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SCIENCE, TECHNOLOGY AND LAW

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The Inter-disciplinary approach

For men and women who, in their daily life, pursue only one field of study it is refreshing to cross over its boundaries and to have a look at wider horizons. Such activities, covering as they do the boundaries of more than one discipline not only widen one's mental sweep, but also lend it depth and content. If science is the accumulated knowledge of centuries, law can be rightly described as collected wisdom of the ages.

Men have risen above the animal level, very largely by means "technics", the use of tools and implements for better procuring the mate means of life. Similarly, when they have achieved a reasonably perfect lei system, they have risen on the intellectual plane. A legal system is intended represent a synthesis of conflicting interests. Knowledge of the material world; its purest form is science, and when put to practical use, it becomes technology. Wisdom, at the peak of its excellence. is the foundation of the ideal political system, and, when utilised to regulate human relationships, becomes law Herbert Spencer defined Science as organised knowledge.[1] Law could be described as the wisdom of organised society given expression in binding rule by the State. "Law is a form of order, and good law must necessarily mean good order", Aristotle's saying[2] possesses as much validity today as when he wrote.

SCIENCE AND LAW

The points of similarity

There are certain other points of similarity between science and law. For example, science itself is organised on the same basis as law. It has been said[3]

"Art, in its legal significance, embraces every operation of human intelligence, whereby something is produced outside of nature; and the term 'science' includes all human knowledge which has been - generalised and systematised, and has obtained method, relations and the forms of law."

[1] Herbert Spencer Education Chapter 2.
[2] Aristotle, Politics, Book 7, Ch. 4, S.5.
[3] Atchison & C.R.R. Co. v. U.S. 15 Court of Claims (per Davis J.); Sarkar Evidence (1971), page 496

In science, general principles are formulated on an observation of specific phenomena. So it is in common law. It was said long ago that a precedent embalms a principle.[4] The famous letter writer[5] Junlus said that one precedent creates another, "They soon accumulate and become law".

One need not therefore postulate a conflict between science and jurisprudence. Such has not been the experience of history. The two disciplines have flourished together, and have often been enriched by the same brilliant minds. For example, the golden age of Greek science the fifth and the fourth centuries before Christ was not only the golden age of Greek literature and art, but also the golden age of philosophic speculation. The fourth century was dominated by two of the greatest personalities of their kind in the whole past. The earlier half was dominated by Plato: the second half by Aristotle. Plato not only speculated about political[6] and legal topics,[7] but was also a great lover of mathematics. On the portals of his Academy, were inscribed the words- “”Let them not enter here who do not know Geometry".

Aristotle was not only a pioneer in the natural sciences; he also wrote extensively on constitutional and legal topics.[8] The life and writings of these two brilliant minds show that deep and extensive knowledge of the world of nature can reside together with insight into law, social sciences and jurisprudence. There is no anti-thesis between science and law.

The progress of science

Science in the twentieth century has become big, complex, and expensive. It has also become relevant to the ordinary lives of men to an unprecedented extent. One could say, without too much exaggeration, that the course of history since the last quarter of the nineteenth century has been a story of increasing acceptance and incorporation of the scientific knowledge and scientists into the practical institutions of society, including both business and government. Science has become involved in our domestic politics, In international relations, and in virtually every institution which vitally affects men in the mid-twentieth century.

A Cornell University scientist caught the mood perfectly[9] when he observed that one of the most surprising outcomes of the war had been the sudden and I believe permanent-enthronement of science in the activities of humanity".

[4] Lord Stowell, opinion given as Advocate-General, 1788;
[5] Junius, Letters; Dedication.
[6] Plato, The Republic
[7] Plato, The Laws
[8] Aristotle, Politics
[9] Quoted by George H. Daniels, Science in American Society (1971), page 293

Let us note some examples. Human labour and education may be revolutionised by computers. The achievements of medicine and surgery in the prolongation of life may alter the very concept of life. New developments in the processes involved in the creation of life may also raise interesting problems. A scientific discovery or a technological invention could be a threat or a promise. it is for society to decide which one of the two it shall be.

Science itself has changed beyond recognition. Centuries of careful observation and beautifully creative thought went into the ancient Greek conclusion that Earth was at rest in the centre of the universe, with the sun, the planets, and the stars rotating about in circles and epicircles. What could be more logical? We do not feel any sensation of the earth's rotation, and a circle is the most perfect of figures. The theory was explained and defined with great precision during the second century by Ptolemy of Alexandria, but, unfortunately, in doing so, Ptolemy sterilized astronomy for some thirteen centuries, until the miracle of Nicolaus Copernicus.

Tennyson told us that science moves but slowly.[10] This may not be literally true today.

But it does seem that in science - as perhaps in many other departments of human civilisation - there is a "time-clock". The hour struck sometime ago for psychology. It may strike now, for biological sciences, since they have reached a point at which they would be in a position to throw light on many fundamental questions.

The role of science should not be disregarded. The great advances in scientific knowledge, the speed at which scientific developments proceed, the enormous part played by applied science in the life of a modern community and the degree to which our progress depends upon it, highlight the importance of a wider appreciation, among the people, of scientific principles and procedures and their impact on society.

The march of law

The law also has had its share of complexity in the course of centuries. Many of the important features of the Anglo-American legal system were established prior to the great industrial expansion. The enormous economic political and social changes of the past one hundred years have been accompanied by corresponding changes in our legal system. As the we became a pre-dominantly industrial and urban society, as the "big business" corporation emerged and labour was organised, as communications developed to create a world market and a world culture, as population doubled and quadrupled, the law

[10] Tennyson, Locksley Hall Line 134

inevitably became far more complex; and at the same time, it became more systematised and more rationalised.

CLASSIFICATION OF SCIENCES AND THEIR IMPACT ON LAW

Science is conventionally divided into certain main branches. The usual distinctions between sciences depend on tradition and convenience in teaching and research. There is the exact and non-empirical science of mathematics. Then, among empirical sciences, there are (1) physical, (2) biological, (3) human and social sciences. It is convenient to separate physics and chemistry, so far as different equipment in different laboratories is required.

Even so, there is interconnection and overlapping. Medical sciences are human and social, as well as biological and physical; particularly when they use special physical methods (e.g. medical radiology).

Scholars make a distinction between “science" and “technology". All sciences developed out of “technics"; mathematics developed from measuring goods in the market, keeping accounts and surveying land; astronomy, from compiling the calendar; mechanics, from working wood, stone and metals, and from construction of buildings and transportation by land and water, chemistry, from smelting metallic ores, brewing, distilling and dyeing; biology, from hunting and agriculture; and so on. But no technical achievement, however great, has by itself produced genuine science. Genuine science was the work of the Greeks of the 6th and 5th centuries B.C. (Thales and his school, the Pythagoreans and their successors). They first released human thought from the “pursuit of utility on the one side and fantasy on the other, in order to make a systematic attempt to understand the natural world. Their most conspicuous success was in mathematics, as a result of generalising problems and discovering methods of proof. Others, in Egypt and Mesopotamia, had discovered particular solutions for particular problems, some quite difficult, -presumably by trial and error; but they could not distinguish an exact from an approximate solution, nor even be sure that an apparent solution was not a lucky accident. The Greeks could do these things, and, by solving a general problem, solved at one stroke a multitude of particular problems.

The development of law offers a somewhat similar parallel. Particular instances are first dealt with, and, in course of time these give rise to general principles drawn from those cases. By enacting a general and universal rule, for example, legislation at one stroke covers a multitude of particular situations.

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Social evolution, and biological and technological progress, must, of necessity, be accompanied by changes in legislation, particularly in penal law;

changes in the sense of modernisation and reform. Social evolution and scientific advancements may be summarised as follows: (1) Those in the political and governmental sector; (2) those in the socio-economic sector; (3) those in the social family sector; (4) those in the medico-biological sciences; (5) those concerning the use of new types of energy; (6) those in the socio-cultural and the socio-ethical sector.

All these aspects concern man. The social sciences, too, have made these aspects substantial progress.

Science and law Points of contact

The points of contact between science and the law are numerous. The evolution of scientific theory, research and development might in the first place, affect the substance of the law, inasmuch as there would arise the need for dealing with so many spheres of nature and the human mind which have been explored by science.

Secondly, the process of law may have to take into account scientific developments. The adjective law-the law of procedure and evidence-is often felt to be in need of modification in the light of scientific developments.

Thirdly, in the actual administration by courts and other authorities entrusted with judicial and quasi-judicial functions, advantage could be taken of new scientific techniques that might be useful in court administration. A meaningful dialogue between the two disciplines is not a luxury; it has its utility, and it may soon become a necessity.

The rapid growth of science both in regard to the variety of fields covered and the intensity of knowledge acquired, might, in the not distant future, compel a close consideration of the subject of the inter-relationship of the two disciplines.

Francis Bacon once observed, "He that will not apply new remedies must expect new evils" We could avoid the emergence of new evils by anticipating them and by devising appropriate solutions.

Past responses

It would not, however, be correct to say that the law has been totally oblivious of scientific developments. The history of legislation in most civilised countries, at least since the time of the industrial revolution, shows that as and when new problems were presented by technological change and by its impact on human beings, the law, sooner or later, did take note of the fact and performed its role of “social engineering", by evolving suitable rules to regulate the conduct of human beings in the light of those developments. Whether this result was

achieved by legislation or by the judicial process (the method of the common law) or by any other method, is a matter of detail. But the fact remains that the problems came within the *fold* of *the* law. *For example, when animal transport* are *to* be *replaced* by *rail* and *the question* arose of *the liabilities* created by railway operations, legislation regulating railways was enacted.

At common law, where a railway is constructed and worked under statutory powers, and there is negligence in the construction or use of locomotives, there is no liability for fires caused by the escape of sparks from locomotives, although there is such liability if the railway is not worked under statutory powers.[11] But this view was rather hard upon farmers who had crops adjacent to a railway line. Accordingly, a compromise was effected by the Railway Fires Act, 1905, and 1923, which cast upon railways a liability not exceeding pounds 200[12], for damage caused to agricultural land or agriculture crops for fire arising from the emission of sparks or cinders from their locomotives, although the locomotive was used under statutory powers.

Same was the case with invention of the telegraph, the telephone, wireless telegraphy and aircraft and discovery of the atomic energy. Each of these developments in the scientific field was followed, if not accompanied, by legislation that was intended to settle problems caused thereby.

The dangers inherent in the setting up of nuclear installations- atomic, energy, radio-active substances, the emission of ionising radiations, the use of radio-istopes for medical and industrial purposes, and the disposal of waste therefrom-created new problems of liability to which the common law, in the form of actions for negligence, nuisance and the rule in *Rylands v. Fletcher,* provided no satisfactory answer. Only legislation could deal with the matter.

Adjective law and Science

Adjective law also furnishes illustrations of the legal approach to science. The fact that science (in the sense of specialised body of knowledge in a particular discipline) is primarily a matter for the experts, has been recognised by the law for a long time. It is precisely on this basis that section 45 of the Indian Evidence Act, 1872-an Act which is now more than a hundred years old-allows experts to give evidence of their opinions. Initially, the law was reluctant to admit in evidence the opinions of "experts", because of the traditional rule that evidence could be given only of facts which can be perceived by the senses, and not of opinion. But adherence to this strict doctrine was soon found to be unrealistic, when the matters of which evidence was to be given were themselves such as

[11] Vaughan v. Taff Vale Rly. (1860) 5 H. & H. 679; Jones v. Festiniog Rly., (1868) l.r. 3 Q.B. 733; Rylands v. Powell v. Fall, (1890) 5 Q.B.D. 997; Mansell v. Webb, (1918) L.J.K.B. 323

[12] Railway Fires Act, 1905 and Railway Fires Act 1923, 5 Edw. 7, c. 11, S. 1; 13 & 14 Geo. 5. c. 27. s. 1.

could .not be perceived by the ordinary human being without the aid of specialised mental and physical equipment.

Pace of the modern developments

Where, then, do we find the peculiar impact of science on law in modern times? In answer to this query, it may be stated that the peculiarity lies in this-that the points of contact between science and the law have, in modern times, increased in their number and intensity.

Each year brings a fresh crop of scientific discoveries. Knowledge that was accumulated a decade ago becomes out of date. Fresh fields are trodden, fresh avenues explored, fresh phenomena unearthed every year. These discoveries and explorations increase not only in quantity and number; they touch individual and social life at so many points. These are the points that ultimately become the points of contact between science and the law. It is in this manner that scientific developments result in an increase in the need of legal response to the various points of contact.

A country would be able to deal with this situation satisfactory to the extent to which its legal machinery that is to say, the machinery concerned with the formulation, administration, interpretation and re-formulation of the law,- takes adequate steps wherein the legal response referred to above finds Its reflection in a satisfactory manner .

Certain scientific techniques could be abused. Need to protect indlvidua1 liberty against unwarranted interference with privacy, which is technically possible, is an example of the need to create legal protection against abuse of technology. It may be elementary, but it is worth pointing out that the law acts only on human beings, and is concerned only with the conduct of human beings. It is not therefore every scientific development that may create legal problems. For example, the purely scientific discoveries have been revolutionary - discovery of X-Ray (Roentgen 1895), psycho-analysis (Freud 1900), Mendelism (1900), radium (Curie 1903). But these did not rise any socio-legal problems. On the other hand, disintegration of the atom (Lord Rutherford 1919) had important consequences in the course of time.

Legal response to technology is not new. The greatest events of the 15th century were the invention of typography about the middle of that century and the geographical discoveries initiated by Henry the Navigator, reaching a climax at the end of the century with Columbus and others. These geographical discoveries continued during the 16th century and immeasurably increased human experience in many directions.

The invention of printing led to a far greater diffusion of ideas than had been possible before it. For the first time, the progress of knowledge could be registered fore ver as soon as it was made, standardised and transmitted to every corner of the civilised world. The discovery of printing was so pregnant that it is well to consider it as the beginning of a new period. Printing, and the abuses regarded as likely to result from a wide dissemination of ideas, led to regulatory measures in law. Many of these measures were politically controversial and some have passed into the oblivion of history. We are riot, however, concerned with their merits. We are concerned with those measures as illustrating the response of the law to technology.

Recent Scientific Developments

During the last two decades or so, there have been certain scientific developments and technological inventions that require regulation in the interests of society and to prevent abuse. The emergence of multifarious devices that permit a prying into the private affairs of men and women through what has come to be known as “electronic surveillance" and similar other devices, has led to a move in many countries for the enactment of legislation to regulate them. The question is essentially one of the protection of the personal integrity and privacy of the human being from the abuse of technology.

There is one important technological development that has not yet been attended to effectively by society and law. With growing urbanisation and the mechanisation of transport, the number of road traffic victims is gradually increasing. While the law has devoted its attention to certain aspects-preventive, penal and compensatory in respect of accidents on the road caused by motor vehicles, much more remains to be done by society.

The measures to be adopted may not necessarily be legal. But they do require an inter-disciplinary study. There is a limit beyond which punitive, or even curative, action may not succeed. Preventive measures should be thought of more seriously than they have been thought of so far.

Difficulty of framing laws

It should not, however, be overlooked that sometimes it is not easy to formulate in precise and detailed terms the legislative response to a new scientific or other development affecting human beings.

The subject of experimentation on human beings provides a good example of the difficulties involved in framing legislation. Such legislation as has been enacted on this subject in some of the countries is restricted to limited areas, such as drug research or conditions for the allocation of grants. It has been found more expedient to regulate the matter by a code of ethics or other documents framed by

the professional bodies rather than by legislation. The general consensus is that it could even be dangerous to issue legislation in this respect, since this might hamper progress in medical research. At the same time, there is a growing concern in some countries on this subject. The main reason for the difficulty in issuing legislative provisions is the fact that it is extremely difficult to take into account the numerous different parameters which have to be considered. There is the problem of benefit versus risk. Are the risks of experimentation balanced by its benefits? Then, there is the problem of differentiation between patients and normal volunteers. How far should experimentation with patients be allowed with or without their consent? Most important is the problem of consent, the quality of the investigator or of the institute and the equipment used and a host of other considerations. Rigid regulations, (with legal sanctions attached to their breach) may do more harm than good in this field. That feeling accounts for the cautious approach shown in the matter. The fact that the most vital human interests are at issue lends a delicacy to the subject.

From the realm of life sciences, one could draw another illustration. A question which raises important ethical problem is the definition of death and the appropriateness of laying down criteria in this respect in legal documents. While the classical definition of death-namely, the arrest of heart and respiratory functions- remains valid, we know that the transplantation of organs, especially those organs which have been called ‘critical organs', has given rise to new problems. Learned discussions have been devoted to the subject; but legislation has not, in general, been found advisable. The question remains whether criteria of irreversible ‘brain death' have to be formulated in legislation. On comparing the criteria formulated by law in different countries, it appears that these are - rather divergent. One wonders if, under these circumstances, it would not be better to limit the criteria to some sort of guidelines for the use of those who have to certify death in relation to transplantation. It is interesting to quote in this respect one of the sentences of the Sydney Declaration, which states that “No single technological criterion Is entirely satisfactory in the present state of medicine, nor can any technological procedure be substituted for the over-all judgment of the physician".

The number of studies made on the subject shows the interest of society in the matter, as also the difficulty of framing a law.

Ethical value judgments

Many fields of social life are imbued-with strong ethical value judgments, having their origin in religious background, historical tradition, climate and level of development of civilisation. These value judgments would vary among different societies. For example, in German law, a party is liable for damages for breach of contract only in case of *culpable* non-compliance with the contractual

obligation, while Anglo-American law, in this particular case, imposes what may be called an objective liability.

Another important aspect to be noticed is that facts requiring or suggesting the need of legal regulation may yet leave scope for the adoption of several possible alternatives. All these factors illustrate the difficulty of framing legislation.

The realm of ideas

Increased scientific activities result in tremendous increase in ‘ideas'. Technological developments, and the increased complexity of business, have made ideas more important and valuable than ever before. At least, people have been stimulated to produce them. Consequently, there arises a demand for legal protection for ideas. The withholding of legal recognition to those persons who have supplied ‘Ideas' would, on the hand result in a mounting number of injustices. Justice as administered at common law does, however, sometimes bear a quantitative aspect. If, with reference to a certain type of claim, the job of screening out the cases built on a false foundation appears difficult or subject to possible error, the courts may not undertake that job, if it appears to the court -that only a few worthy claimants will suffer. If, however, the number of worthy claimants is very large, the judiciary may perhaps be inclined to face the difficulties and to take more chances.

Impact on administrative law

It is a peculiarity of scientific developments that if they are of such a nature as to require intervention of the law in the shape of legislation, then in many cases the legislation would contemplate an elaborate administrative set up. Administrative law deals with the power, procedure and liabilities of the administration; and regulates the manner of the exercise of various authorities and discretion by those authorities, public officers and other instrumentalities of the government. It also brings the administrative processes in accord with law and seeks to control the exercise of administrative discretions and regulations. Thus administrative law relating to scientific advising must concern itself with the extent and scope of the quasi-legislative and quasi-judicial powers of the administrative agencies. In the event of misuse or abuse of power and discretionary the administrative authority, it provides for review of administrative action, its rectification and. if necessary, judicial control. Within its province falls the question of constitutionality of delegated legislation and the legality of the rules, regulation and orders of the administrative agencies.

Protecting the products of the mind

When knowledge increases, ideas multiply and the question of their legal protection arises. There are, of course, several well-recognised legal spheres of protection for the products of the mind, the law relating to patents and inventions, the statutory law of copyright, and the law of literary property. But the ideas sometimes are not of such a nature or in such a form as to bring them within any of these categories. They may not be patentable subject matter, either because they do not fall "within the categories enumerated in the relevant statute, or because they constitute only general ideas which, however valuable, are not sufficiently reduced to a physical embodiment to bring them within the concept of ‘Invention'. The growing recognition of 'property' in ideas-either by Judge-made law or by legislation is an example of the response of the law to expanding intellectual horizons.

Copyright is concerned, of course, only with the expression of ideas. If an idea is set forth in writing, the one to whom it is submitted may be liable if, without consent, he copies the writing or makes unfair use of it in producing another expression of the Idea. This is taken care of by the law of copyright.

The law of copyright has, however, no application when the idea itself has simply been put to use without there being a written record. A question that has proved most controversial is, whether there should be protection for any ideas outside the traditional categories for their unauthorised use. The older cases are very strict in asserting that there is none. Within the last twenty years, however, there has been a tendency towards liberalisation of the law in this regard. Breach of confidence and similar heads of liability are being canvassed.

This shows how wide could be the ambit of possible legal responses to scientific developments and their consequences, and how intricate could be the - process of finding solutions thereto.

Science In the service of law and society

All in technology is not evil. The law should not be blind to such scientific developments as could be effectively and conveniently utilised in aid of the legal process. To take a very homely example, the typewriter, invented in 1873, is now to be found in every office. But its utilisation by the courts has not been so quick and universal as it could have been. Take next, the use of computers in the field of legal research. Computers have now come to stay in industrial and commercial life, but their use in the legal sphere is limited to very few areas. This may be partly due to the fact that the two disciplines-computer technology and the law-have not yet met each other across the table and established familiarity. Their acquaintance, if any, is a nodding one.

Such a process of deriving benefits from science need not be confined to the physical or biological sciences. There is enough scope for applying social sciences as well. Sociology, for example, can be pressed into service in study of the administration of criminal law-particularly, in judging the effectiveness of criminal law. In general, crime is a reprehensible behaviour; but the problem lies in the proper attitude of society towards reprehensible behaviour. It is here that the factors which are related to the moral judgment could be studied. For example, is sex a material factor in moral judgment-what kinds of offences, if any, are regarded more severely by man than by women? Does age make a difference? Has religious belief any impact? What about urbanisation, race, level of intellectual development and upbringing? These questions are the meeting points of psychology, sociology, anthropology and jurisprudence.

Reference was made above to the invention of printing. The debt which the law owes to printing is immeasurable. But for the printed word, it would have been difficult to preserve the wealth of case law for the use of future generations of lawyers.

It is thus evident that the law, sooner or later, has taken note of scientific developments in the past, and should continue to do so in the future.

When future historians[13] look back at the period in which we are now living, they are likely to see it as a time in which scientific knowledge emerged from its, adolescence to become a major factor in the affairs of human societies. They will notice the problem that is posed for scientists and society alike and, with the benefit of hindsight, will pass judgment on the extent to which we took the measure of its significance. In this connection, they will pay particular attention to the grasp we showed in dealing with a new element in the situation-that of relating scientific knowledge to public policy-and, actions speaking louder than words, to the way we shaped our arrangements to this end.

Methodology of study

This brief outline of the points of contact between science technology and law, shows the very wide areas open for study. Since the subject of Interaction of science and law is a vast one and embraces so many fields of human activity, it may be wise to select certain important or pressing areas for study

It is a custom in science and perhaps a principle to select from the infinite reservoir of unsolved problems only those simple ones whose solution seems possible in terms of available knowledge and skills. We are also trained to subject our results to the most severe criticism. Adherence to these two principles- the

[13] James A. Shannon. Science and the evolution of Public Policy, (1973), page 31.

principle of selection and the principle of adherence - result in our knowing very little, but on the other hand, being very certain we really know this little.

In this context an important tool of research developed by science may also be taken note of. In general, the exchange of scientific information does not know of national barriers. Important scientific research conducted in one country travels to other countries within reasonable time. Unfortunately the same cannot be predicted of information relating to the law. This is, of course, partly due to the fact that the content of the positive law varies from country to country, while the content of scientific knowledge does not so vary. Nevertheless, there is scope for adopting the comparative method to some extent. “All perception comes from comparison", said Novalis.

The tree of knowledge has so many roots and branches. It will not be easy to encompass all of them. It would, therefore, be wise either to select one branch of science or technology and study its inter-relationship with law. Or, as an alternative method, it would be desirable to select one branch of law and study its inter-relationship with science.

Conclusion

It is a legitimate task of the law to consider the social merits and demerits of scientific or other development and regulate human conduct.

Knowledge makes us free, but it can also be a danger for man. After all, it was the serpent that caused man to eat from the apple of knowledge and forego paradise. We cannot, however, reverse the progress of knowledge. We can only deal with the risk created by abuse of knowledge.

It is the task of the law to guide and shape the world, and to deal with the dynamics of technical developments and their effect on human beings.

When Newton bound together in one dazzling synthesis the great and the little, the stars in their courses and the fall of an apple, a thankful generation, at once scientific and pious, could exclaim with its spokesman, Pope:

> “Nature and Nature's Laws lay hid in night:
>
> God said, *Let Newton be:* and all was light:"