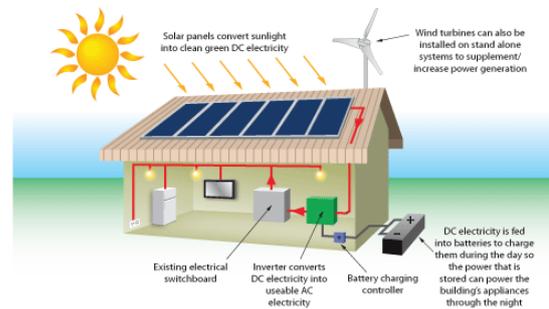


Trends in Technology and Higher Education

1. Technology Trends

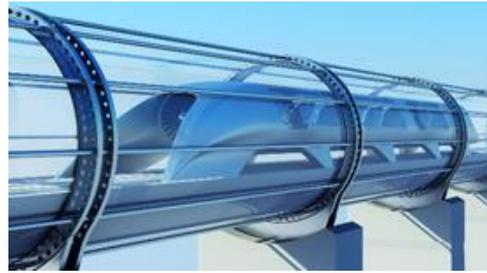
The phenomenon of Global Warming caused by carbon dioxide, generated from the combustion of fossil fuels and other human activities, is largely responsible for the present global climate change. Exceeding the limits of carbon dioxide presence of 450 ppm, by the year 2050, in the atmosphere, could have dangerous consequences for the continuation of the human civilisation. In order to maintain carbon dioxide well within predicted safe limits in atmosphere, governments across the world are encouraging the harnessing of renewable sources for power generation. At present, the total installed capacity of solar power and wind power are 330 GW and 486 GW respectively against a total installed capacity of 16,000 GW. By the year 2040 it is estimated that more than 40% of the then total installed power will be generated from the renewable energy sources. A distinct trend has been observed in Europe, India and many other countries across the world where households, offices and even university campuses are installing roof-top solar power plants for meeting their energy needs. As we move towards the future, the domestic installation of solar and micro wind power will witness a dramatic shift and the cost of solar panels will, correspondingly, come down. Simultaneously, one can also see innovative, cost-effective, micro wind mills are coming into the market. Thus, in future, it is expected that a large number of houses, offices and institutions will become zero energy-draw houses meaning they will not draw energy from the power grid beyond the local boundary of the building clusters. The end use devices and gadgets will, at the same time, become more energy efficient and roof top mounted power plants will be coupled with batteries for energy storage. We can also see a scenario where Battery manufacturers will be able to develop high energy density and light weight batteries having long endurance. In India, during the eighties and the nineties of the 20th Century, people had to wait for several years to get a telephone connection. The advent of mobile phones has revolutionised the communication sector across the country and touched the lives of all of us irrespective of economic and social status. I quote Samuel Bodman, former US Energy Secretary, who, once said in a speech that, "As the technology for solar cells gets better and better, this form of clean, renewable energy will find more applications that take up less space and produce more electricity, to meet the energy needs of our homes, schools and businesses." Surely the installation of roof-top, power plants will be able to revolutionise the power sector of our country given that India is in a position to generate solar energy almost throughout the year.



The transport sector, which has been consuming more than 2340 million tonnes of oil annually, is equally responsible for Global warming and collectively emits almost 32% of the approximately 40 billion tonnes of carbon dioxide released into the atmosphere annually which is about the equivalent of that generated by the power sector. Elon Musk, CEO of Tesla, the automotive company that is pioneering the electric car in the US once said, "Well, my motivation behind Tesla is really to do as much good as possible for the environment and the electric-vehicle revolution." Tesla cars are increasingly becoming popular in the USA. The nations of Europe, China and India are all actively encouraging the move to means of transport using electricity and other clean sources of fuel. In the coming decade we will witness the increased presence of electric vehicles and trains



across the world. The Hyperloop will soon be a reality for fast, inter-city transport. The “Southern Company” of USA believes that “Electricity powers nearly every aspect of our lives, and we’re bringing sustainable energy to transportation, both on and off the road. By offering lower electricity rates and programs for off-peak usage, we help people and businesses reduce costs and environmental impact. Customers save on charging, while commercial businesses increase efficiency by using electricity to transport their goods.” Many governments including the UK and India have introduced policies encouraging the production and sale of electric vehicles.



Waymo, a Google created company, is testing a fleet of autonomous cars in real world conditions and so far the cars together have covered a combined 3 million miles, in test conditions. Major automobile manufacturers have invested significantly in the development of Autonomous Cars. In the near future, autonomous cars will be a reality and transport fleet operators like Uber are already strategizing the shift to autonomous cars.



In low income and middle-to-low income economies, a large percentage of people are involved in agriculture. In India, more than 62% of people are involved in agriculture, yet their gross contribution to the economy is not more than 22% of national GDP. In high income countries, a small percentage of people manage agriculture related activities but successfully produce surplus food. In India, mechanised agriculture will become more popular and automation in agriculture will get a big boost. In the future, Robots that can perform the agricultural activities with much better precision and productivity will be a familiar scene. Such technology has been used for harvesting, food processing and other agricultural activities. As the supply of arable land is limited and population is on the rise science has developed crops that are genetically modified and which can grow in hostile habitats besides their native ones. These actions are necessitated to both increase the yield and productivity to feed the burgeoning population.



The Manufacturing sector, which has already embraced the move towards automation, may introduce further process automation and additive manufacture will be the future. Manufacturing activity, as we see it today, may see a drastic disruption in the near future.



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Industries are already using 3D printers for manufacturing components and systems. Future manufacturing plants will probably have rows of 3D printers instead of machine tools.



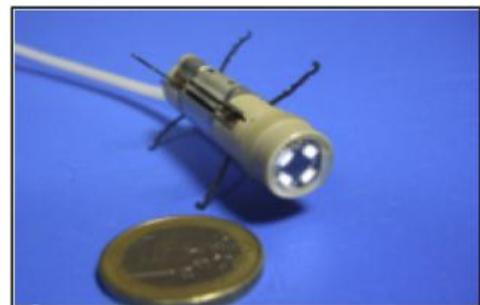
The construction sector too, will be using 3D printers for printing houses and building.

Service industries like restaurants, hotels, retail sectors are emphasising on automation in order to improve the efficiency and reduce the cost of operations. Automated restaurants have already sprung up in many countries. In the figure shown alongside, Robots can be seen delivering dishes to customers at a Restaurant in Harbin, China.



Amazon is already experimenting with its checkout-free store concept, thus eliminating the need for cashiers in retail industries. The shopping experience, for all of us, will be a transformed one very soon.

The Health care sector is undergoing enormous change with the introduction of advanced technologies for diagnosis of health conditions and in actually performing surgical procedure. Advancements in the electronics sector and the progress in nanotechnology have resulted in path breaking technologies that will transform the way diagnosis and treatment are carried out currently. One development is that of Medical Capsule Robots. The idea itself emerged from science fiction which predicted the idea of robots travelling inside the human body to diagnose and cure disorders. The first capsule robot that entered the market was a capsule endoscope, developed to capture images of the gastrointestinal tract. Today, varieties of capsule endoscopes are available in the market. They are slightly larger than regular oral capsules, made up of a biocompatible case and have electronic circuitry and mechanisms to capture and transmit images. In addition, robots with diagnostic features such as in vivo body temperature detection and pH monitoring have also been launched in the market. However, a multi-functional unit that will diagnose and cure diseases inside the body has not yet been realized. A remote-controlled capsule that will undertake drug delivery and surgical treatment has not been successfully launched in the market. The high development costs, inadequate power supply, ineffective control over the release of drugs limited space for drug storage on the capsule, inadequate safety and lack of suitable mechanisms for active locomotion and anchoring have prevented their entry in the market. The Medical Tricorder is used by doctors to help diagnose diseases and collect bodily information about a patient. Some amazing healthcare technologies that are coming into the market include Interoperability between Health Systems; Robotic Nurse Assistant; Artificial Retinas;



Interoperability between Health Systems; Robotic Nurse Assistant; Artificial Retinas;

Advances in Prosthetics; Remote Patient Monitoring; Anti-Aging Drugs; Tooth Regeneration; Lightbulbs that Disinfect and Kill Bacteria; Electronic Underwear Preventing Bed Sores; Long Lasting Batteries for Medical Devices and Wearables; Health Informatics; Plug a Gun Shot with Tiny Sponge; Examination of veins under the skin in real-time Gels that stop bleeding in seconds and Cholesterol removing machines..

Call centres that employ thousands of people are also introducing automation to make their services more efficient and cost effective.

Governments are now actively investing to establish “Smart” Cities. These cities are designed to have better security, well managed infrastructure, green energy, efficient transportation, traffic control and smart health care systems. The use Internet of Things (IoT) technology will play a major role in Smart cities management.



In the education sector, digital learning is slowly catching up and we are now hearing of the concept of online degrees. Scientists are exploring the use of artificial intelligence for teaching.

As we move forward innovation in most of the sectors will be data driven. The trends obtained through data analytics will greatly help industries and businesses in making better choices for their investments. Data Sciences, Data Analytics, Machine Learning and Artificial Intelligence will drive the Knowledge Society as they become the main tools for driving innovation and technology development.

2. Impacts on Society

Technology and human life cannot be separated; all of society has a cyclical co-dependence on technology. We use technology; we depend on technology in our daily life and our needs and demands for technology are continually on the rise. Humans use technology to travel, to communicate, to learn, to do business and to live in comfort. However, certain technologies have also caused us concerns. The increased energy generation has polluted our atmosphere and carbon dioxide emission from the combustion of fossil fuels has become the main cause for global warming and climatic changes. In order to make agriculture, manufacturing and services sectors more efficient and cost effective the introduction of automation technologies may cause huge disruption among communities. The workers in coal mines, people working in service sectors like restaurants, retailing, fleet operators, labourers in the manufacturing sector and even farmers engaged in agriculture may get affected because of reduced opportunities for work. The new technologies and paradigms will create a demand for significant change in the curricula and in the manner in which science, engineering, medicine, management, nursing and other disciplines are taught. As the technology is advancing, people have to continually acquire higher level of knowledge, competencies and skills to remain useful and productive in this ever-growing, knowledge society. Universities will be hard pressed to reinvent themselves through this journey to educate and train the work force of the future. Workers themselves will have to adopt the lifelong learning philosophy to



remain relevant for a longer period of their career. Those who do not keep updating their knowledge and skills may become partially or wholly irrelevant resulting in complex, socio-economic conditions and posing new problems to society.

3. Trends in Higher Education

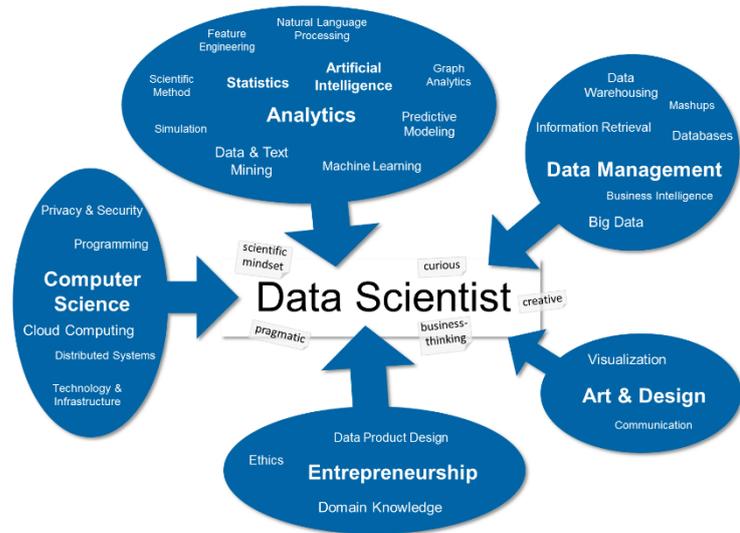
The central mission of higher education is the creation of prepared minds. The prepared minds contribute to the scientific, technological, economic and social development of a nation and world in general. The prepared minds innovate, create new businesses and more jobs as responsible citizens. As new innovations happen, Universities create new programmes and even new schools to focus on developing new mind-sets. Most universities with this central mission are state funded, as it is the responsibility of a country to encourage higher education among its citizens as a means for its development. But, recently there has been a demand that there be a greater focus on career development turning universities into educational enterprises. Many state Universities, world over, have to find ways to raise funds for their sustenance as the funds provided by the State are insufficient and universities in the private sector are mainly dependent upon students' fees for their sustenance and growth resulting in high costs of higher education. As the expectations of students and parents from the higher education system is increasing, the cost of higher education is increasing phenomenally putting many students into disadvantage. Realising the important of higher education many countries in Europe have made higher education available to students free of cost.

Many times people have raised the questions regarding the relevance of present university system under the rapid technological disruptions that are happening in the society. Education is beyond teaching and training students. It is all about preparing minds. Many educationists of repute have opined, including Prof. Philip Altbach of Boston College, that the university system should continue to exist and in fact flourish if society is to progress. Online education and e-content cannot be a comprehensive replacement for the present university system. At best they can supplement university education. The important of universities contribution to the new developments in technology should not be under-estimated.

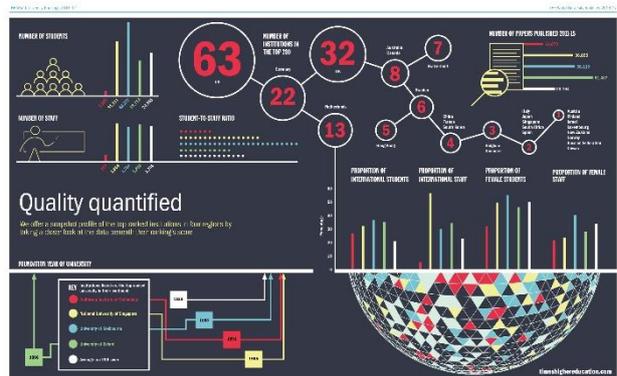
A large number of Universities across the world have adopted the outcome-based, student-centric education model while a significant number of universities are continuing with the traditional, teacher-centric education system. A few universities have started experimenting with competency-based education models. Each education model has its own advantages and limitations and no model can be branded as the ideal one.

Whatever be the educational model a university has embraced, it is necessary to keep the teaching and training content relevant and current to meet the wider aspirations of graduates. It is a great challenge for universities to keep their teaching talent and resources up to date under the rapidly changing circumstances while still mindful of keeping the cost of education within limits. Till the mid-20th Century, the universities focussed on preparing graduates to meet the requirements of the industrial era. After the mid-20th century, it was the beginning of the knowledge/information era and the use of computers became pervasive and automation was introduced in many walks of life. Now, the world is turning towards data driven knowledge era and artificial intelligence. The future devices and equipment are based on artificial intelligence technologies and they may even challenge human intelligence. Industries and businesses at present are preparing for the development and deployment of intelligent systems in a large number of sectors. The work force in the immediate future will be

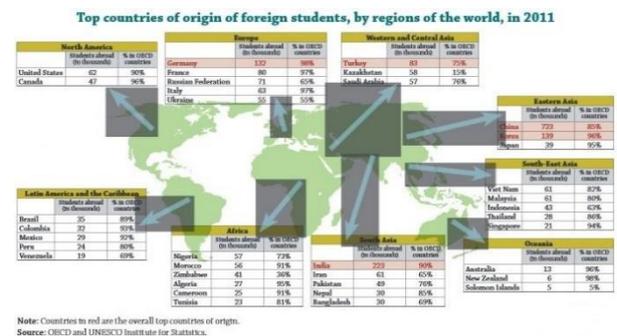
expected to acquire the knowledge and competencies essential to work in industries and businesses involved in the development and deployment of intelligent systems. Universities will also be required to gear themselves up to align with the extremely dynamic changes that are happening in the industry and businesses in order educate and train their graduates. Graduates will be confronted with the need to continuously learn, unlearn and relearn to remain relevant during their work career as technological changes are so rapid. Progressive universities are making changes in their curriculum to meet the needs of graduates in the immediate future. Many knowledge based organisations are creating e-content on advanced topics and delivering such content through MOOCs platforms. Such of those people who have realised the imperative to remain relevant, in this rapidly changing world, have resorted to lifelong learning. Universities, in addition to, face-to-face lectures, use blended teaching and flipped class room to meet the wider requirements of their learners.



In the Universities, it is becoming more and more important to align research activities with rapid technological changes that happen in industries and businesses. The universities are looking for more sources of research funding, as the scarcity of such funds is leading to high student costs. Universities are encouraging innovation and business incubation among its graduates in order to commercialise their research to find more funds for further research and growth.



Universities which are dynamic are working actively to remain relevant with the fast changing society by overhauling their curricula, introducing newer teaching and learning methodologies, emphasis on research and publications, business incubation and increasing the interaction with industries and businesses. These forward-looking universities are attracting better teaching and research talent and highly motivated, talented students from across the world. Such progressive universities naturally have the potential to be ranked high in global university ranking systems which, in turn, will help them to grow further. The top 200 universities, appearing in the world ranking systems, constitute just 2% of the population of higher education institutions across the world. Most of these Universities are, presently, located in the more affluent, High Income group countries.



To make available quality education and relevant skills to aspiring graduates, many countries across the world are taking actions to encourage the international mobility of students and transnational education. Such foresight will not only help the graduates but it will also generate significant social and economic dividends to the sponsoring countries that help generate the knowledge of the future.

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