ISSN 2229 - 7642

TECHNOLOGY IN HISTORY: AN OVERVIEW

JAYAPRAKASH RAGHAVIAH

Working Paper No. 27

January 2012

CSES

Centre for Socio-economic & Environmental Studies
Khadi Federation Building, NH By-Pass, Padivattom, Kochi-682 024, Kerala
Tel: +91 484 2805107, 2805108 E-mail: cses@dataone.in, www.csesindia.org

TECHNOLOGY IN HISTORY: AN OVERVIEW

Abstract

This paper is an attempt to historicize and contextualize the role of technology in history. Technology has always been the determinant part of every culture and civilization. But in no other period in history, has technology entrenched itself into every aspect of human life as it has now, to the extent that the present civilization is called a 'technological civilization'. While science existed in history as an abstruse speculation on knowing the nature of things, technology was always concerned with making and doing things. In this sense, technology is as old as human life. Entrenchment of technology in everyday life has taken place after the marriage of science and technology, coterminous with the Industrial Revolution in Europe during the 18^{th} and 19^{th} Centuries. While taking an overview of growth of technology, this paper examines technology in terms of its political economy, gender and environment and lastly in its own terms. While looking at the diverse viewpoints on the role of technology in history, the paper concludes that even if we accept the present development paradigm, the role of technology as a universal problem solver will have to be viewed with skepticism. Technology has not been above criticism. Is it possible to view technology as a problem creator? And thus having double face! Besides, the paper highlights the technology dilemmas faced by world given the safety records of nuclear technology and the climate impact of hydro carbon based technology.

Key words: Science, Technology, History, Civilization, Industrial Revolution

---

Jayaprakash Raghaviah is a Senior Research Fellow, Indian Council of Social Science Research, New Delhi. He is also a Visiting Fellow of CSES

E-mail: jp.calicut@gmail.com

TECHNOLOGY IN HISTORY: AN OVERVIEW

Introduction

History of technology dates back to the history of mankind itself. Human beings were creators of artifacts as these were necessary for their very survival on the earth. It is not surprising that cultures and civilizations are defined by the artifacts that they produced. But, the creation of artifacts is not limited to man[1]. It is the creation of artifacts by man that is being described here as technology. While reviewing the history of technology, a clear distinction, however, has to be made between technology and science. Technology is a systematic study of making and doing things. Science is concerned with the more conceptual enterprise of understanding the environment. Science depends on the relatively sophisticated skills of literacy and numeracy. These skills were available only with the emergence of great civilizations around 3000 BC, while technology is as old as man. Science and technology developed as different and distinct activities. Science for several millennia remained as a type of abstruse speculation practiced by philosophers, while technology was essentially a concern of craftsmen of all types. There were certainly points of interaction. For example, mathematical calculations were necessary for the design of irrigation schemes or pyramids.

A major change started occurring during the medieval period (AD 500-1500) in Europe when scientific understanding and technical innovations were used to serve commercial interests. Francis Bacon, an astute observer of his times recognized three technological innovations - magnetic compass, printing press and the gunpowder- as heralding a new age[2]. Bacon noted experimental sciences as enlarging man's domain over nature[3]. He emphasized the practical

---

[1] There are many biological organisms that produce artifacts. Examples are beaver's dams, spider webs, birds' nests, etc.

[2] Surprisingly, these three innovations in their original form were first developed in China.

[3] Francis Bacon - An author, philosopher, statesman, scientist, lawyer, jurist, and father of the scientific method - has been called the father of empiricism. His works established and popularized inductive methodologies for scientific inquiry, often called the *Baconian method*, or simply the scientific method. His demand for a planned procedure of investigating all things natural marked a new turn in the rhetorical and theoretical framework for science, much of which still surrounds conceptions of proper methodology today.

role of science by urging scientists to study the method used by craftsmen and vice versa.

From the Middle Ages onwards, there are striking examples of science and craft interacting. Galileo is said to have travelled to Holland to acquire knowledge of lens making from the local craftsmen there. Another noted example is that of the application by Christian Huygens of the isochronisms of oscillation of the pendulum, for the regulation of clocks discovered by Galileo. Such initial interactions were few and far between. During the same period, carpenters and mechanics built bridges and instruments without interacting much with science. It was the genius of these craftsmen that was behind the Industrial Revolution, especially during its early phase. The men who pioneered many inventions during this period like James Watt, the inventor of steam engine and John Key, who invented the Flying Shuttle, were all craftsmen. For example, James Watt was an 'instrument maker' in the Glasgow University[4].

Industrial Revolution as a Technological Process

The Industrial Revolution (IR) of the eighteenth and nineteenth centuries is a turning point in the history of technology. It culminated in a marriage of science and technology. Here IR is viewed as a process of change in the use of motive power as well as the use of labour. The earliest inventions that characterized the IR like the Spinning Jenny by James Hardgrave, the Fly shuttle by John Key and Cotton Gin by Eli Whitney used human power as motive force. But in each of these instruments, the unsteady hand of the labourer was replaced by an objective mechanism. For example in the Cotton Gin, wooden spokes replaced human fingers for removing the seeds from cotton[5].

---

[4] For a detailed account of history of science see: Bernal, J. (1965). *Science in History*. London: Pelican.

[5] Narayana, D. (1981). The *Evolution of Social Technology to the Industrial Revolution*. Centre for Development Studies, Working Paper No. 132. Thiruvananthapuram.

Figure 1: Spinning Jenny by James Hardgraves

Figure 2 : Fly Shuttle by John Key

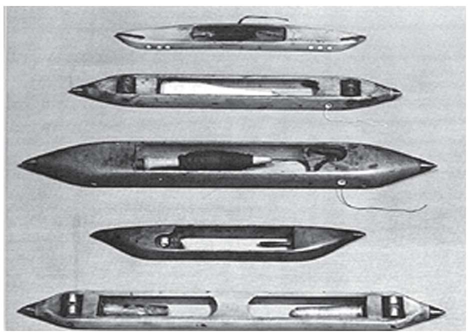
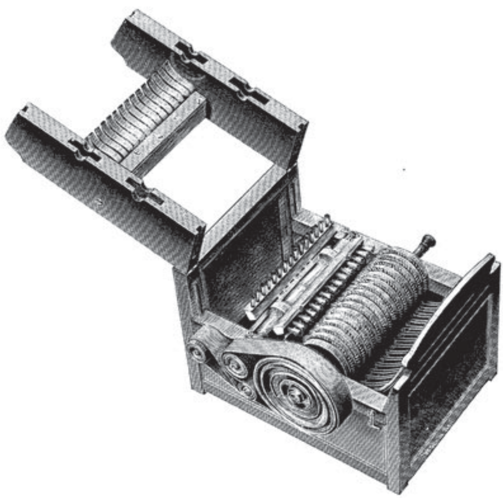


Figure 3 : Cotton Gin by Ely Whitney



At the second stage IR saw the establishment of the factory system by Richard Arckwright. This required a central motive force. Such a motive force was initially found in using the forces of nature, in this case, harnessing water from the stream. This was followed by the use of steam power. The steam engine when it was first used in industries was the atmospheric engine that used the atmospheric pressure acting against a vacuum created by the condensation of steam.

Figure 4 : Newcomen's Atmospheric Steam Engine - Drawing

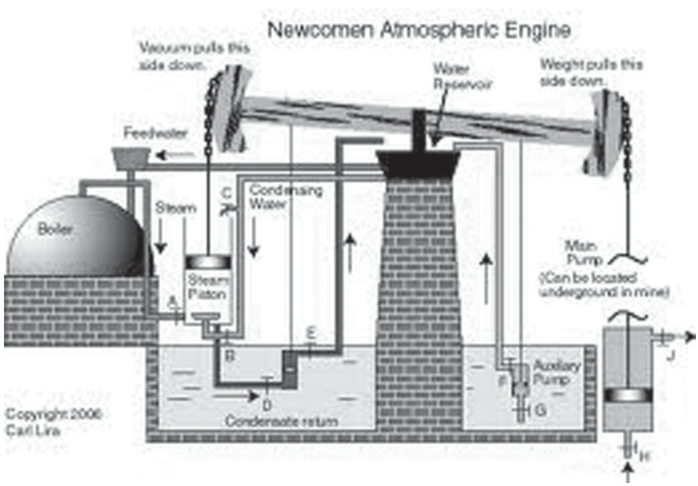
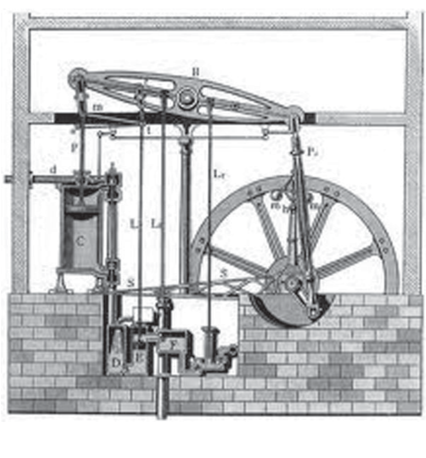


Figure 5 : Rotary Steam Engine that uses Fly Wheels



This process was replaced by the use of steam to move a piston-a motion which is converted into circular motion by using fly wheels. Manufacture of piston was made possible because of the machine process, developed to create a bore of uniform precision in a metal block[6]. Such a machine process was possible due to the availability of skilled craftsmen.

During the latter part of the nineteenth century when development of chemical industries took place, science and technology moved closer. Justus Von Leibig of Germany, one of the fathers of organic chemistry and the first proponent of mineral fertilizer provided the scientific impulse that led to the development of mineral dyes, high explosives, artificial fibers and plastics.[7] Michael Faraday's experiments in the field of electromagnetism prepared the ground that was exploited later by Thomas Alva Edison.

Edison played a distinct role in the establishment of relation between science and technology. Through a trial and error process, he selected the carbon filament for his electric bulb in 1897. In the process, he also established the first industrial laboratory. In this context, the American system of manufacture will also have to be referred. This system involved large scale manufacture of components of a machine to a higher degree of precision and assembling the machine through an assembly line process. This process was amply demonstrated by Henry Ford in the large scale manufacture of Model T which was the first car to be produced on a large scale.

Figure 6: Model T Cars coming out of Assembly Line.

[6] The method used was: Instead of making the boring rod revolve as it was the previous practice, the casting bloc was made to rotate about a fixed bar along which travelled a sliding cutter. This method was pioneered by John Wilkinson. See Mantoux, P. (1947). *The Industrial Revolution of the Eighteenth Century.* London: Jonathan Cape

[7] Henderson, M. (1975). *The Rise of German Industrial Power, 1834-1914.* London. Pocket Books.

Evolution of Technology from the Twentieth Century

The first half of the twentieth century was characterized by the rapid development in land, sea and air transportation and telecommunication. From the second half onwards, developments took place in the use of nuclear energy, space travel, electronics, computer science, artificial intelligence, information technology and now, nano technology.

Figure 7: Otto Lilianthal - Experiments in Flying - 1891

Figure 8: First Powered Flight - Wright Brothers - 1903

It took mankind nearly 200 years of vivid imagination to create the first airplane that flew on its own power. But between the first flight in 1903 and the first manned landing on the moon in 1969, the space was only 66 years. Between the discovery of atomic fission and the exploding of the first atom bomb, the gap was only six years.

Even in the machine production, which first went into mass production type of manufacture, drastic changes have taken place. Because of the computer aided design capabilities, machines need not be mass produced now. They can be made to order. Manufacturing a prototype before manufacturing the actual machine is no more necessary. The prototypes exist in the form of millions of bytes of information in the computer that simulates the machine[8].

Three looping relations between science and technology seem to have been formed over the recent decades. Firstly, the so called pure sciences, even in the most abstruse areas of mathematics and logic are being pumped back into technology as aids to productivity. Secondly, in order to do research in 'pure science' it is not enough to speculate, but it is important that one has technology. Examples are the huge particle reactors and the present hedron collider experiment. Thirdly, technology paradigm has colonized the study of society in many interesting ways. It has created new objects of social field to be studied. The most obvious example is the use of internet and virtual reality technologies[9]. Now we hear of virtual pilgrimage. It is possible to traverse through a virtual temple, navigating oneself with the mouse of computer. The idol can be garlanded through the click of a mouse and finally offerings can be made to the deity through credit card. The virtual pilgrim has not moved from his seat in front of a computer yet. 'Virtual' is a space. It is possible to be a virtual tourist, have virtual sex, scan through the pages of a book from a virtual library. The line between the virtual and real is becoming increasingly narrow. One builds a virtual house in a virtual internet site. And when the house is sold through the net, and the money is received, virtual becomes real.

Evolution of Technology - Divergent Trends in Europe and China

While trying to understand the technological evolution during the past 500 years, a historian faces several questions. What is now called modern technology is European technology. About 500 years back, Europe and Asia

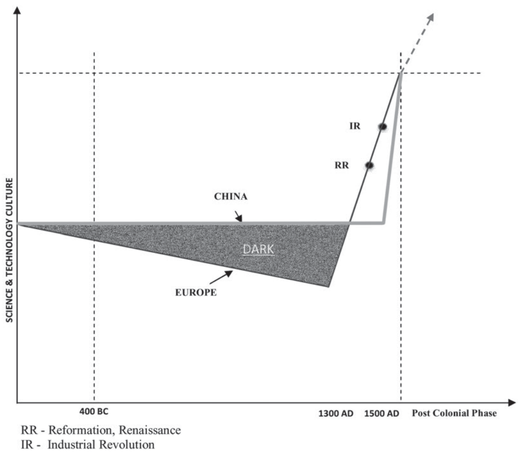
---

[8] (1994, March 5). Manufacturing Technology. *The Economist*. London

[9] **Virtual reality (VR)** is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of telepresence and telexistence or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus, and omnidirectional treadmills. The simulated environment can be similar to the real world-for example, in simulations for pilot or combat training-or it can differ significantly from reality, such as in VR games

were more or less equal as far as technology was concerned. If this clock is placed back to another 2000 years, Chinese civilization could be placed certainly at a higher level in terms of technological advancements as revealed in their advancements in hydraulics, mechanical escapement, compass needle, gun powder, printing, manufacture of paper, pottery and plant science. In this section an attempt made by Ingster to graphically locate Greek, European and Chinese technologies[10] is presented.

Figure 9: Growth of Technology
Comparison of European and Chinese Technologies



The above diagram gives a comparative picture of European and Chinese technologies across a long period of time. From around 400 BC, and right up to the time of Renaissance, European science and technology shows a steady decline. From around 1500 AD, growth can be seen. This is the period of Voyages of Discovery and colonialism. Another landmark is the Industrial Revolution of the 18th and 19th Centuries. Chinese technology is shown as more advanced than European technology up to around 1500 AD. At the same time, Chinese technology is seen as static or is it that, China began to apply their technology in fields, or objects and individuals which is non-comparable with the European.

---

[10] This graph is taken from: Ingster, Ian (1998). *Technology and Industrialization, Historical Caste Studies and International Perspectives*. Ashgote :Hamphire

This could perhaps be the reason why dynamism of it is overlooked or unregistered. From the post colonial era onwards, Chinese technology is seen to be catching up with European technology. Several questions can be asked about the above conceptualization, but this can be seen as reflecting the general trend in the growth of technology in China and Europe.

The above comparison leads us to some basic questions. What factors enabled Europe to overtake China and achieve a level of superiority so that even colonization of distant lands was possible? While Europeans were applying technology for colonization did Chinese do so, or is it that even for this China is still catching up? What explains the emergence of western science during the 17th and 18th centuries and the establishment of the industrial societies or disciplinary societies in the 18th and 19th centuries as a result of which Europe became a world leader in science and technology?[11]

Several explanations are given for this phenomenon. Needless to add, such explanations are tentative and partial. One such explanation is that the small sized European economies were more responsive to change and were capable of growth. This worked to their advantage. A contrast is noted in the case of Chinese society, enormous in size and governed by a hierarchical and bureaucratic system.

Another explanation put forth is that the chaos and disorder of late medieval period in Europe created openings across boundaries of class. According to some thinkers on the subject, Christianity played a part in providing a metaphysical distance between man and nature that allowed the former to take an exploitative attitude towards nature. Such a view of nature was a determinable factor in the technological industrial development of Europe. Such attitude is not predominant in other cultures[12].

It is also argued that in Europe, technology provided the emerging science with its methods of investigation by positing a set of mediating instruments between nature and the natural philosopher. The telescope and microscope are examples of such instruments. Experimental instruments required

---

[11] George, Basilla. (1987). *The Evolution of Technology*. London: Cambridge. p. 171

[12] These different viewpoints are discussed in: Atul, W. (Ed.), (1988). *Science, Technology and Development*. London: IT Publications.p23-30.

a new experimental discourse, a new code of communicating experimental results and a new kind of social practice with corresponding social space.

Trajectory of Technological Growth: Any Pattern?

The basic question addressed here is whether any pattern can be observed in the paths of technological progress. There have been attempts to view technology as a Darwinian type of evolution. But one does not find technological evolution having any sudden and big break comparable with the mass extinction of species. History of technology does not record any widespread cataclysmic extinction. It is found that, all the articles like bow and arrow, pottery and the canoe which was once used widely by many ancient cultures still survive. In many cases, artifacts that were once used and discarded were reinstated in a different social context.[13] Even in its evolution, technology seems to have followed a disjoined path. One of the greatest inventions of mankind was the wheel. The wheel has been in use for more than 6000 years. Still in some parts of the world like the present Mexico, wheels were not in use till recent times. Even in the use of wheels, there are differences. Spiked wheels weigh less, are equally powerful and more maneuverable than the 'full wheel'. Spiked wheels were more prevalent in Europe than in Asia. What explains this?[14] The enquiries like the one above point to a wider question. Is it possible to have a theory of invention?

Another way by which invention or innovation can be studied is by developing a hindsight-which can be developed only at a speculative realm. To explain this, the assumption that the establishment of the railroad was inevitable in America has been challenged in studies in economic history. Fogel who studied this issue comments:

"The time that elapsed between the understandings of the principles of the internal Combustion engine in the early 19th century and its embodiment in working model in 1860s might have been shortened, were there no railways."[15]

---

[13] George, B. Opp.cit

[14] George, B. Opp.cit. pp. 7-11

[15] Robert, Fogel. (1964). Railroads and the American Economic Growth. As quoted by George Basillia. Opp.cit

Political Economy of Technology Growth: The Social Scientistsí Perspectives

Bertrand Russel noted rightfully, that: "Science as a dominant factor in determining the beliefs of educated men had lasted for 300 years ,as a source of economic technique for about 150 years."[16]

Scientific and technological changes were decisive during the eighteenth and the twentieth centuries. This evoked sharp responses by scholars who could actually observe the changes taking place in front of their eyes. Adam Smith, father of Political Economy noted the changes taking place in the organization of production which heralded the dawn of a new age, where people worked for their own selfish ends, but the invisible hand of market forces led to the creation of wealth in the economy. The utilitarian philosophers who believed in the greatest good for greatest number viewed technology as a contributing factor. Early exponents of science fiction like H G Wells and Jules Verne explored vividly the future possibilities which technology unraveled.

Karl Marx on Technology

Karl Marx was a close observer of the changes in manufacturing pattern that was taking place during his time. He was an admirer of productivity of the capitalist system. He had noted the changes that were taking place in the production relations from simple cooperation and then to large industry. In his writings, Marx had also combined internal and external approaches to analyze the machine as a social phenomenon. As Marx saw, the most important characteristics of a machine were that it replaced human labour. It did so by combining three parts-a motor mechanism, a transmitting mechanism and a working machine or 'tool'.[17]

There are, however some difficulties in understanding Marx's views on technology as different pronouncements are made under different contexts. On one hand, Marx sought to uncover the laws of capitalist development and present the history of technology as a logical unfolding of the capitalist process. On the other hand, he was critical of the way in which technological development was taking place under capitalist mode of production. Marx was positive about

---

[16] Bertrand, Russel. (1967). *Impact of Science on society*. Madras: Blackie Anderson

[17] Karl, Marx (1978). *Capital,* Vol. I Progress Publishers: Moscow

the potential of machine based production while being critical of its actual development. There was thus built into Marxism a central ambiguity about technological innovation. Since science based industries grew in size, it became difficult for the later Marxists to reconcile their positions[18].

It was Engles who formulated the technological version of Marx's argument. According to him:

"All technological development is manifested in specific modes of production, but far from carrying marks of the latter in its objective structure, it actually determines and ultimately transcends them"[19]

Lenin and Kautsky followed this line. This made Lenin come to a conclusion regarding the time and motion study pioneered by Taylor[20] (mentioned below) as on one hand "a combination of refined brutality of bourgeois exploitation" and on the other, "one of the greatest scientific achievements in analyzing mechanical motion during work."[21]

Debate on technology continued among Marxists. Georgy Lucas in Hungary, and Herbert Marcuse in Germany stressed the critical side of Marxism on technology and came to formulate an all encompassing critical analysis of 'instrument rationality' and technological civilization. Marcuse noted:

"Not only application of technology but technology itself is domination (of nature and man), methodical, scientific, calculated, calculating control. Specific purposes and interests of domination are not fostered upon technology subsequently and from outside, they enter the very construction of the technical apparatus."[22]

---

[18] We note that there is a great deal of polemic on the subject. An attempt is made to summarize the same into barest essentials

[19] Engles, Frederik. (1954) *Dialectics of Nature*. London. p. 267

[20] Frederick Winslow Taylor (1856-1915) was the father of time and motion study which was used widely in assessing the productivity of labour. In his own admission, he was a managerial agent who fought to wrest control from the workers as a means to increase output.

[21] Lenin V I . Collected Works, XXVII. (1975). Moscow: Progress Publishers. P 316

[22] Braverman, H. (1975). *Labour and Monopoly Capital*. New York: Penguin .p85.

Dominance of Technology: Dissenting Notes

There were dissenting notes on technology. American writer Thoreau[23] went back to the lakeside, at Waldon and lived for a time in an environment of pristine purity untouched by the effects of technology. Another American writer Ralph Waldo Emerson[24] gave an ominous warning, "Things are in the saddle, and ride, mankind." By 'things' he meant creations of technology. Even H G Wells, after his initial euphoria had disillusionment over technology as it is revealed in his book "Mind at the End of its Tether." Aldous Huxley,[25] a philosopher of modern times in his book "Brave New World" pictured a society in which technology was firmly entrenched keeping human being in bodily comfort without knowledge of want and pain, but also without beauty, creativity and robbed at every turn of a unique personal existence.

The theme of technological tyranny has been a source of concern for many authors in recent times. Jaques Ellul in his book "The Technological Society" (1964) argued that man now lived in a milieu of technology rather than nature. He argued that this new milieu is artificial, autonomous, self determining, nihilistic and having primacy over its ends. Technology, he argued has become so powerful and ubiquitous that other social phenomenon like politics and economics had become **situated in it rather than influenced by it .**Questions are being asked now as to whether technology has become a **logic unto itself and if so, how that logic can be defined.** A visual picture of technology overpowering man appears in Charlie Chaplin's film "Modern Times". Here man is shown as caught in the cogs of a machine, unable to extricate himself.

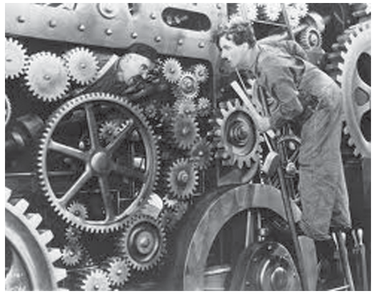
---

[23] Henry David Thoreau (1817-1844), American poet, abolitionist, naturalist and philosopher. He stated that most of the luxuries and many of the so called comforts of life are not only indispensible but also positive hindrance to the elevation of mankind. His experiences in his pristine life at Waldon is well documented in his book on the same name.

[24] A contemporary and friend of Henry David Thoreau. American essayist and poet led the transcendentalist movement of the mid 19th century. His essays titled "Self Reliance", "Nature", and "Experience" are famous.

[25] Aldous Leonard Huxley (26 July 1894-22 November 1963) was an English writer best known for his novels including *Brave New World* and a wide-ranging output of essays.

Figure 10: Visuals of Technology overpowering Man in Charlie Chaplin's 'Modern Times'



The poignant imageries presented by Chaplin acquired a new meaning when the world plunged into a great depression during the 1930s. The depression shattered the faith in the prevailing economic system and its technological basis. Successful defense of democracies in the Second World War strengthened the faith in technology but it was with reservation. For example, Robert Oppenheimer who was the chief scientist in the project that built the first atom bomb, refused to participate in the development of the hydrogen bomb.

Present Dilemmas on Technology

Societies, particularly developed societies face a technological dilemma; overdependence of life on technology on one side and a fear that technology will destroy the very quality of life including social relations, labour relations, relations of power on the other. It has changed the geography of going to work. Physical labour is substantially reduced. Technology has made life easy in many ways. Is that essentially a better life? The questions that Thoreau asked, still remains. Thoreau himself did not live his entire life in a log cabin. He returned to live in town and countryside.

In modern life, with the rapid growth in communication technology, people have access to a large array of information without actually understanding what to discern from these. A moment of silence is often lost. English poet T S Eliot expressed these concerns somberly in the following lines.

"The endless cycle of idea and action,

Endless invention, endless experiment,

Brings knowledge of motion, but not of stillness;

Knowledge of speech, but not of silence;"

He further asks.

Where is the Life we have lost in living?

Where is the wisdom we have lost in knowledge?

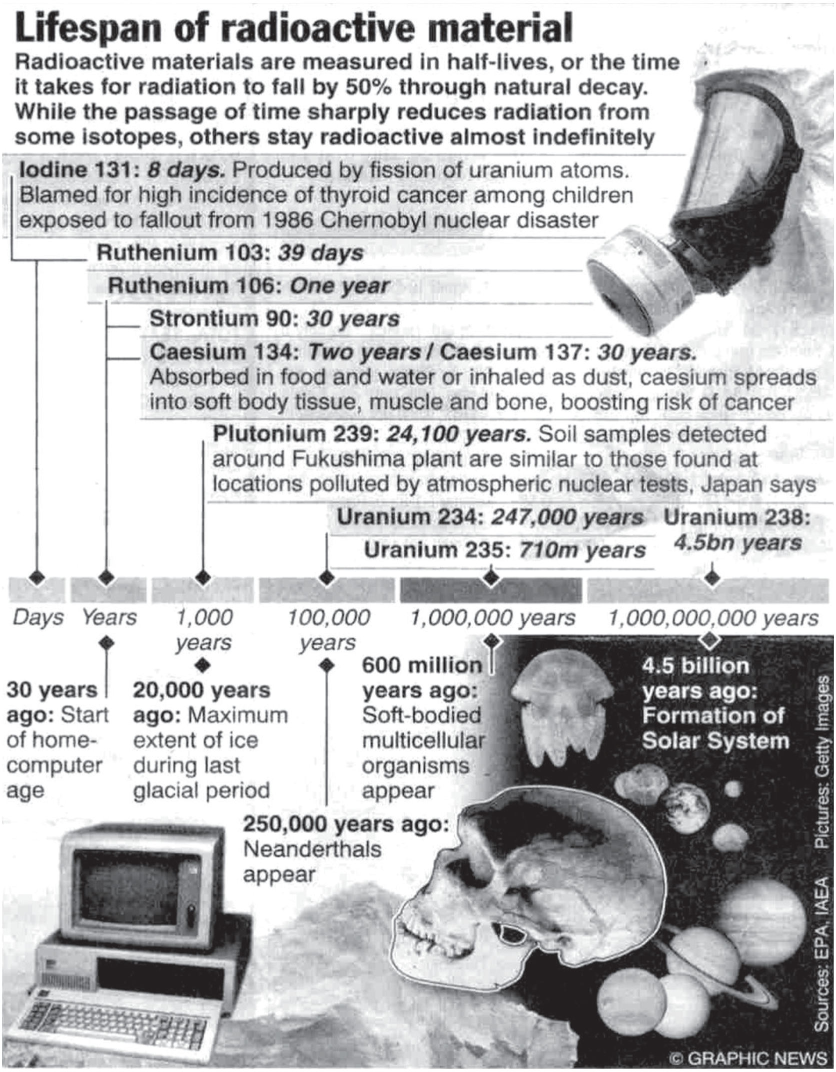
Where is the knowledge we have lost in information?"[26]

Nations face problems on two other fronts. One relates to the use of nuclear energy. The technologies developed in these nations presupposed abundant availability of power. In the context of depleting supply of hydrocarbon fuel and their alarming impact on climate change, attention is being focused on nuclear fuel. But nuclear technology has not solved the problem of radioactive waste, some of which have a half life of unimaginably long periods[27]. (See the illustration below.)

---

[26] Opening Stanza from Choruses from "The Rock" (1934). T.S. Eliot (1888-1965): Edited by Peter Y. Chou, www.wisdomportal.com

[27] Even the commercial viability of nuclear technology depends on its linkages with defense technology. the development of nuclear energy and nuclear arsenal are correlated as the output from the former becomes an input for the latter. Besides the cost of safe keeping of nuclear waste for indefinite period does not enter the cost calculations of nuclear technologists.



Source: The Hindu, 25/04/2011

At present the world is still trying to reconcile itself to the accidents that took place in nuclear power stations at Three Mile Island in the United States, Chernobyl in Russia and now Fukushima in Japan. Nuclear power technology is increasingly being viewed as 'immature.' Due to the cheap availability of hydrocarbons and 'clean and cheap nature' of nuclear energy projected by the civilian and military lobbies, research on non conventional energy attracted very limited funding support

Behind the demand for abundant power and nuclear technology is the notion that human wants that are unlimited, can be and should be satisfied. This premise is also the sorrow of humankind now, because such satisfaction of unlimited wants can only be done (by resorting to negative-technology!) at the cost of heavy environmental destruction, climate change etc.

Gender Bias in Technology

During recent times there has been an interest on the gender bias of technologies. It is believed that even long after the Industrial Revolution in England, kitchens in England continued to be primitive. Some of the recent studies on the gender bias in technology reveal that till recently women were not involved even in the design of washing machines or central vacuum cleaning systems. The 'smart house' or the house designed to make use of many automatic electronic gadgets are often described by feminists as more of 'techno fantasies' of men. Absence of adequate women designers is a reason often pointed out to explain this[28]. But then, do we need 'techno fantasies of women? Or forget, if possible, such techno fantasies?

Political Economy of Technology

If we try to summarize the logic of modern technology, it can be said that it is based not on the production of a technological object, but on the capacity to innovate and create one within the shortest time, given the resources. A great deal of new technological products developed, are produced with a view that these will become obsolescent in a very short time so that new products can enter into the market. At the heart of such an approach are the research and development capabilities, which in a globalised environment can be sourced globally. In this sort of effort, industrially developed nations have an edge.

Modern technology has a labour saving bias. This is due to the nature of capitalist system in which they operate. Modern technologies are also

---

[28] Cockbures, Cynthia. & Ruya Feirst Dellic. (1994). *Home ,Gender and Technology in Changing Europe*. Beckingham: Open University Press .p10

conceived in such a way that it creates deskilling of labour force. The skills are increasingly attributed to machines. It is not possible that in many cases the notion of labour as the source of value is now rendered redundant by the fact that labour often just 'looks over' the production process. Modern technology is capable of surveillance of the workplace to such an extent that a simple socialization by the workforce is not possible. It is a case of disciplinary society; not only at work place but in schools, prison, hospital etc. Workforce is dehumanized. The system of monitoring by electronic means is so developed that it is assumed that the worker cannot have a 'bad day'. Software industry bears the greatest criticism for producing 'software slaves' who are actually professionals who work in a "modern" but slave like environment. In the organizational structure that modern technology demands, the power of the Chief Executive is enhanced while there is an equivalent reduction in the power of the operatives below.[29] Technology has become global. That makes it difficult to talk about technology in region specific or culture specific terms.

The Present Dilemmas on Choice of Technologies

This is not to deny some of the benefits that modern technologies offer. The same CNC lathe that makes a skilled technician redundant enables physically or mentally challenged persons to work and earn a living. Communication revolution has altered our geographical conception of boundaries.. It has altered our concept of 'going to work'. Definition of 'work place' has changed to the extent that factory/disciplinary conception has become problematic. As technology is double faced or janus faced, the question of 'choice' face indecisiveness. An apparently innocent demonstration of technology may cause unimaginable consequences. This is so, despite correct choice and sufficient care, as we have been experiencing them throughout the century. The best example that we have is that of nuclear technology. Choice becomes difficult for the inherent unpredictability of these technologies which has the potential to pervade into all spaces, be it natural or social. In short, at the same time, it is enabling and disabling; discloses and closes; permits and prevents. Therefore, it appears that answering the question **what technology does** or effects is more worthwhile than facing the question **what it is**; at least in the context of choice issue.

---

[29] Russel. Opp.cit .p49-82

Another issue in the present context is the use of technology. By using one or other technology, the user's selfhood/self-identity gets refashion; either with his/her awareness or without that. These constant processes of effecting with technology something or other and getting affected by that, is complex-not merely complicated. First of all they take place in clearly separable spaces distinct from the pre-techno period. For instance even a still photograph of a cyber space or even preschool computer room is clearly distinguishable from a most modern printing press or satellite manufacturing factory.

Discourses on technology constitute new truths; not only scientific truth but truths about what we are, how we ought to be; how to relate with others; how one should relate with one's past, present and future. Functioning of technology in the social fabric is accompanied by a new kind of distribution of individuals as technology enabled new possibilities like internet, facebook communities etc. New ways of learning without going anywhere except cyber space; this redistributes learning individuals in a completely different manner. The possibilities of 'direct communication' becomes lesser and lesser; such moments are perhaps less preferred!

There is an indispensability attached to technology, its functioning and power effects that it generates. This is evident in the ongoing discourses on technology and 'technology practice'. Technology is indispensable to all but in totally incomparable ways. What are indispensable for the state, individual subjects and subjugated people, are not comparable. One may require nuclear technology whereas other may find it dispensable or unconnected to their lives.

Just like technology creates Things, it creates us as well. This is where its function is intricately related to power relations. Contemporary application of technology generates Control Society rather than Regenerating Disciplinary Society of the previous century. The question of choice may reappear even if we find convincing answers as both the technology practice and the subjectivity of individuals also undergo over time irrespective of the effects of the agents. Intention of the agents and the outcome of their agency function are beyond control of the present.

Notes

The term technology used in this paper is defined as the systematic study of techniques of making and doing things. The terms, "modern technology", "traditional technology" and "global technology" are also used. By "traditional technology" we mean the technology used in Asia, Africa and Europe before the dawn of modern age which is roughly before 1500 AD. By "modern technology" we mean post Industrial Revolution Technology. By "global technology" we mean the most modern technologies generally developed or used by multinationals around the world.

I am thankful to Prof. K K George, Dr. S Raju and Prof. Michael Tharakan for their valuable comments, which helped me to revise an earlier draft of this paper.

References

Basilla, G. (1987). *The Evolution of Technology*. London: Cambridge

Boulding, K.E. (1983). "Technology in the Evolutionary Process." in Mc Donald Stuart (ed). *TheTrouble With Technology, Explorations in the Process of Technology Change.* London: Francis Pinter.

Braverman, H. ((1974).*Labour and Monopoly Capital*. New York: Penguin

Dumas, M. (ed). (1969). *A History of Technology and Invention* Vol I, II, III. New York: Crown Publishers

Harding, Thomas (et al). (1973).*Evolution and Culture*. University of Michigan Press:Michigan

Heidegger,Martin. (1977). *The Question Concerning Technology and Other Essays*. New York: Harper and Row

Hill,Stephen. (1989). *The Tragedy of Technology: Human Liberation Versus Domination in the Late Twentieth Century.* London: Pluto Press

Lenin, V.I. (1977). *Selected Works*. Vol I-III. Moscow: Progress Publishers

Marx, K. (1978). *Capital*. Vol I. Moscow: Progress Publishers

Mohammed, S (1978). *Technology and Social Values*. New Delhi: Daya Publishing House

Pacey,Arnold (. (1983). *The Culture of Technology*. Basil Blackwell: Oxford

Rahman, A. (1978). *Science, Technology and Development, Essays in Honour of A Rahman.* New Delhi: Sterling Publications

Reddy, A.K. (1975). *Technology, Development and the Environment.* New Delhi: United Nations

Rosenberg, N. (1976). *Perspectives on Technology*. London: Cambridge University Press

Russel, B. (1989). *Impact of Science on Society.* Madras: Blackie and Son(India)

Slater, P. (1980). *Outlines of a Critique of Technology.* London: Ink Links

Shekhawat, V. (1983). *Technology and the Pursuit of Freedom*. New Delhi National Publishing House:

Adas,Michael. (1990). *Machine As The Measure of Men*. Bombay:OUP

Wad, A.(ed). (1988). *Science, Technology and Development.* London: IT Publications

Bagchi,Amiya Kumar. (1980). Inventiveness in Society. *Social Scientist*. Vol 9 Dec 1980

CSES Working Papers

1. Impact of Liberalisation on Kerala Economy
   K.K.George
2. Kerala-The Land of Development Paradoxes
   K.K.George and N.Ajith Kumar
3. What is Wrong with Kerala's Education System?
   K.K.George and N.Ajith Kumar
4. Labour Market and Household Behaviour: A Case of Unorganised Sales Women
   Martin Patrick
5. Higher Education and Development in Kerala
   Jandhyala B.G.Tilak
6. State Level Fiscal Reforms in India: Some Core Issues
   K.K.George
7. Developments in Higher Education in India- A Critique
   K.K.George and Reji Raman
8. Financing Secondary Education in Kerala
   K.K.George, George Zachariah and N.Ajith Kumar
9. Fiscal Management in Kerala: Constraints and Policy Options
   K.K.George and K.K.Krishnakumar
10. Centre-State Relations, Finance Commissions and Kerala's Fiscal Crisis
    K.K.George and K.K.Krishnakumar
11. Deepening Decentralised Governance in Rural India: Lessons from the People's Plan Initiative of Kerala
    M.A. Oommen
12. Dynamics of Change in Kerala's Education System: The Socio-economic and Political Dimensions
    K.K. George and Parvathy Sunaina
13. On Some Currently-Fashionable Propositions in Public Finance
    Prabhat Patnaik
14. Twelfth Finance Commission's Award: What it Foretells for Kerala
    K.K. George, K.K. Krishnakumar and V.K. Praveen
15. Kerala Model Revisited: New Problems, Fresh Challenges
    P.K. Michael Tharakan

16. Labour Migration to Kerala: A Study of Tamil Migrant Labourers in Kochi
Surabhi K.S. and N. Ajith Kumar

17. Micro Finance and Poverty Alleviation: The Case of Kerala's Kudumbashree
M.A. Oommen

18. Impact of Rupees Appreciation on Non-resident Malayalees
K.K. George and Remya S.

19. When The Kerala Model of Development is Historicised: A Chronological Perspective
P.K. Michael Tharakan.

20. Regaining the Constitutional Identity of the Finance Commission: A Daunting Task for the Thirteenth Commission
K.K. George and K.K. Krishnakumar.

21. Kerala's Development Experiences: Its Implications for Finance Commissions
K.K. George and K.K. Krishnakumar.

22. Kerala's Education System: From Inclusion to Exclusion?
N. Ajith Kumar and K.K. George

23. Health of Women in Kerala: Current Status and Emerging Issues
N. Ajith Kumar and D. Radha Devi

24. Population Pressure on Land: The Case of Kerala State, India
D. Radha Devi and N. Ajith Kumar

25. Kerala Economy: Growth, Structure,Strengths and weaknesses
K.K.George

26. Vulnerability of Migrants and Responsiveness of the State: The Case of Unskilled Migrant Workers in Kerala, India
N. Ajith Kumar

Centre for Scio-economic and Environmental Studies (CSES) is an independent, non-profit, non-governmental organization for promoting policy and action-oriented research, and consultancy services. It was established in 1996 by a group of academics, scientists, technologists, management experts and social activists. The legal status of the Centre is that of a society registered under the Travancore-Cochin Charitable, Scientific and literary Societies Act 1955. The Centre has got FCRA registration from the Government of India.

CSES positions itself as a non-partisan Think Tank. It seeks to fill a critical gap between the academic world on the one hand and policy makers, opinion shapers and the public on the other. It has already carved out a niche for itself by identifying areas of research, relevant to both policy makers and social action groups, which were not getting due attention from other academic and research institutions. While deciding its research priorities, CSES takes into account the present and the future role of the particular sector(s)/ issues in development. The Centre has been multidisciplinary in its orientation.