



Scientific Innovations in the Service of Society

Ajey Lele

Innovation mostly indicates advancements, however, it is important that such advancements should be novel too. This is because, at times, the advancement is more about the progression for the existing technology than having discovered something new or original. Say in case of developments being witnessed over the years in the domain of computers: a 32-bit microprocessor introduced in 1985, the Intel 80386, which was known as 386 was replaced by a 486 microprocessor after a few years, which was a higher performance unit. Here the nature of technology almost remained the same, but the upgradation of technology was witnessed. However, if the present

conventional (known as classical) system in future gets replaced by a quantum computing system, then it could be correct to conclude that a new innovation in the computing technology has occurred. This is because the processes of undertaking computations are different in classical format and quantum format and quantum computing has been projected to bring in major change to the existing structures of computing processes. At present, quantum computing is at an experimental stage and it is expected that in a few years this technology could become a reality bringing in major disruption in the IT (Information Technology) sector in particular and ICT (Information and Communication Technology) sector, in general.

Technology forms the subtext of human development. History is replete with instances of technology serving as catalyst in the grand narrative of human development. From basic necessities like food, air, water, clothing and shelter, to structural requirements like security, technology has played a tremendous role in every field of human growth and survival. Over the years, the world has witnessed various innovations happening in the field of science and technology (S & T) which have made significant difference to the lives of the common man. Such innovations have been happening in various fields of science from Physics to Biology. Some of the innovations which have been predicated to change

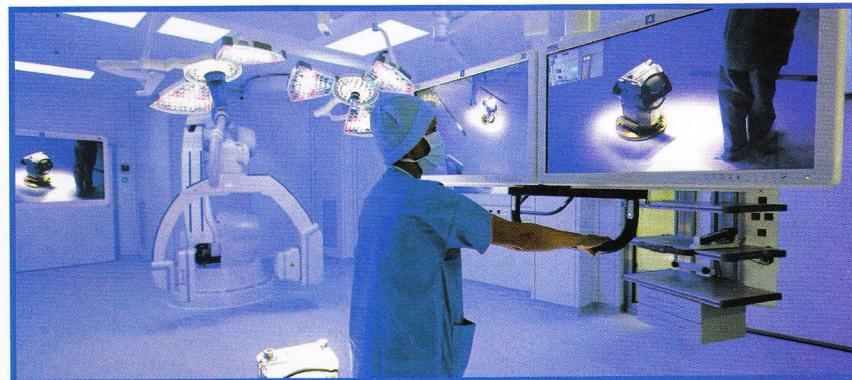
The author is Senior Fellow at the Institute for Defence Studies and Analyses (IDSA), New Delhi. His specific areas of research include issues related to Weapons of Mass Destruction (WMD) and Strategic Technologies. He has authored few books.

human lifestyle in the near future, are presently at various levels of their technology development life cycles.

Around the year 1948 the invention of the transistor, a device with potential to have numerous applications in radio technology by replacing the vacuum tube, took place. This electronic component demonstrated its capability to have instantaneous action. This was possible because there was no workup delay that used to take place in the vacuum tube, since no heat was getting developed. The innovation of the transistor could be viewed as one of the most significant innovations of the modern era. The transistor is a resistor or semi-conductor device which helps amplify electrical signals as they get transferred through it. The presence of the transistor enables all kinds of binary logic operations and has brought a revolution to the field of electronics and computing.

Historical Perspective

Actually, manifestation of various technological developments have resulted in various industrial revolutions since 17th/18th century onwards. The beginning of the industrial revolution had British industry at the centre. Slowly, industrialization spread from Britain to other European countries like Belgium, France and Germany, and then to the United States. By the mid-19th century, industrial progress had happened mainly in Western Europe and the North and Northeast of the United States. It was the period when the United States was emerging as a major global industrial centre. In Asia, countries like Japan, and in the later part of 20th century, South Korea contributed much towards the industrial revolution. However, during the last few decades, one country that has shown remarkable progress towards industrialisation is China. Countries like Israel and India are known to have made some contributions too, with Israel playing a major role in the realm of technology development. The main



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features of these industrial revolutions are as follows:

- The First Industrial Revolution: 1760 – 1840. It was a period which witnessed the emergence of steam engine, textile industry and mechanical engineering
- The Second Industrial Revolution: 1870 – 1914. The revolution was about emergence of railways and steel industry.
- The Third Industrial Revolution: 1969 – 2000. Electric engine, heavy chemicals, automobiles and consumer durables made their presence felt during this period.



- The Fourth Industrial Revolution: the digital revolution, since 2000 or a few decades prior.

This is an ongoing phase of this industrial revolution which has also been called as Industry 4.0. Developments in the oil industry and the IT industry have led the initial phase of Industry 4.0. At the same time there are various other S & T innovations which are leading the progression of this Industrial Revolution.

Innovation in Various Sectors

Biology, Biotechnology, Pharmacy and Medicine are the areas which have witnessed various important innovations over the years. Particularly, all these innovations matter much to humanity because they have helped to increase the life expectancy of humans, have also found cures to various diseases and have overall assisted to make humans healthier. Invention of Penicillin during 1928 by the Scottish scientist Alexander Fleming could be considered as the beginning of the modern era of medicine. It transformed the field of medicine by its ability to cure infectious bacterial diseases. Almost seven decades later during 2001, the secret behind the complete sequence of all three billion base pairs in the human genome was discovered. The discovery of DNA (deoxyribonucleic acid) has totally revolutionized the

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field of biology and demonstrated that this discovery would help humans to resolve various challenges beyond medicine. Today, DNA profiling has major utility for confirming if people are related to each other (parenthood testing). It also helps the law enforcement agencies towards solving crimes. Apart from these important discoveries, the research on the stem cell is also an important innovation. Such cells have the unique ability to develop into specialised cell types in the body which could be used to replace cells and tissues that have been damaged or lost due to disease. In addition, various innovations in the organ donation field which assist to replace (repair) eyes, lung, heart, kidney, liver, pancreas or intestine have helped human race immensely.

In the power sector, from nuclear power to solar power to space based solar power to biofuels, various clean options have been made available. A major innovation with regard to wind turbines is getting discussed where a start-up is working on an environmentally friendly aero-generator which needs no blades. This is expected to be a more cost-effective option. Another interesting technology/method for energy generation is by using nuclear fusion reactors. Presently, much work is happening in the arena of development

of nuclear fusion reactors. In southern France, International Thermonuclear Experimental Reactor (ITER) is getting developed. This technology, when fully operationalised, is expected to change the global energy habits. A major innovation could happen when the current nuclear fusion reactors where the hydrogen isotopes tritium and deuterium are used as the fuel would be replaced by other technology. If helium-3 and deuterium could be used as fuels, then a major revolution in the energy sector is expected. The helium-3 is not available on the earth's surface hence, at present few states are undertaking missions to Moon where helium-3 is available in abundance. However, this entire process of

getting helium-3 down could take few more decades.

Innovation in Modern Technology

For many years one of the best approaches to industrial production was considered as CNC (Computer Numerical Control) machine. This milling technology has existed since 1950s and is being used to produce significant quantities of large, heavy, precision-crafted products having applicability for commercial and industrial equipment, machines, and engines. Today, with the developments taking place in the additive manufacturing (AM) sector it is expected that a major change is at the doorstep of global manufacturing processes. This technology which is commonly known as 3D printing is a mechanism of direct digital manufacturing. This would allow object creation by simply using a digital file which is having the design of the product. This file would send a signal to a printer, which would be constituting the required material (say powder) and 'print' the product as per the requirement.

Internet of Things

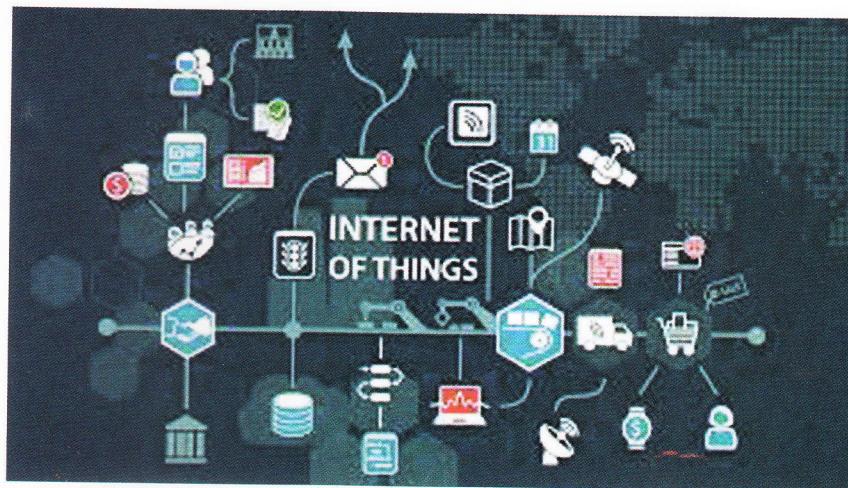
At the heart of various technological innovations over the years, lies the Internet. This is the single most technology which has helped to change the face of the world within a few years. This one innovation has actually led to various other

COMPUTER NUMERICAL CONTROL

The diagram illustrates the concept of Computer Numerical Control (CNC). It features a central title 'COMPUTER NUMERICAL CONTROL' in large, bold, orange and blue letters. Below the title, the letters 'C', 'N', and 'C' are displayed in large, stylized, orange and purple fonts. To the left, a computer setup is shown, consisting of a monitor displaying a 3D CAD model of a mechanical part, a keyboard labeled 'INTERFACE', and a large green vertical component labeled 'CNC'. To the right, there is a smaller inset showing a 3D printer in operation, printing a complex object.

innovations. Internet could be branded as one technology which connected the world and has changed various practices of human survival from education to healthcare to nature of doing business including financial transactions. Today, this Internet is being viewed as a first setup towards a major disruption in IT and ICT. Internet 2.0 is expected to bring in major changes in the present-day setup of doing various things. Development in multiple fields of science and engineering like nanoscience, electronics, and sensor technologies are offering new opportunities to relate with internet differently. The idea of using internet differently and by using diverse effects (normally "thing" or "object" are viewed as any possible items in the real world that could join the communication chain) is expected to upswing to the model of Internet of Things (IoT). Generally, IoT is considered to be simply a means of connecting different sensors to a network. It is important to look at IoT over a broader canvas of numerous IT related and futuristic IT technologies. Ambient Intelligence and Cognitive Technologies are anticipated to have a major impact on the future of IT. Technologies like Fog computing, Distributed computing, Cloud computing, Big Data and Block-chain are expected to impact the future of IoT.

Artificial Intelligence (AI) is another technology which has been



there for many years and is presently found making a lot of impact on the developmental cycle in various disciplines. However, even today, AI is still an evolving technology and the scope for AI is varied. There are various viewpoints about the exact applicability of AI. No final verdict has yet been announced whether AI is a saviour or destroyer. Issues of ethics do get raised in regard to the applicability of AI. However, globally it has been observed that AI could bring in various advantages in very many fields associated with human growth and progress. Robotics is one area, which is associated both directly and indirectly with the AI and has already made many inroads in various human activities over the years. Broadly, it could be argued that AI and Internet 2.0 could decide on the future of the world.

The most fascinating aspect of modern S&T innovations has been its evolutionary and adaptable nature. It is important to appreciate the fact that despite being developed for a specific purpose, some technologies have witnessed modifications and have provided innovation for altogether different purposes. For example, cell phones (mobile phones) were originally developed as a unit for remote wireless communication. Since then, however, phones have been implanted with GPS chips that provide information about the device's geographic position.

Developments in the field of Outer Space have been fascinating. This is one technological field, which could be said to have made major contribution towards addressing various issues of socio-economic importance. Voice and data communication in real time and offering accurate inputs for various developmental aspects and managerial issues has been the key focus of space technologies. Today, communication, navigational, remote sensing (earth observational), weather and scientific satellites actually almost fully control humans lives.

Largely, technology could be said to have evolved as a response to the various requirements of society and it is expected that the S & T innovations happening in the future too would help humans to live more peacefully and happily. □

(E-mail:ajey.lele@gmail.com)

