Chapter 51

SCIENCE, TECHNOLOGY AND SOCIETY

Meaning of Science and Technology: Definition of Science — Nature and Characteristics of Science — Meaning of Technology — Differences Between Science And Technology — Institutionalisation of Science --- Science as a Modern Institution --- Effects of Institutionalisation of Science --- The Norms of Science: Norms of Universalism, Communalism and Its Consequences, Norm of Disinterestedness and Organised Skepticism --- Social Process of Innovation --- Competition in Science --- Resistance to Scientific Innovations - Influence of Factors on Scientific Innovations: Influence of Four Factors as Suggested by Kingsley Davis --- Technology and Society --- Technological Determinism --- Ogburn and His Technological Deterministic Theory --- Technology and the Rate of Social Change --- The Social Control of Science and Technology: Problems Arising Out of the Lack of Systematic Control Over Scientific and Technological Innovations --- Difficulties Involved in Establishing Systematic Control Over Science and Technology --- Conditions For The Success of Science and Technology in The Service of Society --- Science and Technology Should be Made the Servants of Society ?

We are living in an era of science and technology. Both have received ascendancy in almost all the modernised nations of the world. Even in the economically backward countries the longing for science and scientific achievement persists. Scientific and technological achievements have become the measuring rods to assess the economic strength of a nation today. In fact, the control of information, especially scientific and technical information, is a source of prestige and power in all post-industrial societies. Especially in the beginning of this 21st century, nations that are doing well in the fields such as computers, and super computers, information technology, electronics, biotechnology, telecommunications, etc., are normally regarded as the *"most modern"* and *"technologically and scientifically most advanced nations."* India which is regarded as a fast developing nation too has started giving more importance to these subjects of great scientific importance in its educational system during the recent years especially after 1995. In fact, in the newly established engineering colleges, these subjects are introduced and greater number of students are getting attracted towards them. Thus, *"science is a major institutional sector of modern societies; a hallmark of the modern social order is the conduct of scientific research in universities and other research organisations"*[1] The study of science and technology, has, therefore, become an increasingly important sociological speciality.

1. **William Kornblum** *"Sociology" - "In A Changing World"*, Page: 469.

Science has become a part of modern life. Any modern society's existence today depends very much on the advanced scientific knowledge and its technological applications to fields such as, computers, telecommunications, satellite launching, aircraft, antibiotics, life saving drugs, skyscrapers, synthetic fabrics, automobiles and so on. Not only our physical existence depends on science and technology but even our world view has radically changed over the past century by scientific thought. Our very conception of subjects such as physics, biology, psychology, medicine, astronomy, sociology, etc., has been altered. Our vision of the future life also rallies round science and technology and the question how they will be able to transform our future way of life. In contrast with this modern situation a century or two ago, the value of science was not considered that important, and science as such was *"The private hobby of wealthy gentlemen of leisure. Hence, throughout the Napoleonic Wars, scientists travelled freely between France and England in spite of the political rivalry between the nations to show their harmless conversations."*

Unlike in the past, science has become a central institution in the life of all modern societies. *Science itself is institutionalized*. Science is recognised as very essential and important. *It is standardized*; scientists throughout the civilised world follow the same basic methods and procedures. There is no capitalist or communist or Christian or atheist way to conduct a scientific experiment or to programme a computer.

1. MEANING OF SCIENCE AND TECHNOLOGY

The two terms *'Science'* and *'Technology'* are very often used interchangeably in our ordinary speech. Though these are very much interrelated they are distinct phenomena as such. Hence the difference in the meaning of both must be properly understood.

Definition of Science

Science is essential knowledge. The word *"science"* is derived from the **Latin** word ***Scientia*** which means *"knowledge"*. But science is a particular kind of knowledge, that is, knowledge that has been obtained through the *'scientific method'* . One or two definitions of science may be cited here.

1. ***In a more general sense,*** science refers to *"any systematic study of physical or social phenomena."* [1]
2. ***In a more restricted sense,*** science can be understood as *"The study of physical and social phenomena where this involves observation, experiment, appropriate quantification and the search for universal general laws and explanations."* [2]
3. ***From a sociological stand point,*** *"Science is a body of knowledge about the natural world and a method for discovering such knowledge and a social institution organised around both."* [3]
4. ***In simple words,*** *"Science is a systematic body of knowledge".*

Two Main Branches of Science

Science is customarily divided into two branches namely *"pure sciences"* and *"applied sciences"*. (i) ***Pure Science*** is concerned mainly with the acquisition of knowledge and not its application. It is scientific investigation that is devoted exclusively to the pursuit of knowledge for its own sake. It has no immediate concern or pressure for using that knowledge to solve practical problems. ***Examples:*** Physics, Chemistry, Biology, Sociology, Anthropology, Political Science, Economics, Psychology, etc., are all pure sciences. (ii) ***Applied Science***, in contrast, is the application of known scientific principles to a practical problem, and the outcome in many cases is new technologies. It may thus be stated that if pure science is interested in the acquisition of

1. *"Collins Dictionary of Sociology"* - Page: 576.
2. *"Collins Dictionary of Sociology"* - Page: 576.
3. **A.G. Johnson** in *"The Blackwell Dictionary of Sociology"* - (200) Page: 244.

theoretical knowledge, applied science is concerned more with the task of applying the theoretical knowledge, for human utility and service. Each pure science, however, may have one or more applied fields. *Engineering* is an applied field of physics, *pharmacology* is the applied field of chemistry, *social work* is the applied field of sociology, and so on.

Nature And Characteristics of Science

1. *Science is Concerned with Knowledge*: The ultimate objective of science is acquisition of knowledge. Exploring the different horizons of knowledge is not only a challenge but also a matter of great intellectual delight to a scientist. Knowledge is as vast as an ocean. The more a scientist acquires it, the more it remains to be acquired. A scientist is not only more interested in acquiring knowledge but also is better equipped to do so.

2. *Division Of Sciences Into Two Types Or Branches*: The sciences are conventionally divided into two main branches : 1) *natural sciences* , and 2) *social sciences*.

The Natural Sciences study physical and biological phenomena. They are said to be more precise, exact, and objective. ***Examples*** : Physics, Chemistry, Geology, Biology etc. ***The Social Sciences*** refer to *" a related group of disciplines that study various aspects of human behaviour"*.[1] They are mainly concerned with man, his social life and society. *Examples:* Sociology, Economics, Political Science, Anthropology, etc.

Characteristics of Science

1. *Factuality*: Science is not based on imagination. It is based on facts. *"A fact is an observed phenomenon itself".*[2] It may be about a thing, an event, a measurement, etc. *"Any statement which is true can be described as a fact."* [3] ***Example:*** 1) Stone is a solid substance. 2) Hindus constitute a major religious community in India.

2. *Causality*: Science tries to find out the causal relationship between the events or things. In other words, it explores causation. Causation states that *"the occurrence of events is determined by cause-and- effect relationships."* Causation assumes that events do not occur in a random fashion. It also assumes that events are associated in a one-way relationship. ***Example:*** (1) Harmful bacterias cause diseases. (2) Poverty is one of the causes of economic backwardness. The function of science is to uncover the laws of cause and effect relationships.

3. *Universality*: Scientific findings or truths or laws are expected to have universal validity. They are not supposed to be limited to any race, nationality, religion or region, social class or political ideology. It means scientific laws or findings must allow themselves to be evaluated purely in terms of their scientific worth. ***Examples***: (1) Fire burns, water flows, wind blows, etc..., (2) Hindus are polytheistic, Muslims and Christians are monotheistic, and so on.

4. *Predictability*: Prediction refers to the *"foretelling of an event or set of events."*[4] Prediction is generally understood as *'foretelling' or 'making' "statement about the future"*. It is an estimation of what the future will look like. Making prediction is one of the tasks of science. ***Example***: (1) Physical scientists make predictions about earthquake, rainfall, cyclones, eclipses, and so on. (2) Though predictions are difficult, if not impossible, in the field of social sciences, attempts are being made to make predictions. Predictions are being made about demographic trends, rate of economic growth, rate of increase in literacy, and so on.

5. *Verifiability*: Science is based on verification principle. According to this principle, a proposition or hypothesis or statement can be accepted as *"scientific"*, only if it is verifiable. *"Verification refers to any procedure regarded as establishing the truth of a proposition or*

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1. **Ian Robertson** in his *"Sociology"* - Page: 10.
2. **William.P. Scott** in his *"Dictionary of Sociology"* - (1988) Page: 144.
3. *"Oxford Dictionary Of Sociology"* - (1998) Page: 217.
4. **William Scott** in his *"Dictionary Of Sociology"* - Page: 310.

hypothesis".[1] To verify a statement is to provide evidence generally of an empirical or observational kind for believing it to be true. ***Examples:*** (i) Earth revolves round the Sun, and the Sun is bigger than the Earth, (ii) All men are mortal.

6. ***Objectivity and Value Neutrality*:** Science expects scientists to be objective. Objectivity implies *"an absence of bias in making or interpreting observations."*[2] Objectivity means interpreting the facts in such a way that our personal judgements are eliminated from them. A scientist should allow facts to speak for themselves. He should not attribute his personal views to them.

- ***Value-neutrality*** is closely connected with objectivity. This concept was first explored by **Max Weber.** He insisted that a scientist / researcher should not choose methods and interpret data in ways that favour his values or ideological stance. The principle of value neutrality implies that the researcher must control whenever possible the influence of values on his studies or research.

In fact, it is highly challenging for a social scientist to become objective and value-free in his studies. He must try to guard against his own views and values affecting the study of topics such as role of love in marriage; consequences of racism, sexism, improvement of worker productivity in work place, role of communism in economic development, and so on.

7. ***Insistence on the Scientific Method*:** A branch of knowledge can be called a *science* only if it relies on the scientific method. **Francis Bacon** who laid the foundations of modern scientific method insisted that science should follow a systematic method in its studies. As **Karl Pearson** has remarked, *"The unity of all science consists alone in its method, not in its material. The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science."*[3]

While scientific methods are more or less same for all sciences, *scientific techniques differ.* These techniques refer to the particular ways in which scientific methods are applied to a particular problem. Each science must therefore, develop a series of techniques which fits the body of material it studies.

- ***Scientific method*** can be understood as a systematic and organised series of steps that ensures dependable results in researching a problem with maximum objectivity.
- ***Scientific method*** refers to *"the building of a body of scientific knowledge through observation, experimentation, generalisation and verification."*[4]

MEANING OF TECHNOLOGY

1. **Horton and Hunt:** *"Technology is the use of scientific discoveries to solve practical problems".*
2. **William Kornblum:** Technology which is an aspect of culture can be defined as - *"the use of tools and knowledge to manipulate the physical environment in order to achieve desired practical goals."* : [Page - 469].
3. Technology refers to *"The practical application of knowledge and use of techniques in productive activities."* - *Collins Dictionary of Sociology* - Page: 678.
4. In simple words, *"technology refers to the practical application of knowledge about nature."*

SCIENCE AND TECHNOLOGY : DIFFERENCES

Science and technology though interlinked, are distinct. Main differences between the two can be noted below:

1. The Goals of Science and Technology Are Not One And The Same

Science is concerned with the pursuit of knowledge about nature, whereas technology is concerned with putting the knowledge of nature to some use. When the scientific knowledge is

1. ***"Collins Dictionary of Sociology"*** - Page: 718.
2. ***"The Blackwell Dictionary of Sociology"*** - (2000) Page: 193.
3. **Karl Pearson** as quoted by **Horton** and **Hunt** in *"Sociology"* - Page: 27.
4. **William P. Scott** in his *"Dictionary of Sociology"* - Page: 370.

applied to the problems of human life, it becomes technology. Technology is systematic knowledge which is put into practice, that is, to use tools, and run machines, and to do such other things to serve human purposes. *Science is theoretical knowledge whereas technology is practical knowledge.*

1. Basic Research And Applied Research

Difference between science and technology is also expressed in terms of the differences between *basic research* and *applied research*. ***Basic Research*** which corresponds to "science" aims at merely increasing the quantum or sum of knowledge. In the previous centuries most of the scientists were involved primarily in basic research. But the trend has reversed in favour of applied science. In America, for example, during the 1970-80's hardly 14% of the scientists were engaged in basic research.

Applied research which corresponds to *"technology"* on the contrary, aims at finding technological applications for scientific knowledge. The modern governments and industries are concerned more with useful technologies than with the pursuit of knowledge. The determination of how money should be allocated for what type of research has little to do with what scientists themselves regard as the most pressing social or scientific priorities.

2. Technology Is Much Older Than Science

Every society has at least a simple technology, even if it is limited to such techniques as making stone implements, bows and arrows, fire building, making crude boats such as canoes, etc. All primitive people have some body of practical knowledge on which their technology is based. But this kind of knowledge is not virtually science. On the contrary, such knowledge is derived from earlier trial-and -error experience, and not from an understanding of the abstract principles involved. The cave dweller, for example, does not know why fire burns, and why some substances burn while others do not, how water or, sand extinguishes fire, and so on.

3. Technological Innovation May Precede The Scientific Investigations

People in all societies whether they have scientific knowledge or not, have always needed to find out better ways of doing things or ways of making their lives more comfortable. Technological innovations have met these needs for thousands of years. *"In fact, technological change proceeded without the benefit of scientific knowledge for the bulk of human history".*[1]

4. Science Or Scientific Knowledge Is Not Universal

Science is not the inborn trait or inherited quality of all persons. Hence all the societies may not have the tradition of science. On the contrary, technology however crude, is found in all societies. Even the stone age people had their own crude technique of using stone implements and sharpening them. Science, very rarely appeared in human societies in the past. Because, scientific knowledge requires a proper and a systematic understanding of the principles that underlie natural events. Advanced technology is possible only by a proper scientific understanding of the world. Understanding of science and its principles is not that simple. Satellites cannot be launched, atomic reactors cannot be built, and nuclear bombs cannot be manufactured, for example, without the precise knowledge of the relevant scientific principles.

5. Science And Technology Together Support Modernisation

Only the close link between scientific and technological development can accelerate the process of modernisation. In fact, the close link between science and technology which we normally take for granted today, is a relatively recent development. Accelerated by the discoveries of modern science, technology rapidly expanded the human capacity to live in and exploit different habitats. In the past two - three centuries it has changed the face of the earth. Heavy industries, big dams, international airports, supersonic rockets, super computers, satellites, skyscrapers, big ports, oil

1. **William Kornblum** in his *"Sociology - In A Changing Society"* - Page: 469.

refineries, super highways, atom bombs, etc., are all the products of technology that have transformed the surroundings in which human beings live and work. *"It is this interrelationship between science and technology that is responsible for the breath-taking speed for technological change in our century."*

2. THE INSTITUTIONALISATION OF SCIENCE

Though science was hardly recognised as an important aspect of man's socio-economic life, its practical importance began to be felt over the years. Today, science is institutionalised. Throughout the civilised world, science is recognised as highly important and useful. It is standardised. Scientists throughout the civilised world follow the same basic methods and procedures. Scientists in governmental, industrial or university laboratories work in predictable ways to bring about unpredictable discoveries.

Institutionalisation of Science - A Recent Development

Though science and scientists have been in existence since centuries, science has emerged as a major social institution relatively recently.

The Background of Institutionalisation

Two-three thousand years ago, a few ancient people such as the Indians, the Arabs, the Greeks, the Mayans accumulated considerable amount of scientific knowledge especially in the fields of mathematics and astronomy. They made some practical use of their knowledge in such fields as agriculture, architecture and navigation. But they had hardly any specialised scientific roles, and *they made no efforts to link science to technology.*

The beginning of the modern science was marked by the rebirth of learning in the 16th and 17th centuries. Even at this stage there were no specialised scientific roles.

Until the 20th century, science was practised primarily by gentlemen equipped with intellectual curiosity and private wealth. The activity was not of great importance from the societal point of view, for its practical purposes were not widely recognised. Virtually, there were no full time professional scientists. The field of science was dominated by people who are understood in today's language as *"gifted-amateurs"*. Though universities were gradually admitting science to the curriculum, they continued to give more importance to the more prestigious traditional subjects such as classical languages and philosophy. Specialised scientific roles existed mainly in the universities and scientific research was largely confined to the ivory towers of the academic world.

Science As The Modern Institution

It is in the 20th century the relationship between science and technology has become fully recognised and exploited. This development has made the science to become a full-fledged and a well-developed institution. Science which was referred to in the previous centuries as *"little science"* has now become the *"big science"*. It is now firmly associated with big organisations, big money, big industries and big politics. The number of scientists in the world has grown very rapidly. In fact, the 20th century produced more than 90% of the scientists who ever lived on earth. [Price, 1963]. At the fag end of the 20th century (1980), more than one lakh scientific journals were in circulation and more than 2 million individual scientific papers appear each year. In America, for example, by 1980s, there were more than 5.66 lakh full-time scientists. Most of these scientists were employed by large formal organisations, universities, industry and the government. Of these, the universities constituted the largest single employer. The scientists had considerable freedom to choose the area of research in a university, provided it got the financial assistance from some agency. As far as the industry and government are concerned, the scientist's specific tasks are usually set by the organisation in accordance with its own political, military, commercial or other purposes.

Effects of Institutionalisation of Science

The institutionalisation of science has important effects especially on the scientific community. Some of them are mentioned below.

Firstly, science no longer remains a field to be occupied by the *"gifted-amateur";* or a field of *"respectable leisure activity"* to serve *"the needs of gentlemen equipped with intellectual curiosity and private wealth."*

Secondly, scientists must spend many years in training for scientific careers and can rarely expect to make a significant contribution until they have mastered a specific sub-section of some scientific field.

Thirdly, scientific disciplines have become more and more specialised. Even the super specialists in the scientific field may find it difficult to keep up with the literature that gives report about the developments taking place in that field.

Fourthly, scientists in order to face these realities form social organisations of various kinds. These organisations may be either as large formal organisations as the international organisations or small informal, *"invisible colleges"* consisting of a small number of scientists working in the same field. These organisations are of great help to the individual scientists to keep themselves in touch with the latest developments taking place in the field. These are also of help to find answers to specific questions, to sense new trends and to seek critical remarks about their own work.

Fifthly, competition among the formal scientific organisations has become almost inevitable. *"One consequence of this unplanned growth of scientific organisations in universities, government, the military and the private sector,* ***Bell*** *concluded, is that it became impossible to create a single set of policies for the support of science. The various organisations must compete for resources and are vulnerable to changing national needs as well as new demands for scientific knowledge by business and industry. This makes scientific institutions even more intense and competitive."*[1]

Finally, conflicts between scientists and the sponsors of the scientific researches have almost become inevitable in the modern complex socio-political situations. Since many resort to scientific career as professional, scientists are to be paid for their work. The more their research is on *"pure"* sciences [that is, basic research] the more it is to be supported by the institutions like the government or the university. If they resort to *"applied research"* which aims at finding technological applications for scientific knowledge, the chances of getting financial support by the institutions such as industries, and commercial establishments, are brighter.

Neither the educational institution nor the formal scientific organisation itself, is able to support continuously all the research projects that the scientists want to take up. *"This dependence of science on other institutions continually subjects scientists to pressure to make their work relevant to the needs of business or the military. Conflicts between scientists and their sponsors thus have been a feature of science since its origins".*[2] In fact, a glance at the norms of science or scientific institutions help us to understand more fully the nature of this conflict.

3. THE NORMS OF SCIENCE

It is quite known that every social institution develops its own norms that specify how its special functions are to be carried out. The institutions of science not an exception to this.

"The norms of science, like the norms in any other social system are the set of rules that govern how scientists do their work."[3]

Members of the scientific community have developed a set of norms to control and govern their own work. Those norms are not made very much public, but they are implicitly followed by most of them. These who violate these norms are tackled by the community members in their own way. **Robert K. Merton** (1942) identified four principal norms that constitute the *"moral*

1. **William Kornblum** - Page: 471-472.
2. **William Kornblum** - Page: 472.
3. **Allan G Johnson** in *"The Blackwell Dictionary of Sociology"* - Page: 245.

imperatives" of science. They are: (i) *universalism*, (ii) *communalism*, (iii) *disinterestedness* and (iv) *organised skepticism*.

1. Norm of Universalism

One of the basic norms of scientific institutions is universalism. This norm emphasises the universal nature of the scientific enterprise and its findings. This norm requires scientists to evaluate findings solely on their objective scientific merits rather than on such subjective criteria as the personal or social characteristics of the scientists who report them. It means *the truth of the scientific knowledge must be determined by the impersonal criteria of the scientific method, not by the criteria related to race, nationality, religion, social class, or political ideology.* In brief, this norm suggests that research findings must be evaluated purely in terms of their scientific worth.

2. Norm of Communalism

This norm of science refers to the *"common ownership of scientific findings."* The principle behind communalism is that *"scientific knowledge should not be the personal property of the discoverer."* This norm of *"communism"* or *"communalism"* has nothing to do with the economic or political systems for it only requires scientists to share results freely with one another in order to further the scientific discovery. All science rests on a shared heritage of past discoveries and no individual can claim property rights over the outcome of research. *Any new work of any scientist for that matter is only the continuation of what others have already done in that field.* This fact was acknowledged with all humility and humbleness by **Sir Issac Newton** when he reacted about his scientific achievements in the following manner. *"If I have seen any farther, it is by standing on the shoulders of giants."*

The scientific findings are not the property of any individual although in some cases they may bear the name of the person who first published them as in *"Darwin's Theory of Evolution"*, *"Raman's Effects"*, *"Einstein's Theory of Relativity"*, *"Boyle's Law"*, *"Newton's Laws of Motion"*, etc. These discoveries in actualities are common property. Technology, in contrast, can become private or corporate property through the use of patents.

Consequences: The Norm of Communalism Leads to Two Consequences

(i) This particular norm may, however, give rise to frequent conflicts over scientific priority, that is over *who was the first to discover* or *publish a particular item of scientific knowledge.* For example, there is the continual controversy over who discovered the differential calculus - **Newton** or **Leibniz**. But there are no limitations or restrictions on the use of the calculus.

(ii) Yet another consequence of the norm of common ownership is *the norm of publication.* The scientists are required to give full and open communication relating to their scientific findings in journals, and periodicals which are accessible to all. Theoretically, secrecy is thus, out of place in science. Though theoretically scientific findings are required to be made public, they are not often done so. Scientific research is often conducted in the interests of national defence, or under the sponsorship of private firms that hope to profit from applications of the findings. The norms of common ownership and publication are often suspended. Situations like this have led to innumerable conflicts in scientific circles.

3. Norm of Disinterestedness

According to this norm, the scientists should be free from self-interests in their professional roles. Scientists are expected to act in the best interests of science. The scientist is not supposed to allow the desire for personal gain to influence the reporting and evaluation of results. Further, fraud and irresponsible claims are outlawed. Scientific research is subject to the scrutiny of others. In fact, this is a part of the research itself. The results of the research are to be verified by others. Scientists who falsify research results in order to make a name for themselves clearly violate this norm and threaten the credibility of scientists in general. *Science is, in a sense, 'self-policing'.*

The norm of disinterestedness, however, does not imply that scientists cannot and should not hope to profit from their findings. On the contrary, scientists may legitimately hope that their work will be recognised and praised by the scientific community. There are many instances in which scientists have held lucrative patents for their discoveries. Though he is entitled to obtain the reward in terms of recognition or in other approved means, his main interest should be to contribute to the sum of scientific knowledge. In other fields, for example, say in business or politics- it is almost expected that people will distort the facts to serve their own ends. *But in the scientific community, the dishonest manipulation of the data or any other fradulent practice is intolerable.*

The norm of disinterestedness has also been violated. Some instances of scientific fraud have become notorious. Some states have taken advantage of the general public's lack of scientific knowledge to spread scientific misinfomation on such matters as racial purity as in the case of Nazi Germany.

4. Norm of Organised Skepticism

The norm of organised skepticism requires scientists to always question their results, to resist the temptation to conclude that any idea about how things work, is once and for all proven to be true. There are no *"sacred"* areas in science that should not be critically investigated, even if political or religious dogma forbids it. No theory, however ancient and respected, or new or old or revolutionary, can be uncritically accepted. *"The skepticism of the scientific community is "organised" in the sense that is built into the scientific method itself and is binding on all members of the scientific community."* [1]

The norms that are described above, are well established aspects of modern science These norms make science become clearly differentiated from other institutions such as religion or state. These norms have added dignity and prestige to the institution of science. But the emergence of these norms in the institution of science, is only a recent phenomena. Hence, science was not always viewed as a legitimate institution or a respectable occupation. Science in its early history was often regarded as a dangerous activity with the potential to threaten the existing social order. The repression of the scientific activities of **Galileo** by the Holy Court Inquisition is an example in this regard.

Norms of Science Are Not Always Obeyed !

Commenting on the norms of science, sociologist **R.K.Merton** says that as long as these norms are obeyed so long the scientific knowledge will accumulate. If norms are violated, scientific inquiry will suffer. But the bitter fact is that norms of science, like any other type of norms, are sometimes broken. Some examples in this regard are cited below.

1. *The norm of universalism* for example, was blatantly violated in Nazi Germany which attempted to distinguish between *"Jewish"* and *"Aryan"* science. This distinction is associated with racial discrimination which resulted in the suppression of the Jews.
2. *The norm of communalism* is often violated particularly when research is conducted for military purposes and commercial interests that hope to profit from a monopoly over some item of knowledge.
3. *The norm of disinterestedness* is also violated for the scientists may prove to be as greedy or ambitious as any one else.
4. *The norm of organised skepticism* is also violated, probably more frequently than the other types of norms. Scientists after all, are human beings, they have their own private values and prejudices, and may be unwilling to give up old ideas or to accept new ones.

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1. **Ian Robertson** in *"Sociology"* - Page: 395

4. SOCIAL PROCESS OF INNOVATION

Science is a part of the aspect of modern life. Science is not stagnant. It is ever growing. Science is after knowledge. Scientists are always at work to explore the new horizons of knowledge. Scientific inquiry is an unending process .The object of scientific inquiry is ***innovation***, that is, *the discovery of new knowledge*. This innovation is neither automatic nor accidental. It is product of deep thinking, careful observation and systematic activity. Innovation does not simply occur in a random fashion. Science is not just the creation of a few curious and inquisitive individuals. *It is a social institution that is subject to the influence of social forces, both within and beyond the scientific community.* The social forces that influence science not only govern the growth of science but also strongly affect both the rate and the direction of scientific innovation.

Science is not a matter of a steady accumulation of knowledge. All scientific inquiries need not necessarily lead to success. New theories are proposed, some of the existing ones are still used while some others are abandoned. The existing knowledge at any period is only provisional, never final and irrefutable. In fact, **Karl Popper** (1959), one of the philosophers of science, is of the opinion that it is never possible to prove anything in science with absolute finality. He asserts that there is always a possibility that an exception will be found to every scientific law. *"All that we can do is disprove hypotheses, and our scientific knowledge consists entirely of theories that are not yet disproved, although one day they might be."*[1]

Competition In Science

***Scientist's Desire For Recognition*:** Competition is one of the factors involved in the social process of innovation. Scientists are also caught in a competitive race like any other individuals because of their longing for recognition. Those who arrive at first in a discovery naturally obtain name, fame and honour. The scientist who gets there second by independent work is ignored, no matter how meritorious his or her work consists in. Scientists are also socialised to do original research. Importance is laid on this aspect. Because, researchers get no credit or recognition for following in the footsteps of others. Since professional recognition is of great importance to the scientists they normally prefer to follow their own path and break away from that of others.

Functional Effects Of The Desire For Recognition

The desire for recognition on the part of scientists may have its own undesirable effect by encouraging secrecy. But such a desire is not always dysfunctional. It has several functional effects such as the following:

Firstly, *desire* for recognition encourages scientists to publish their findings and communicate their results to others as soon as possible.

Secondly, competition reduces wasteful duplication of efforts for scientists are motivated to tackle problems that the others are not working on.

Thirdly, competition encourages scientists to explore new specialities or even to find new disciplines in the existing areas of ignorance.

Resistance To Scientific Innovations

Innovation is an essential aspect of science. Growth of science hinges more and more on innovations. But the history of development of science reveals that innovation has not always been encouraged and welcomed. On the contrary, it is often resisted. As **Thomas Kuhn** points out, *"Resistance to radical innovation has been the norm rather the exception in the scientific community."*[2]

Examples **:** (i) **Galileo's** colleagues, for example, refused *to look through his telescope to the moons of Jupiter.* (ii) Scientist **Giordano Bruno** was burnt at the stake for having proclaimed that

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1. Ian Robertson in his *"Sociology"* - Page: 397.
2. **Thomas Kuhn** in his *"The Structure Of Scientifi c Revolutions "*- (1962).

the earth revolved round the sun. (iii) **Louis Pastuer's** *germ theory* was ignored by the surgeons of his time, who could have saved countless lives by washing their hands and instruments before operating on the patients. (iv) **William Harvey's** *theory of the circulation of blood* was greeted with hootings and derisive laughters when he presented a paper on the subject in a gathering of the physicians. (v) **Sigmund Freud**, was shouted down by his furious fellow psychologists when he proposed his theory of childhood sexuality. In fact, a contemporary biologist **Edward Wilson** made an attempt to launch a new science namely, *"sociobiology"* -(the unified study of all social animals, including human beings) which was severely opposed by scientists in several fields.

In the same manner, various discoveries of modern physics, such as - *the laws of gravitation, theory of relativity, wave theory,* and *quantum theory*, were vigorously resisted for years after they were first announced.

Influence of Social Factors on Scientific Innovations

The examples cited above give rise to a pertinent question : *" Why so many of these scientists themselves are reluctant to accept scientific innovations ? "*

Scientists during the early days were reluctant to accept new scientific theories or innovations mostly due to the following reasons :

Firstly, most of the scientists used to follow the existing norm of the day, that is, -rejecting as unacceptable any new theories or discoveries that deviated from or undermined the existing one.

Secondly, scientists might be reluctant to give up the ideas that have proved useful in the past, and particularly when their reputation is very much tied to their work.

Thirdly, scientists were reluctant to admit fresh evidence that would upset their tidy theories, or make them look foolish in the eyes of the public.

Fourthly, the scientific community was under the heavy influence of the society especially during the early times. As it could be observed in the 17th and 18th centuries, and also earlier, scientists were blinded to the facts by the religious dogma of the time. By the late 19th and 20th centuries, the religious world view was no longer uncritically accepted. Further, there was growing faith that the science could unlock the mysteries of nature. Hence, new theories started getting quick acceptance.

Factors Contributing To Quick Acceptance of Innovations

It is significant to note that the time lag between an innovation and its final acceptance was far greater in the past than it is today. For example, it took centuries for the scientists to accept the evidence of the earth's age, but it took only decades before most of them accepted the evidence for the evolution of the species. Scientists have become today more open minded. They are mentally equipped to accept new facts and give up the old ones, if they are proved to be wrong. *Why is this change in their approach? Why are the scientific innovations much more readily accepted today?*

Influence of Four Factors As Suggested By Kingsley Davis

According to *Kingsley Davis,* there are four factors which make the modern society more or less willing to accept comparatively quicker the scientific innovations. They are as follows:-

Firstly, *society's attitude towards change* very much influences its preparedness or unpreparedness to accept innovations. Most of the modern societies are no longer suspicious of change. Those societies which believe in *"progress"* and acknowledge the role of scientific innovations in bringing about that progress, normally have a readiness to accept novel ideas, new findings and innovations.

Secondly, *the factor of institutionalisation of science* affects also influences the acceptance of innovations. *The process of institutionalisation of science leads to the primacy of science.* In a society where science is institutioalised, science becomes a central activity rather than a marginal

one. In such societies, scientists are socially rewarded for new discoveries. Needless to say, innovations take place much faster in them.

Thirdly, *the factor of specialisation* also affects the tempo of innovations. We are living in an amazing world where life is short and intellect is limited. If scientists are amateurs in several fields, they are less likely to make discoveries than highly specialised practitioners. These practioners are intimately acquainted with a particular field. They delve deep into that field and try to know a small topic. They become specialists in their respective fields. They are the ones who take initiative in innovations and who invite and encourage innovations.

Fourthly, *the factor of the methods and means of communication* not only influences innovation but also contributes to its diffusion. If new ideas can be conveniently stored and quickly transmitted, information becomes more accessible and can more readily be put to use. The modern means of communication such as computer networks, internet, e-mail, etc, have added to the process of diffusion of innovations.

As **Kingsley Davis** has pointed out the four factors mentioned above, have been operating in most of the well developed modern societies to make them accept rather than resist innovations.

5. TECHNOLOGY AND SOCIETY

Technology and technological developments have reached their heights in the modern society which is often picturised as a technological society. Though technology has assumed importance in the present world it is yet to acquire a prominent place in the sociological thinking . In spite of it, there are a number of sociologists who argue for its importance especially in understanding the course of history and social change. Major types of societies such as - hunter-gather society, horticultural society, agrarian society, industrial society, or post industrial society- are mostly distinguished by differences in technology. The industrial revolution, which produced enormous social change, was based to a great extent on technological innovations.

Technological Determinism

Science in the modern world is more and more tending towards developing sophisticated technology. Much of the scientific knowledge that is required in the modern industrial society has been used to create an extremely sophisticated technology. It is indisputable that technological innovations have immense social significance. Our way of life and social behaviour are influenced by technologies available to us; from kitchen gadgets to automobiles.

The influence of technology on society seems so powerful that some sociologists have adopted a position of *technological determinism*. They are of the view that the technology available to the society is an important determinant of its nature and character.

"Technological determinism is an assumption that technology is both autonomous and has determinate effects on society. Technology is seen as political and as independent variable in social change." [1]

There is a strong element of technological determinism in the work of **Karl Marx** also. He drew attention to the technologies of economic production that affects the social order. In fact, Marx's famous phrase - *"the handmill gives you society with feudal lord; the steam mill, society with the industrial capitalism."* - is sometimes used (mistakenly) as an example of technological determinism. Marx, however, saw technology as intimately related to the social relations of production.

Technological determinism is associated with neo-evolutionary theories which give technology primacy in the analysis of social change.

Several American social scientists such as **Thornstein Veblen** (1922) and **William Ogburn** (1950), have also stated that the specific historical developments and culture traits are the direct result of particular technologies.

1. *"Collins Dictionary of Sociology"* - Page: 678.

Ogburn And His *"Technological Deterministic Theory"*

Ogburn made technology a powerful factor of social change. He even tried to explain specific social or historical events in terms of suggesting that the self starter in the motor-car had something to do with the emancipation of women in the American and Western Europe. Similarly, he gave us illustrations of the labour saving devices in the kitchen and the use of new fuels like gas and electricity which reduce the toil of the woman in the kitchen. Ogburn in his attempts to trace connections between historical events and technological developments stated that the invention of cotton gin in 1793 promoted the institution of slavery in America. The cotton gin greatly increased the productive capacity and thus the profitability of the textile industry. As a result, many more slaves were needed to work on the new cotton plantations that had emerged.

Ogburn divided human culture into *material* and *non material* elements. He stated that normally changes occur in the material culture first. People accept new tools and implements much more readily than they accept new ideas, values, norms, or institutions. These technological innovations invariably lead to changes in the non material culture. As a result, there is always a *cultural lag* as the non material elements attempt to *"catch up"* with changes in the material elements. Ogburn argued that this culture lag is a continuing source of social disorganisation and social problems.

Ogburn's argument has its own limitations. It is very difficult, if not impossible, to isolate the technological factor from the others as the main cause of social change. Technological change, such as the introduction of cotton gin, always occurs in the context of other changes. Technology cannot operate independently.

More over, the precise effect of technological innovation depends on the culture into which it is introduced. Thus, different cultures will accept, reject, ignore, or modify an innovation in accordance with their existing norms, values, and expectations.

It is thus argued that the theory of technological determinism cannot be pushed too far. It is better to see technological innovation as a part of social system along with other elements in society such as religious, political, economy, military, educational, familial , and so on.

Technology And The Rate Of Social Change

Technology has established itself as a powerful agent of social change. The more the society is advanced, the more it encourages technology, and, as a result, the more it gets changed due to technology. And the more rapid the technological change, the more rapid is the social change that it generates.

Significant technological changes have taken place in the past 70-80 years. For a long period in history, people lived in a world little different from that of their parents. Parents expected their children and grand children to live much the same lives as they did. The *traditional societies* assume an almost unchanging social world and are typically very suspicious of change. On the contrary, in the *modern societies*, however, people accept change as the norm. They look for novelty, new experiences and new ventures. People expect constant improvements in their material environment. This fact has been beautifully explained by **Alwyn Toffler** (1970) in his famous book *"Future Shock"* .He has argued that *"we are living in a permanent state of "future shock". The future, he contends, continually intrudes into the stability of the present. Ours is a "throwaway" society in which change takes place faster than our ability to adjust to it."*[1]

The technological change has its implications on almost every aspect of society. Some examples may be cited here.

1. *Advancement in the medical field has lengthened life expentancy and brought down the death rate and this has radically altered the population structure.*

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1. Views of **Alwyn Toffler** as expressed in the words of **Ian Robertson** in his *"Sociology"* - Page: 403.

nnovations in the field of industry have turned thousands of workers as unemployed persons. ld manufacturing machineries have become obsolete within a few years.

ultural activities of the people have undergone revolutionary changes due to such innovation radio, television, cinema, computer and phonograph records.

ne socialisation process has become more complex in the modern society. The elderly :ople can no longer pass on safely the age old culture to their children. **Margret Mead** nts at it in a curious way. She suggests that *" the pace of technological change is now so 'eat that the old and the young live in quite different worlds- so much so that, in a sense, e parents have no children and the children no parents. For the first time in history, she ints out, the old are no longer the main source of wisdom and knowledge in the community. ie young often know far more relevant information about the modern world than their trents."*[1]

is, indeed, beyond our imagination to say with certainty about the direction, dynamics, and ions of technology. It is bound to grow with ever greater speed. Since technology is a part of , it is sure to affect and influence the course of our social life. People in the days to come find it more and more difficult to adjust and accommodate themselves to the ever growing logy.

THE SOCIAL CONTROL OF SCIENCE AND TECHNOLOGY

cience and technology have become today two formidable forces. Both are changing fast and king other institutions to undergo fast changes. Interaction of other social institutions with science and technology is a great challenge of our time.

cience and technology are advancing so fast that they have irresistible effects on other ions. Commercial establishments, business firms, industries, etc., stand to lose heavily unless e the latest technology. Technical changes often alter the problems of the government. Religion :d to adopt its teachings to meet new scientific interpretations. Education seeks to prepare s for scientific and technical developments.

Problems Arising Out of The Lack of Systematic Control Over Scientific And Technological Innovations

; it is made clear, science and technology have been undergoing relatively fast changes. changes do not always guarantee beneficial results to the society and people. These changes often give rise to some special problems also. At the same time, we have not been able to) a system to exercise control over scientific and technological innovations. Our failure in ard has further added to these problem. Three main problems in this regard are worth citing

Problem Related To The Nature And Qualities Of The Environment

environment has been the first casualty as far as scientific and technological innovations are ied. A relatively unsystematic and uncontrolled scientific and technological advance may any unforeseen social effects particularly on the quality of the environment. ***Examples;*** (i) excessive use of chemicals and artificial fertilisers soil impoverishment has taken place in such as South Italy, Greece, Palestine, Egypt and Morocco, (ii) There have been fears that ditives may contribute to human cancers, blood pressure, diabetes, nervous weakness and her diseases. (iii) Atmospheric pollution caused by man may lead to climatic changes that ause a new ice age, (iv) Gases sprayed through aeroplanes may interfere with the planet's ayer and allow dangerous radiation to reach the surface of the earth. Many more examples of d could be cited.

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ws of **Margret Mead** as expressed in the words of **Ian Robertson** in his "*Sociology*" - Page: 403.

Distortion of The Priorities of The Research Matters and Efforts

Society should take up the responsibility of fixing priorities for making scientific researches echnological findings. If such priorities are not fixed then the innovations may not take place in dance with the defined social goals. The haphazard way in which the scientific and technological nces take place not only cause unforeseen effects but also distort the priorities of techno-scientific lopment. Critics are of the opinion that under the present conditions, the scarce natural resources o be judiciously handled and conserved; and they must be used for serving important human s such as - *producing more effective life-saving drugs, predicting more effectively and well in nce the probable dangers of earthquakes, cyclones, and such other natural calamities; for ucing more effective instruments to increase the efficiency of physically and mentally handicapped ren and so on.* Scarce resources, for example, need not be wasted just for producing new types smetics

Highly Technological Society Posing A Possible Threat to Democracy ?

In a participant democracy ordinary people and their elected representatives take part in the sion making process. In a highly technological society such decision makers may owingly cause great dangers to the society by taking unscientific and wrong decisions. ***For mple,*** *they may take decisions to build nuclear reactors near urban-settlements, to issue nses to industries that cause environment pollution of the worst type; to issue such licenses e industries without considering, the "sustaining power" of that particular environment, so on.* Due to their ignorance of scientific and technical matters, such representatives may te dangers to the society.

Further, there is another danger caused by what is known as *technocracy.* **Galbraith** (1967) and rs have warned about technocracy, that is, rule by technical experts who play their role behind scenes. In modern corporations, big companies and government departments, the real decisions often made by the so called experts The decision makers normally rely upon the specialised wledge and recommendations of these technical experts. Sometimes, societies will have to pay a y penalty for the erroneous technical advises given by these experts.

FFICULTIES INVOLVED IN ESTABLISHING SYSTEMATIC CONTROL OVER SCIENCE AND TECHNOLOGY

It is clear from the above analysis that there exists a need for establishing a systematic control scientific and technological developments. But the establishment of social control over science technology is not an easy task. According to **Ian Robertson**, such an attempt itself involves e difficulties or problems [Page: 405] which may be briefly examined here.

Problem Of The Conflict Of Values

The task of establishing social control over science and technology gives rise to the problem of flict of values. The ultimate object of science *is the pursuit of knowledge.* Any real scientist for matter expects an atmosphere of complete intellectual freedom. **Albert Einstein,** one of the atest scientists of the 20th century, points to this conflict in the following words. *"There arises at e the question; should we consider the search for truth... as an autonomous objective of our k? Or should our search for truth be sub-ordinated to some other objective, for example, to a " ctical one?" This question cannot be decided on a logical basis. The decision, however, will e considerable influence upon our thinking and our moral judgement, provided that it is born of deep and unshakable conviction.."* [1] He further writes ".... *any thinking individual would it impossible to have a conscious, positive attitude towards life"* unless he is allowed to have ependent objectives.

Albert Einstein in his article *"The Scientist: His Responsibility and Dignity"* published in **Bangalore versity's** publication entitled *"Thoughts on Science and Society"* - 1975, Page: 1.

Einstein also states that *"... intellectual individualism and the thirst for scientific knowledge emerged simultaneously in history and have remained inseparable ever since..."* - [Page: 2]. Should a scientist be allowed to have intellectual liberty and freedom to do research, even if his research or findings would bring disastrous effects on the society? This is virtually a question related to *value conflict*.

2. Problem of Non-Scientists Dictating Terms to Scientists Regarding Science and Technology

There is the problem of non-scientists giving orders or directions as to what scientists should do, and should not do, what researches to pursue and what to drop out, and so on. If it is a question of imposing restrictions on research, it again becomes difficult to decide the nature of restriction. It becomes impossible for the scientists with conscience to receive such orders or commands at the hands of unqualified persons.

3. Dilemma Created By the Shifting of Priorities

The issue of establishing social control over science and technology gives rise to yet another conflict of values, particularly if society attempts to shift its priorities in applied research from one set of goals to another. ***For example,*** if a manufacturing company which has been encouraging scientists to produce new types of packed food, suddenly changes its priority towards producing cosmetics, it may lead to heavy loss in terms of infrastructure. It may also mean interference in the intellectual freedom of the scientists. In a capitalist system like America, such shifts in priorities are often resisted by the scientists.

4. The Question of Owning Moral Responsibility for The Research

Scientific and technological innovations or researches may not always bring about positive results. They may often lead to deadly and disastrous consequences. The problem that arises here is, *-who should own the moral responsibility for having taken decisions about research that may have far-reaching consequences ?* The manufacture of atomic bomb, and later the development of hydrogen bomb, are but examples of many such cases. In these cases, for example, technical and moral issues are not easily separated in practice.

5. The Problem Of The Scientists Not having Any Control Over Their Own Research

The present day scientists in most of the countries are not able *"to control the uses to which their work is put"*. Many scientists are very much disturbed about this situation. **Albert Einstein** points out at the helplessness of the scientist in the following words. *"What then, is the position of today's man of science as a member of society? He obviously is rather proud of the fact that the work of scientists has helped to change radically the economic life of men by almost completely eliminating muscular work. He is distressed by the fact that the results of his scientific work have created a threat to mankind since they have fallen into the hands of morally blind exponents of political power..... the concentration of economic and political power in the hands of small minorities which has not only made the man of science dependent economically, but also threatens his independence from within..... He even degrades himself to such an extent that he helps obediently in the perfection of the means for the general destruction of mankind"* [1]

6. The Necessity of International Science Court

Who should take decisions regarding new technology and new researches? This question has assumed to be an important one. Moneyed people with greediness, scientifically ignorant people with political power, and common people who conspicuously lack genius - can never take such important decisions. It is, in this context, establishment of an international controlling agency such as an *"international science court, with full legal powers to restrict certain dangerous or risky research*

1. Albert Einstein in his article - Page: 3-4.

seems to be the need of the hour. Many thinkers and scholars have already made proposals of such a *'science court'* ." It is left to the community of scientists, technologists of international standard, and the formal organisations of scientists to take a final decision about this proposal. **Ian Robertson** has warned that *"The question is a very important one, for scientific and technological advance in the years ahead may change our material and social environment in ways that many people might consider undesirable."*[1]

7. CONDITIONS FOR THE SUCCESS OF SCIENCE AND TECHNOLOGY IN THE SERVICE OF SOCIETY

Science and technology are an inseparable aspect of the modern life and hence progress without science and technology is inconceivable. Research in the scientific and technological field is a sine quo non for economic advancement. Industry and society must provide the necessary environment for research to flourish. Effective utilisation of research is equally important. Knowledge can be a real *"power"* only when there are able and efficient people to use it. From the society's point of view, scientific and technological research is useless in a practical sense unless it is properly tapped or exploited. Such exploitation, however, requires more successful, aggressive, forward looking and efficiently organised mechanism for development.

Science and technology cannot assure progress or service to humanity by themselves. They depend on certain conditions to make available for the society and people, their utilisation. The conditions for the success of science and technology in service of society and people, may briefly be examined here.

Conditions For The Success Of Science And Technology

1. ***Presence of Scientists and Technologists*:** The first requirement for the success of science and technology is the very presence of scientists and technologists. Technology can be imported, but the scientists cannot be. Import of research results cannot assure progress. A nation which is interested in quick progress must have its own natural resources, raw materials, and finally its own scientific personnel. It must pay proper attention to develop its own scientific community.

2. ***Institution To Support Research*:** Research work is supported, sponsored, organised and directed by a well established institution. The tasks of the institutions are- *to identify the areas of research, select problems which need immediate solutions, arrange resources, and fix priorities relevant to country's economic growth.* Constant attention should be paid to the way in which the expected results can be made technologically and economically more practicable. *It is necessary to sell the results of research in a profitable manner.* The capacity to succeed depends more on the strategy and efficiency of the management than on the research potential.

3. ***Presence Of The Potential User*:** Success of technological and scientific researches depends upon the presence of the potential users and their capacity to appreciate and actually utilise the relevant technology made available by research. There has to be a proper communication line between the sender and the receiver. Research result can be sold only within the limited circle of the people, such as industrialists who can take the actual benefits out of it.

4. ***Proper Market and Enterprise*:** Applied research is most effective when it is coupled with a proper market and enterprise. Creation of market, identification of needs and demands and an appropriate environment are thus important.

5. ***Strong Government Support*:** Science and technology can hardly flourish in the modern situation in the absence of strong government support. As far as India is concerned, the Indian Government is highly supportive of science and technology. India has gone ahead of many of the developed nations especially in the fields of computer software and space research because of the strong government backing. The nation has now a firm commitment to science and a strong will to achieve results through the application of science and technology.

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1. **Ian Robertson** in his *"Sociology"*, Page: 405.

6. *Enlightened Public Opinion In Support Of Scientists* : Another major prerequisite for science to succeed is a public opinion sufficiently well informed and enlightened to give every support to scientists. Well-informed public opinion can be got only through education. In this fast changing world of science, we need to focus our emphasis on the development of attitudes towards creativity, scientific method, critical thinking, devotion to the sense of values and ideals and individual excellence. Superstition, ritualism, and prejudice must give way to rational thinking, questioning attitude, spirit of adventure and scientific temper.

7. *Proper Identification Of Problems and Issues Relevant to Economic Growth*: Benefits of scientific and technological research will largely depend upon the proper identification and definition of problems that are relevant to economic growth. Researches and technologies are to be oriented towards the national priorities and the felt-needs of the people. Raw material resources and the genius of the land must be properly utilised. Proper facilities must be created for the designing and engineering establishments of the research. Industry, society and government must provide a necessary atmosphere and economic environment for research to grow.

Thus, the research yields differ from country to country differing at the levels of incomes, levels of technology, in industrial structure, size, technical and skilled manpower, the rate of expenditure on research and development.

8. *Proper Co-ordination Between Research Industry and Society*: Research and industry are partners to promote and catalyse the progress of the country. The support for science and technology from the side of society should be an act of faith. Industries must turn towards science and scientific research not only for finding solutions that crop up in their process of productive activity, but also to develop their intrinsic strength and efficiency.

"As it stands now, research and industry in India are running parallel like the two banks of a river, so near yet so far. What is most needed is the creation of common industry-research culture. The research and the industrialist must each live in both the worlds in such a manner that the worlds of research and industry become a single world." [1] Further, the society should create a proper social and economic environment that is favourable for the growth of science and technology. Science and technology, in turn, must support each other and contribute to the progress of society and industry.

8. SCIENCE AND TECHNOLOGY SHOULD BE MADE THE SERVANTS OF SOCIETY - ?

As it is already made clear, science and technology are growing at a very fast rate in the modern world. Changes taking place especially in the technological world force changes in the society. Science influences technology and in turn, gets influenced by technology. Both are changing and both contribute to changes in other fields as **Horton** and **Hunt** have pointed out, *"Science and technology have irresistible effects on other institutions. Business concerns face bankruptcy unless they use the latest technology, governments find that technical change has altered the problems which they face, religion must adapt its teachings to meet new scientific interpretation, and eduction seeks to prepare students for scientific and technical developments."*[2]

The Irresistibility of Science and Technology

Science and Technology have become a powerful force now. It is very difficult, if not impossible, to resist their temptation. Once set in motion, they cannot be stopped. Any attempt to prohibit new scientific and technological research would soon put us in the backwaters of history. Because all

1. **Y. Nayudamma** in an article *"Research, Industry and Society"*- published in the book *"Thoughts on Science and Society"* - Published by Bangalore University Page - 159.
2. **Horton** and **Hunt** in their *"Sociology"* - Page: 309.

sciences are interrelated and interdependent, and discoveries in one field open new vistas in others. As **Horton** and **Hunt** have said, *"Marx may have been wrong in making the economic institutions dominant over all the others. It may be that science and technology have greater effect upon our social relationships than any other institution."*[1]

Science and technological advancements spread very fast. In fact, it is very difficult to maintain secrecy in the realm of science and technology. Anything that scientists and engineers or technicians in industry, corporation or nation can do, the scientists, engineers and technicians of any advanced country can duplicate. Given a little time and a lot of money techniques involved in the new innovations are often stolen illegally. The findings of science and technology can never be secret for long.

Is Humanity at The Mercy of Science And Technology - ?

Science and technology are considered two important means for socio-economic progress. When we speak of science and technology, we speak in terms of their practical utility and convenience, and neglect their impact on human satisfaction for it cannot be demonstrated. When we evaluate the effects of science and technology, we normally do not examine them in terms of the totality of human experience. We say this or that invention is valuable because it generates other inventions. Because, it is a means to some other means not because it achieves an ultimate human end and we undermine the *"side effects"* which often completely negate all the alleged benefits. The advantages of all technological progress will be totally outweighed the moment nuclear war breaks out.

It is true that once a new technology is accepted, its hidden consequences may be unavoidable. For example, automobiles pollute environment, mass production promotes monotony and alienation, sophisticated technology produces technological unemployment, birth control techniques augment instances of sexual immorality, pesticides cost human health, war weapons make international peace a casualty, and so on. These, and many more examples of these kind, make us believe that we are becoming helpless victims of technology.

Science and technology have developed far faster than have social mechanisms to control them. A century ago, science was struggling to secure recognition and technology was relatively undeveloped. Today, they have brought about socio-political upheavals. They have the potentiality of causing wholesale destruction of human life. These undesirable consequences of science and technology were never anticipated previously.

The Question of Controlling Science and Technology: Now the question before us is - *can people control science and technology* - ? The answer to this question is an emphatic *"yes"*. It is 'yes' only if there are other values which are more important and precious. When people make reckless use of technology, science gets blame. As we see it today, political control of scientific and technological research is increasing. The autonomy of science diminishes as the domination of the Government grows. Popular skepticism is also increasing about science and technology especially after the two World Wars and the recent war between Iraq on the one hand, and America and the European Union, on the other. Hence, there is an urgent social challenge to find some means of ensuring that science and technology continue to develop in the direction of serving humanity rather than destroying it.

Einstein's Call to the Scientist to Face the Chanllenges with Courage: **Albert Einstien** who analyses the role of a scientist and his responsibility in an article - [Page: 4] also gives a call to the scientist to face the challenges of the modern situations in a courageous manner. According to him, no one should feel that *"there is really no escape for the man of science..."*, and he should not *"tolerate and suffer all the indignities"* perpetrated on him. He cautions that no scientist should

1. **Horton and Hunt** - Page: 309.

allow himself to be *"enslaved or used as a blind tool."* He writes; *"If the man of science of our day could find the time and the courage to think honestly and critically over his situation and the tasks before him and if he would act accordingly, the possibilities for a sensible and satisfactory solution of the present dangerous international situation would be considerably improved.*[1]

Conclusion: Science and technology have not only become major institutions of modern times, but also posed big challenges to the present world. The advances in these fields carry along with them latest consequences, which are difficult, if not impossible, to control. Still both can be directed at human welfare rather than human destruction. **Horton** and **Hunt** conclude this discussion in the following words: *"Those who really understand science have always been in the minority. Science may even go into temporary eclipse in one region, as in Hitler's Germany in the 1930s or in the People's Republic of China in the 1950s, but barring the worldwide destruction of civilization in a nuclear holocaust - which is not at all impossible - science and technology will continue to promote both innovation and change."*[2]