go from a solid state to a liquefied state that can happen when the ground is shaken during an earthquake. Hence, as the civil engineers fasten their belts for development of such artificial islands "**building safe and secure artificial islands**" is the **challenge** they face! They still need to answer the question "whether they are technically equipped and ready to face these unavoidable, unpredictable natural attacks?"

Another challenge facing the **Power Engineering** discipline, in this population context, is coping with the all time increasing demands of electricity or energy, in general. The fossil fuels like natural gas, oil or coal cannot remain the dominant sources of energy forever. Their depletion to demand numbers, just can not keep pace with each other. The science achieved one of its **mile stones** when it could convert the abundant **solar energy into the electrical energy** where it proved that only the solar power offers a long-term, sustainable energy source and remains the only alternative available with the engineers. Its availability far exceeds than any other energy source, it is environmentally clean and its energy is transmitted from the sun to the Earth free of charge. But how "**to exploit the sun's power**

in economical way" is a **future challenge!** The solar power generation to a wider scale will require engineering innovations in several areas like in capturing the sun's energy, converting it to useful forms, and storing it for use when the sun itself is obscured. But today's commercial solar cells, most often made from silicon, typically convert sunlight into electricity with an efficiency of only 10 percent to 20 percent only. To make solar energy economically competitive, engineers must find ways to improve the efficiency of the cells and to lower their manufacturing costs. Yes, this still remains a challenge for the future, for the engineering discipline.

Let us now have a look at **Environmental Engineering** discipline. When some famous English poet wrote "**Water, Water, everywhere, nor a drop to drink**", he did not have the 21st century's global water situation in mind. However he wasn't far from correct. Today, the availability of the clean water for drinking is a critical problem in many areas of the world. When this engineering branch came up with implementation of innovative idea of desalination, which is the process of extracting salt from water in order to generate clean water, it was thought of one of the **remarkable shift** in the technology where abundant source of oceans was thought as raw material. The technique as called nano-osmosis, filters out salt with the use of tiny tubes of carbon. Experiments have shown that such tubes, called nano tubes have exceptional filtering abilities. After some successful implementations in middle east, the implementations have started facing **challenges** when huge plants of desalination are demands of the time. Now, the challenge is that when these plants are to be implemented on mass scale, they face the reality that they are too expensive to tolerate the efficiency at which they work. So "**building cost and output efficient desalination projects**" is the major challenge, the environmental engineers have to rub their head against! The survey of existing plants show that the energy requirement, cost to output generated ratio, is not satisfactory. Some

traditional techniques like recycling, rain harvesting for saving the clean water is a social responsibility. However, in reality, facts say that "social" responsibility is of everyone and hence of no one!

After discussing some major future challenges which have aroused either because of violating the laws of the nature or which can be solved by seeking the help of the all time generous nature, let us now discuss future challenges facing other engineering disciplines.

Let us discuss the case of **Electronic and communication Engineering** discipline. The launch of Internet has been the **paradigm shift** in this branch, no doubt! Communication technology evolved a lot thereafter and now wherever one goes, the network follows! Huge usage of the cyberspace has now, come up with a **challenge** of "**security and privacy management of this "open" cloud of network.**" Famous security breaches have already demonstrated the high technical abilities of the hackers. Even though the software engineers can develop a strictly secure system, the trade off between flexibility of usage and required security becomes difficult to resolve. The mentality of cyber users then tend to be resistant for such system. Along with security, privacy management is also one of the issues facing of the design engineers. We never know when-how and what details of us are exposed to whom and by whom, when we are once on the cyberspace! Take the example of the latest 3G technology of communication. It proves best for facilities like video conferencing; however, it exposes the "unwanted" details! Not only the cyber laws and regulations are to be evaluated thoroughly but also "moral" responsibility of entire cyber users is to be tested and moulded in correct direction! Isn't it a really great challenge?

The case of **Computer Engineering** discipline also has a similar story. The branch evolved with the science of artificial intelligence, wherein, when the "thinking machines" in form of computers who could emulate the human

thinking capability evolved, they astonished every one! The evolution of this virtual expertise was thought of a great **achievement** and many interesting topics ranging from expert systems to neural networks. These technological advances however could not **challenge** superb speed and computing capabilities of the Human brain. "**Simulating the human brain**" is still one of future challenges the computer engineers need to tackle. The computing speed, imagination power, recalling capabilities, concurrent processing are some distinct features of the human brain that still remain untouched by current trends in artificial intelligence or neural networks. Hence achieving the results for guessing or predicting "what is mind of a brain" or "reverse engineering the brain" do sound much farther goals. Said again, the engineering technologies have still to answer the "**Natural super power of the human brain that comes from the heaven!**"

Looking at the growth rate of worldwide terrorism; yes, the engineering disciplines like **Biotechnology, Chemical Engineering** are already being questioned for their answers to prevention of bio and nuclear terrorism. You may be watching a movie in a local theatre where you just ignore the small incidence of a something itching or penetrating your skin and later on you may find yourself as victim of aids! Dangerous!! The **nanotechnology** when stepped into these engineering disciplines was thought of one of the greatest discoveries. Ranging from field of medicine, energy, optics to security, food, electronics, this science captured every important aspect of the needs of the society. However, no advances come with side effects! Just like the hackers are utilizing the Internet for breaching the people, the terrorist are making the use of nanotechnology against the society from where they themselves have come! We already have become victims of many famous bioterrorism attacks like Japan-1995-Sarin gas attack, Ireland-1998-Omagh bombing attack etc. Many countries do hold strong nuclear ambition! Hence "**prevention of bio and nuclear terrorism**" is definitely a

challenge facing the engineers! Although the pathway seems difficult, the day should not be farther when this should also be tackled successfully.

This list of the emerging technologies and the advances they are bringing can still be extended! However, just like the two sides of a coin, every advancement is also bringing new challenges for the engineering community. The President of U.S.A. Mr. Barack Obama has said once, "Technology is an ally; use it to reach to the masses!" However this "mass" is a mix of good and bad minds! This "mass" encompasses good and bad attitudes. And whichever may be the engineering or medical or any other branch of science, it will always

face the challenge of moulding these minds into right direction; the direction of peace, the direction of harmony, the direction of right attitude. When this balance of technological advances and right approach of exploiting the maximum benefits from them will be achieved, the day of glory intended by all the noble hearts will be here, here on this beautiful planet of MOTHER EARTH!! **May God bless the entire engineering community with the patience, courage and capabilities to fight against these future challenges and to bring the intended peace, harmony and glory here, very soon!!**

