

MAN, SCIENCE AND SOCIETY

Proceedings of a Seminar

Edited by
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P R E F A C E

The present volume of the Transactions of the Indian Institute of Advanced Study contains the papers presented at and proceedings of our ninth seminar, the one on Man, Science and Society, held at the Institute beginning Tuesday, 14 May through to Saturday, 25 May, 1968. The volume has been edited by Dr Arabinda Poddar, one of our esteemed Fellows, to whom our grateful thanks are due. He also undertook to write an Introduction to the volume. We appreciate very much the trouble he has taken in this regard.

We hope, the volume will be found useful by those who are interested in the study of interaction between science and society.

Simla
February 1, 1970

NIHARRANJAN RAY
General Editor

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INTRODUCTION

This introductory essay aims at providing a guide to the topics discussed, the problems raised and the suggestions offered by participants in our seminar on Man, Science and Society. In an encounter between scientists and non-scientists it is natural that certain problems will get more accent than others. One very hopeful feature of the essays is that no pathological resistance to science has come from any quarter; some contemporary issues and some others specifically related to India's development programmes have only been stressed.

All our contributors seem to agree that if the deplorable state of India's economy and social life were to be remedied, then more and more of science and technology have to be absorbed and our economy set on the proper key of scientific planning. India, despite her appreciable strides in the direction, cannot yet be said to have joined the race for scientific progress. Her eagerness to obtain the quickest results at the shortest period may or may not find satisfaction. For, scientific progress in a country like India which had in a way resisted the growth of the scientific spirit because of the introvert nature of her traditional worldview, is sure to cause strains and tensions and ambivalences, and may also involve embarking upon courses that would ultimately prove wasteful. But, yet, we can discard science and technology 'only at our own peril', as has been stressed by Niharranjan Ray in his address of welcome. He also has brought to the notice of our participants some of the problems the western industrial societies are suffering from, deploring at the same time that 'a well-thought out and comprehensive national science policy, has not even in twenty years' time been formulated in India'.

What, under the circumstances, is needed is to draw up a map of our needs and problems and inclinations, as has been correctly highlighted by Mrs Margaret Chatterjee, so that the builders of a new nation may hopefully 'navigate' in the 'troubled waters'. The task of navigation in the present situation, both national and international, is very difficult, but there

is really no cause of despair, provided 'we increase our knowledge and our love'.

That science in India has already achieved tangible success when commissioned to secure specific ends, for example controlling and eradicating certain diseases or production and storage of nutritive food products, has been spotted by U. P. Basu, G. C. Esh and P. S. Sharma. Jagdish Shankar suggests that with increased utilization of atomic energy the pace of industrial growth can be accelerated and the welfare of humanity guaranteed. But their optimism is not shared by N. P. Dani, who points out that scientific research in India is more or less a 'fruitless activity', since it is not market-oriented. Moreover, at a time when proper utilization of national wealth and talent is a crucial problem, our industries are not making use of academic research and are buying foreign patents by preference. A strong argument to the effect that only through a self-generating science can a developing country like India hope to carry out her programmes of economic and social progress has been put forward.

Difficulties in the process are too obvious to need emphasis. For, scientific progress is linked to the prevalent mode of production and social and productive relationships. A capitalist economy geared to earn maximum profit at the cost of minimum entrepreneurial enterprise, cannot be expected to either plan adequately or look to the welfare of the people. Imbalances and recessions are bound to occur, as they had actually occurred in the past. A recognition of this vital issue makes M. K. Chaudhuri to make a plea for 'strengthening planning processes accompanied by revolutionary changes in the existing mode of production and social relationship'. Though Marx has not been mentioned by name, the perspective and the conclusions arrived at are essentially Marxist in content. As such, it may be profitable for us to recall what Marx foresaw a century earlier. The basic feature of the modern industrial economy is 'the social production of value'; but it cannot work effectively and also beneficially 'unless it is accompanied by the social utilization of value produced'. This discrepancy would be resolved, as Marx had shown, only in the socialist transformation of the economic system.

The role science and the scientists have to play in the transformation or preservation of existing social relationships is a question on which opinions and attitudes are sure to clash. For, it involves a basic problem whether or not science is an amoral pursuit blind to the ethical or moral values. That a disregard for and indifference to such values has led to a sad retrogression and estrangement of many a scientist in the West is the theme of A. Poddar's paper. Both Niharranjan Ray with citations from Oppenheimer and A. Poddar from Einstein and Schrödinger have stressed the point of scientists' alienation from the people, and have pleaded that only a

creative sense of belonging together can solve this problem. It would indeed be profitable for all of us to remain alert about the destructive uses scientific research is being put to by some western powers. For, in this crucial period of transition India can hardly afford to misuse her scientific talents or to waste her resources in barren projects having no social utility. This point makes it imperative for our scientists to assert themselves more effectively and for our administrators to seek the former's assistance at various levels of planning and in matters of policy formulation.

Moreover, the recent history of science in the capitalist West, the psychological imbalances it has produced, the vacuums it has created in the lives of individuals and in the social organism as a whole, have also to be carefully studied. Decentralized and local need-based industrial growth is a point which deserves close attention. It would be rather stupid on our part to commit the same mistakes committed earlier by planners of scientific research in Europe-America, and to 'go through the same unthinking thrill and eventual remorse', V. V. John's words. A lesson from their history may profitably be derived.

The dilemma of the time has therefore to be boldly confronted. One very impertinent feature of our time is the erosion of moral values. This erosion confronts us with the same assertion which found expression long ago in the succinct words of E. M. Forster: everything exists, nothing has value. A mere existence without any sense of participation in human affairs may have its own justification for some, but loses significance completely when viewed from humanity's larger interests. Such a philistine existence is deplored, and the need is felt by U. E. Chawdhary of a 'fraternity — dedicated scientists, philosophers, writers and artists — who can make living purposeful for their contemporaries and the coming generation'. This goal is to be consciously sought after by all interested in the affairs of life. Idealism of this type may have lost its meaning in the West, but would be particularly welcome in a society like ours. Consciousness of involvement and a sense of responsibility for what is going to happen in the world take us a long way towards fulfilment of that aim.

Some are of opinion that in this sphere our traditional sense of morality may yet make some contribution. The aim of science has been defined by Bronowsky as imaginative recreation of reality. This definition in itself would sound hollow if it is not taken to mean recreation of reality through guarantees of material prosperity and internal harmony and peace. That science is capable of guaranteeing this can never be disputed. But yet the dilemma of our time which 'destroys millions through war and tries to save millions by medicine', as has been pointed out by Rukmini Devi

Arundale, remains a challenging one. This dilemma has also created a sense of 'cheapness of human life in men's minds' (C. S. Rao). In their perplexity many have, therefore, felt the need of re-assertion in life of moral and spiritual values, which, argues Pranananda, are capable of guiding the scientific civilization to serve social progress and save humanity.

That the values of science are essentially rational human values have been stressed not only by scientists themselves but by non-scientists also. But there exists a gap between theoretical assertion and its materialization. Application of science does not often fall within the spheres of the scientist's activities. For, these are largely determined and controlled by the political power structure of a state. And so it is not fair to blame them whenever anything goes wrong. But an apathetic attitude to human problems or considerations, wherever found to exist, is to be singled out and deplored. Ties that bind and sustain are to be stressed and re-stressed. It would, therefore, be good to remind ourselves of what *The Spectator* in an editorial comment on March 30, 1962, reminded its readers: 'In fact, the cult of science and technology without an adequate sense of moral direction is simply the "scientism" of the nineteenth century dressed up in the fashionably emotional garments of aid to underdeveloped countries, higher standards of living, and space exploration. . We can wonder at some colossal feats of engineering as we wonder at the Pyramids, but only an effort of imagination and a sense of values can enable us to count the cost or pity the slaves who built them. It is the business of writers, philosophers and moralists to represent those values which can alone give life to culture or direction to the vast human achievement of science'.

A direction-less cultivation and application of science and technology in India is not to be desired.

Science was no doubt cultivated in India in the distant past ; but a purely scientific tradition as distinguished from the religious, had not been either maintained or created. This was perhaps because science was generally taken to be a component of the religious worldview. The scientific spirit was ultimately abandoned. The cultivation of science calls into being a new intellectual framework which usually runs counter to the attitudes fostered by religion. A clash therefore becomes unavoidable. But no such thing has so far happened in India, because scientific and religious attitudes have not, strictly speaking, been differentiated. In this phenomenon perhaps lies an explanation why many of our present-day scientists are ambivalent in their attitudes. As A. Rahman sees it, science in India will have to go through the same vicissitudes and conflicts with institutionalized reli-

gious codes, as science in Europe had to experience in the early stages of its history, when its full impact is on them.

He appears to have been unduly perturbed over the possibility of acceptance of science by the traditional Indian society. It is also not clearly understood wherein lies the fear of western history being re-enacted here. For, if we, the scientists included, have not the capacity to derive a lesson from other people's experiences, then our future is indeed bleak. But the fact is that, despite discrepancies and ambivalent attitudes of some scientists, science in India has already succeeded in making an impressive breakthrough and there are distinct signs that future generations of Indians will be as fully informed of the scientific spirit as those in the highly developed industrial societies.

But, even then, the problem of a total or unifying view of life and of values will remain. An awareness of this problem has led many of our contributors to explore possibilities of a harmonization of different and varying attitudes. The emphasis laid and the conviction gained are naturally unequal, but that a holistic or organic approach to human experience has emerged from their discussions is both refreshing and re-assuring. G. D. Joglekar, for instance, is concerned about 'the importance of the integration of the outer life with the inner life', and thinks that 'the conflicts now raging in the world could be diminished if man realises that he is a member of mankind rather than a member of his own community and race, and that the present civilization based on science and technology could continue, if progress is made in the direction of providing a sort of collective life'. He finds no apparent contradiction in science and spirituality mutually cherishing each other for the 'highest good of humanity'. G. P. Chatterjee goes a step farther and declares: 'In such a world of conflict, man's future today depends on how far the physics of his intangible spirit triumphs over the physics of his tangible body — how far mind triumphs over matter, how far man triumphs over atom'.

Intellectually it may be entirely unrewarding to enter into a discussion on the metaphysics of perplexity, but one may yet be catholic enough to see others' points of view. For, there cannot be any final numbers in human knowledge. We do not know what other mysteries are soon to be revealed by science. So a verdict this way or that is unwarranted. K. Ramanna has brought to our notice that the elusive particle called meson which holds the constituents of the nucleus together and which is 'short lived and does not exist freely in nature', may have something very radical to contribute to our idea of matter. He adds: 'The age-old method of analysing a system by dividing it into constituent systems seems to have reached its limit, and an entirely new approach to this question of what matter is in its ultimate stages is required.'

Representatives of non-scientific disciplines have been at pains to reduce the points of dissimilarity and establish a bond of unity between science and art. Mulk Raj Anand has argued at length about the fundamental oneness of the positions of the artist and the scientist. They share certain fundamental values, and in their independent outlooks on life, critical attitudes of dissent, and in the faculty of imagination they stand on the same plane. As such, there is great need for understanding each other 'in order to bring experience of all kinds into the realm of creativeness'. The basic unity of all human experiences has also been stressed by Rukmini Devi Arundale. To her 'science, art and religion are all ultimately one and the same, and ultimately lead us to the one goal, the goal of self-realisation', which means acceptance of life that pervades all manifested and unmanifested creation. The stress here is obviously on the ancient Indian intellectual tradition which advocated fusion with the principle governing the universe as the goal of all experience. Viewed from that angle, art and science are only two forces which, instead of creating barriers, bring us 'away from ourselves' to generate a selfless sympathy and love for all.

Philip H. Ashby, while making a sound plea for having correct perspectives so that dynamic solutions could be offered for our current ills, quotes Whitehead to the effect that 'modern science has imposed upon humanity the necessity for wandering'. This element of wandering Ashby re-discovers in the 'great continuing religions of human history' and suggests that in the quality of their being wanderers 'they have the potentiality to serve man and his society in the age of modern science'. He makes good use of Bohr's Principle of Complementarity which sought to solve the mystery of Hiesenberg's principle of indeterminacy by 'suggesting that the two experiments which exclude each other form a unity complementing one another'. Applying the same principle he concludes that the scientific attitude and the religious experience which exclude each other are in reality 'interrelated' and complementary.

This point receives further elaboration and emphasis from S. C. Biswas. He argues that apparent differences in attitudes and all conflicts evaporate 'when we look at it from the point of view of the whole'. What matters and is valuable is the total human experience. Seen in this spirit 'science, philosophy, and religion are but the organically related, if different, phases in mind's pilgrimage towards the ultimate'... 'The perfect life is an enjoyment of the integrated whole of experience. This is the stage of *vijnana* or science in the true sense of the term, in realizing of the fuller meaning of which religion is but a living engagement'. The emphasis, apparently, is on individual experience; and it remains polemical if this ideal could be held out before humanity as a whole.

These thoughts, however, bring to mind, one particular comment of

Marx on Science. In his *Economic and Philosophical Manuscripts of 1844* Marx wrote: 'The whole of history is a preparation for "man" to become an object of *sense perception*, and for the development of human needs (The needs of man as such). History itself is a *real part of natural history*, of the development of nature into man. Natural science will one day incorporate the science of man, just as the science of man will incorporate natural sciences ; there will be a single science'.

Whether or not science is to be considered as one and indivisible, and whether or not religion is to be considered as a 'living engagement' of the human experience are debatable points. But religion as alienated human consciousness has and will have little potency in rebuilding human life in an age of science ; and science, on the other hand, will perhaps have to concede that by itself it is inadequate to explain the world of human values, unless humanistic considerations are granted foremost importance.

Scientific discoveries in the modern age have become a great source of political power. Consequently, science has come to play an increasingly predominant role in hot and cold wars between nations. From that perspective the relation of science with political ideologies and the national interests of different states makes an interesting study. But, unfortunately, very few essays in this volume cover this area.

One paper, that by A. Appadorai, studies power in the thermo-nuclear age, chiefly power in international relations. It seeks to show, through a few case studies, how 'the ability to cause fear as an element of power' has played and is playing a decisive role in inducing potentially weaker nations to follow the lead of the stronger. But, mutual accommodation of common interests and a desire to be guided by 'third-party judgment' are also not inconsequential elements in power-relation in modern times. In the background of dark consequences of a global war Gandhi's insistence on the morality of a means adopted to achieve a certain end regains relevance. His philosophy of action has been analysed as both 'moral and functional', and at the same time as also honourable. A discussion on this theme by K. P. Karunakaran is welcome. But an appraisal of a philosophy of action or of the morality or immorality of a means without reference to that against which the action is directed, that is, without a total examination of all the relationships of a given situation, loses some of its weight, and cannot adequately measure the effectiveness or ineffectiveness of a means.

Mrs Uberoi's study of modernization of Chinese politics is interesting ; and it may have some instructive lessons for our political leaders as to how a science-based ideology could be accepted or embodied in all sections

and levels of society. In a delightful exercise in logic K. J. Shah has examined some of the premises on which a decision to wage war or not to do it can be formed, and has pointed out that even in the case of a nation moral considerations are relevant, though they have wider dimensions than in the case of individual action.

The role of the elite, scientists included, in newly independent countries is largely an unexplored subject. It would be exceedingly interesting to make a statistical study of the role, progressive or the reverse, played by the elite in general in transforming the destiny of India. The fact is that they find themselves precariously positioned vis-a-vis their society. Because of the existence of a deep-rooted xenophilia due to our long subjugation to foreign rule, they feel diffident and seek academic recognition from the West. Not only the elite, but industrial and business magnates also suffer from the same complex. Foreign recommendations and researches are valued, but a promising local research is usually not recognised. As a result, the scientists themselves, however brilliant, as also the professional organizations, often fail to take an independent stand. Kailash Kumar, in an absorbing analysis of all the facets of the elite's relationship to their national situations, supports the conclusion of Frantz Fanon that intellectuals in those countries are unsuited to play a progressive role. This conclusion, even if correct, would be taken by many in India as unsound, and there can hardly be any consensus on this point. For, great many instances can be cited in its repudiation.

Socio-political structure of a nation, in general, determines the frame within which scientific investigations are to be carried out. In a sense it also determines or controls human behaviour. So in the credit or discredit of an act society has a just share. This truism is the theme of Mrs. Iravati Karve's essay. A. R. Vasudeva Murthy's attempt at materialistic interpretation of India's ancient history promises well, but more investigations on the tools of history are needed before a definitive structure could be built.

The foregoing gives an outline of the main themes presented in these essays. There are some others which either repeat or substantiate the arguments, pro and contra, discussed above, and have not, therefore, been specially referred to. For this the editor offers an apology. It cannot be claimed on behalf of our contributors that their contribution in the field of ideas has been emulative or exalted, but all their collective efforts are needed for an understanding of our cataclysmic present. These, once again, will help in the task of 'navigation'.

PART ONE

INAUGURATION

NIHARRANJAN RAY

Introductory Address

Dr Atma Ram, esteemed colleagues, ladies and gentlemen :

I am no scientist, nor even a trained sociologist, but a mere student of history. But since as Director of this Institute I have been ultimately responsible for the decision of having a seminar on "Man, Science and Society", and for initiating, planning and organising it, it is my duty, I feel, to explain to you, as briefly as possible, why I chose this particular theme, how I have sought to plan it, and what aims and purposes have been at the back of my mind.

The interaction between science and society has been a subject of particular interest to scholars and intellectuals for the last half-a-century or so, especially since the First World War. The reason why it has been so, is pretty obvious. During the last five decades science, and following science, technology too, have advanced more than they did in the previous 2500 years of human civilisation. Indeed, today the impact of science and technology on human society is tremendous, total and all-pervasive. In the sixteenth, seventeenth and eighteenth centuries, the scientists and technologists, even the tallest ones of them were, relatively speaking, "amateurs"; despite their passionate involvement with science, it was with them nothing more than an avocation, since they used to live by other means. There was indeed during those centuries no approved careers for scientists in society. But in any industrial society of today there is a firmly established social basis for scientists and technologists; indeed, the elaborate occupational structure of science and technology is now an essential part of the complex division of labour and intense specialisation which any modern industrial society would call for.

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Science in modern society is not unique in kind, but it is certainly unique in its extremely wide scope and in its very high and accelerated degree of development. By the highly generalised and systematised conceptual schemes, the highly powerful and sensitive experimental apparatuses that have extended man's power of observation and control of data, but mainly by the large-scale benefits they have brought to countless millions of people of the world, science and technology have gained to-day widespread approval of the masses of population as well as of the élite. In hitherto non-industrial societies too there is the cry for more and more of science and technology, since these have proved to be the only means by which a feudally organised static agricultural social economy with all its attendant evils, can be transformed, relatively quickly, to a higher social economy, and hence to a better life, materially speaking. Whatever the ideological position one may choose to take, one can no longer turn one's back to science and technology as understood to-day, unless one chooses to be a recluse from society or to live in an ivory tower of one's own — both absurd propositions in the context of modern life.

Yet at the same time it is difficult to deny that this total, all-pervading impact of science which has brought about tremendous changes in the structure of human society, has also raised grave social, political and economic problems in all industrial societies. India is not yet an industrial society, but we have already made a commitment to science and technology, and to an economy that is aimed to be based on large and small scale industries. This commitment, coupled with the fact that we are entering into a scientific vacuum as it were, is likely to accelerate the pace of development of science and technology, if we can go by the evidence of what happened in the USSR and more recently in China, so as to enable us to join the race, if not to catch up, if at all we want to, with the rest of the industrial world. It is therefore not just indulging in fancy if one suggests that the social, political and economic problems that I have just spoken of as afflicting the advanced industrial societies of today, will make their appearance in India as well. Indeed, symptoms of an industrial society are already manifest in most of our large urban industrial centres, in our universities and other higher centres of study and research, for example. These symptoms consist of, among other things, increasing number of professional scientific workers, technologists and technicians, high degree of specialisation, increasingly developing division of labour, increasing demand for material benefits and comforts, and an "open class" system which allows increasing opportunities of social climbing, the last not only in liberal but also in authoritarian societies.

To the extent these are essential features of a developing economy, to that very extent is the need of adjustment of the structure of the society

affected by that economy, since rapid changes brought about by science and technology create tensions of all kinds : social, psychological, political and economic, tensions leading naturally to all kinds of problems. And the more of science and technology we want for expanding and stabilising the base of an industrial and industry-based agricultural economy, which in India we must, if we are to function effectively, the more would be the variety and dimension of such tensions and problems. In unadorned terms this is the dilemma of modern India : we can disregard science and technology only at our own peril, and if we choose not to do so which is perhaps the only choice left to us, we must be prepared to face the tensions and problems and try to the best of our understanding and ability, to resolve the tensions and solve the problems.

But how are we to do it ?

First, what is most important for us to do is to try to identify the tensions and the problems in the more advanced industrial societies of the West, including the USSR (I am not one of those committed ones who believe that there is no such tensions and problems in that wide area of the world, though I recognise that in a socialist but authoritarian society their depth and dimension have a different face and colour), in Japan and now in China, and then in India of to-day. Once we are able to identify them, we should be able to find out their nature and character and their depth and dimension in the respective areas. Doubtless there will be certain features that will be universal, certain others of more or less local or regional significance.

Secondly, the question will naturally arise : should we try to resolve the tensions and solve the problems by harnessing the increasingly new powers of science and technology or/and should we do it by trying to bring science and technology under planned social and political control for the ultimate good of humanity, which in other words mean, should we try to do it by cultivating wisdom and a respect for human values? I have just spoken of planned social and political control of science and technology, knowing full and well that neither in Nazi Germany nor in Stalinist USSR, control of science in the name of planning has been either for the good of science or for that of humanity itself. But one must take note of the fact that in most Western societies including the European area of the USSR, science has already reached a state of saturation, and there is evident need to decide which areas to cover and which ones to be left open, and this decision should not merely be on the score of utility, immediate or distant. In India we are only taking our first steps in modern science and technology, and the state of saturation is still far away ; yet it seems to me that some kind of planned social control and rational organisation of science and technology is called for, if we are to avoid some of the serious ten-

sions and imbalances that Western societies have passed and are still passing through. There is no reason why we should not learn from their experiences, both positively and negatively.

It is most unfortunate that even after twenty years of Independence and despite our commitment to science, technology and industrialisation, we have not yet formulated a well-thought out and comprehensive national science policy, and hence no educational policy has been geared to that direction. We have from time to time enunciated our industrial policy, but no well-thought out policy for science, which, to my mind, has been like putting the cart before the horse. Yet, in twenty years' time we have taken a great leap forward both in science and in technology without doubt: one has only to look at the number of national laboratories, research bodies, scientific and technological institutions, advanced study and research centres in our universities, and the number of professional scientific and technological workers, to be convinced of it; but all this has been achieved more at the pressure of our immediate national requirements as and when they made themselves felt than as the result of any long term perspective policy in the interest of science itself as well as of national needs and aspirations, that is, of utility.

Years ago at the instance of the UNESCO a national committee was set up to compile a history of science and technology in India. I know that something is being done in that direction, but this at such a slow pace that one does not know when the results of the work of the committee will see the light of day, and what their history will be like. It is unfortunate that what one individual like Needham could do for the history of science in China, we have not yet been able to do for India. Such a history is necessary not merely to satisfy our intellectual curiosity but to gain insights into the nature and character of the interaction of science and technology on the one hand and the society on the other, in this sub-continent through the ages, in other words, to understand the sociology of science and scientific tradition in India. This area of human knowledge still lies uncharted altogether; science and scientific institutions are still among the major undeveloped areas of historical and sociological enquiry.

Science is a way of life in the ultimate analysis, a mode of thinking and doing related to a world view of things. Very naturally therefore science inter-penetrates and conditions, sometimes even determines, all other walks of life, in some form or other: politics, economics and social affairs certainly, but even art and aesthetics, religion and philosophy, the entire super-structure of life itself. The history of Western societies in the last three centuries affords countless number of examples of such inter-penetration and conditioning. There is no reason to think that this is not going to

happen in India ; indeed, it already started happening in the third and fourth quarter of the nineteenth century, despite social and ideological resistance, and now with the accelerated pace of growth of science and technology, evidence of such inter-penetration and conditioning is daily being made more and more manifest, creating more and more tensions and problems in the process. Such tensions and problems in our social, political and economic life are more or less clear even on the surface and I need not refer to them, though one must admit that not much knowledgeable analysis has yet been done in these fields by our scientists and sociologists. But I cannot help referring to one or two fundamental tensions and problems, basically socio-psychological in character, which are becoming more and more evident and are affecting our society, our sense of values, our art, and literature and perhaps our total way of life even. High specialisation in science in Western societies has already broken up the total, universal personality of man into fragments. In addressing the Roosevelt University Founders' and Friends' Dinner in Chicago, on May 22, 1956, Robert Oppenheimer said:

“Positive knowledge, what is recorded in the technical books and learned journals, all of it that is new and true and not trivial, is of course not wisdom ; it can on occasion almost appear incompatible with wisdom. I think that such positive knowledge doubles in less than a generation, perhaps in a decade. This means that most of what there is to know about the world of nature, was not discovered when a man went to school ; it means that universal knowledge, always, even in Leonardo's day, a dream, but not an irrelevant dream, has been a mockery ; it means that the specialised sciences, genetics for instance, or astrophysics, or mathematics, are like the fingers of a hand ; they all arise from the common matrix of common sense, from man's daily experience, his history, his tradition, and his words. Each is now developing a life, an experience, and a language of its own, and between the tips of the fingers there is rare contact. For many centuries mathematics and physics grew in each other's company in happy symbiosis. To-day at their growing tips they hardly touch. Logic, psychology, philosophy were long studies in the same room, and often by the same men. To-day, they rarely speak to each other, and are more rarely understood or even heard. The deep, detailed, intimate, almost loving knowledge of a specialised science is lost in synoptic views of science as a whole. These changes mean that ignorance is a universal, pervasive feature of our time. It is clear that they have an essential relevance to the problems of education.”

What Oppenheimer said of the Western societies more than a decade ago, is slowly but increasingly becoming manifest in India too, but what is more fraught with danger, this intense urge for specialisation leading to frag-

mentation of knowledge without any sense of its universality, is invading the Humanities and the Social Sciences as well. We are knowing more and more about less and less, and to that extent losing the perception, the vision and imagination of the whole.

Alienation from and loss of the sense of belonging to, non-involvement with and non-commitment to social realities and matters of the human spirit on the part not only of the scientists of the younger generation but also of scholars and intellectuals in general, which is now a more or less universal phenomenon in the West and is invading the Indian scene as well, seems to me to be an indirect, if not a direct result of such intense one-eyed specialisation. The purely empirical and experimental approach and method of science and the scientific way of thinking have certainly been at the root of the tremendous progress mankind has made in course of the last four hundred years, but in their absolute exclusion of other avenues of knowing and seeing, science and the scientific method have perhaps been responsible for the slow erosion of the total personality of man, his universality and the countless bonds that unite him with the rest of humanity. This has started happening among our own scholars and intellectuals, and it is time that we beware.

What I have said so far, has been in the background of my mind in choosing the theme of this seminar, in initiating and planning it under five broad heads as indicated in our original invitation letter.

Interaction of Science and Society: a historical and sociological analysis
Science, Politics, Political ideologies and the State
Science, Art, Religion and Philosophy
Science and Human Values
Sociology of Science

Our purpose is very simple and straightforward. *First*, we want to underline the importance of the theme and the urgency for an understanding of its basic implications. I do believe there is not much time to lose. *Secondly*, we want to gain insight into an understanding of the far-reaching effects of science and technology on contemporary and future Indian society, and take a close look at the social organisation of science itself in our country, and *thirdly*, we want an adequate understanding of the very complex problem of science and the social order, generally in the context of the world situation, but particularly in that of the Indian. I do not think a seminar can aspire to do more. To what extent we should be able to achieve our purpose, would depend almost exclusively on those who have agreed to participate in the discussions.

Many leading scientists of the world seem to feel today that while they

have contributed a great deal to the material well-being of mankind and to their knowledge of the world of nature, they have also been responsible, in part at any rate, for the dark, perilous paths mankind has been treading in the last few decades, and for much of the tensions and problems they are being obliged to face. But why should this be the responsibility of the scientists and technologists alone? It is as much the responsibility of the creative writer and the artist, the philosopher and the sociologist, the historian and the economist, indeed of all intellectuals, of all those who care to think and are concerned with and involved in the affairs of man. We are all beneficiaries of what modern science and technology have given to mankind, and it would not be moral on our part to keep ourselves away from this responsibility.

We therefore wrote not only to a large number of leading scientists and technologists, but also to a number of creative writers, philosophers, historians, sociologists and economists, earnestly inviting them to come, stay with us for a few days and participate in this seminar. While the response from the latter category of our intellectuals has been more or less adequate and satisfactory, for which I feel very thankful indeed, I regret very much to have to say that this has not been so from the scientists and the technologists. Indeed, this seminar which we originally planned to have early during our last academic session, has a chequered story to tell. Last year the seminar had to be abandoned, since the timing, even with two changes, did not suit a good number of our scientists and technologists and our two Visiting Professors who were scheduled to deliver their respective series of lectures on the very theme of the seminar. This year the timing was fixed in consultation with some of them who had agreed to come. The response from them as well as from a good number of others, to our invitation, was very encouraging indeed, and we were looking forward to a lively and stimulating intellectual confrontation. But as the days for the seminar drew close, most of them regretted their inability to come, for some reason or other, including our two most eminent Visiting Professors. I cannot help saying, with sadness in my heart, that we have been very badly let down, since in a seminar with the theme as we have, the scientists and technologists were supposed to be the heroes and we were looking forward to what they had to say. My disappointment on this count is very deep and real. Not that they are not represented altogether, but their number is proportionately small and some of the more important branches of science and technology will have to be left out altogether. I feel very grateful to all those who have been able to come: I am deeply beholden to them. Let me hope and pray that their active participation will somewhat make up for the loss.

The Registrar has already extended our most sincere welcome to you all,

particularly to all our participants who have obliged us by accepting our invitation. I welcome you once more, most warmly and sincerely. I am thankful to Dr Atma Ram for having kindly agreed to come to preside over this inaugural function and deliver the inaugural address, despite his heavy schedule of duties. I am also thankful to the organisation of which he happens to be the distinguished head ; one of the wings of this organisation, the INSDOC, has helped us in setting up a small exhibition of books and journals on the theme of this seminar. We invite you all to have a look at this exhibition, if for nothing else at least to convince yourselves that throughout the Western world a great deal of thinking is being done on the theme of the seminar. Perhaps you may concede us this that we have not convened this seminar any too soon, and that we should begin to think and act without any further loss of time.

Thank you, ladies and gentlemen.

PART TWO

PAPERS

Interaction of Science and Society

U. P. BASU

Eradication of Malaria

THE marvellous developments of science and technology during the last fifty or sixty years had not been able to bring home to the intellectual world the importance of science in society. Scientific achievements like the synthesis of the beautiful colour of the yonder rainbow, the production of the charming fragrance of beautiful flowers, the inventions of artificial yarn akin to silk, the manufacture of drugs for saving millions of human lives against attacks of the dreadful diseases, failed to attract the attention of the intelligentsia it deserved. But the unprecedented devastating power unleashed by the atom bombs in Hiroshima and Nagasaki has stirred the human minds of all nations and has promoted a sense of urgency to realise the interaction of science on society. In this seminar on "Man, Science and Society", it will, therefore, be of interest to place a narrative that would tend to show how people have been benefited socially and economically by the promotion of science in one or other field. Your lecturer being associated with the problems of medicinal chemistry, would prefer to elaborate the welfare attained by the society in particular and mankind in general from the performance of scientists in eradicating and controlling malaria.

WHAT IS MALARIA

Prior to 1880 malaria was considered to be due to the pernicious influence of a "miasm" which arose from the ground during night, particularly in low swampy localities. In 1880 Alphonse Laveran who was making a microscopic study of the blood of a malaria patient in Constantine (Algeria), observed the presence of a foreign organism therein, which he finally identi-

fied as a "plasmodium". This plasmodium was later demonstrated to be a form of the malarial parasite. Subsequently, the study of the organism was taken up in Italy, Great Britain and in India. Finally in 1895, Ronald Ross established at Secunderabad (Deccan) that the malaria parasites are transmitted through the mosquitoes. He subsequently elaborated the life cycle of the plasmodium in this vector. There are about 1,700 species of all kinds of mosquitoes, but it is only the anophelines that carry the malarial parasites which have two cycles of developments, an asexual and a sexual. The former parasites go through a period of growth inside the red corpuscles of human blood, and the latter through a cycle of development in the body of the mosquito. The life of the parasite virtually begins when a female anopheles mosquito sucks a sick person's blood that contains sexual form of parasites. The cysts produced by the sexual malaria parasites develop in the stomach of the mosquito, and the malarial parasites, fully developed and multiplied, are present in the salivary glands of the mosquito. When this mosquito bites a healthy person, the latter becomes infected. The parasites then develop in the liver of the infected person, and later on grow and multiply in the red cells of the person. This phase is manifested with the appearance of fever in the victim and development of anaemia, and other symptoms often leading to death.

NEED FOR CONTROL OF MALARIA

Human ingenuity worked for controlling this disease. Measures were taken to destroy the anophelines numbering about 170 species that carry the malarial parasite in the larval or aquatic stages in the breeding grounds. The number of mosquito vectors of India however do not exceed eight, and their distribution and characteristics may be found in Table I. The task undertaken was a giant enterprise and the World Health Organization in its eighth sitting in the Mexico city in 1955 was given charge of this operation. It is an adventure without precedence in human history. Never before have concerted international forces on such a scale been deployed against a single disease. Never before have doctors, engineers, laboratory workers, and helpers of all kinds been mobilized in such large numbers in so many different countries to combat the same evil. Never before has a scheme been launched that so intimately affected the living conditions of such vast numbers of the earth's inhabitants. Malaria is prevailing in various parts of the world. About eleven hundred million human beings are living under the constant threat of malaria. In India, there were several million cases of malaria occurring annually before the Second World War. Malaria is not only a horrible disease, but also a disaster. Its terrible consequences can not be so easily realised by people other than those who have suffered from it. Those who are in malaria ridden areas accept it

as a natural part of their everyday life. The victims are quite unaware of the physical and moral deterioration it has brought about and through many centuries it has sapped their strength, robbed them of initiative, and made them vulnerable to other more deadly infections. It is also responsible

Table—I

Some Mosquito vectors of India and their distribution

Mosquito	Place	Function
Culcificacies	North West & Peninsular India	May feed within 1½ hrs. after dusk. Chief biting time 22.30 to 00.30 hrs.
Fluviatilis	Foot hills of South India	May feed within 1½ hrs. after dusk. Usually feeds before midnight.
Mimimus	Foot hills of U.P., Bengal & Assam	Main feeding between midnight and dawn specially before 03.00 hrs.
Jeyporiensis	Travancore State	Chiefly between 23.30 and 03.00 hrs.
Philippinensis	Deltaic Bengal, Orissa, Andaman and Assam	May bite soon after sunset, but main feeding after midnight.
Leucosphyrus	N. Assam	Chiefly between 23.30 and 03.00 hrs.
Stephensi	Peninsular and North West India	Probably commence to bite at dusk or soon after.
Sundaicus	Coast of Orissa, Andhra, Bengal	Starts biting at dusk or soon after, but main attack from 22.00 hrs. until dawn. May bite in day time.

for 10-15 per cent of infant mortality in these countries. An idea of its social economic effect has been described in a noting on "Malaria Eradication", 1958 (W.H.O). It runs as follows:

Premature death caused by malaria occupies the first place under this head. In terms of economics, deaths occurring at age 15 or under may be considered on an average to represent a net loss to society; where death does not occur before age 40, there is a net economic gain and where death does not occur until age 65 the net gain is more than twice as great. In many parts of the world mortality in infants and children, caused directly or indirectly by malaria, is appalling. The indirect effects when malaria increases the mortality from other diseases can not be easily assessed, but are certainly very high.

The loss of working time is one of the economic effects of the disease that can be assessed with a fair degree of accuracy. It has been shown that each infected adult suffers from at least one recurrence of malaria annually which incapacitates him for six days. Computation of the total

number of malaria cases and the percentage of the economically active population show that in 1955 the annual loss of working time due to the average six-day attack was some 130 million man-days in India, 4 million in Mexico and from 9 to 9.5 million in Thailand.

In addition to causing the loss of life-capital through premature death and the loss of working time through the annual six-day attack, malaria decreases working capacity throughout the year. To compute the money value of the losses caused by the decrease in production, it would be necessary to determine the exact extent of disablement; this requires further study. In India, however, the annual loss on this account has been estimated at \$ 450 million, on the assumption that the decrease of working capacity amounts to 25 per cent.

In the densely populated monsoon areas of Asia, in Central America and equatorial Africa, great tracts of fertile land lie uncultivated or abandoned because of malaria—and the situation thus created is aggravated by the growth of population and the increased pressure on land. Since the introduction of malaria control measures during the last decade, large areas of unused rich agricultural land have been brought under cultivation in Ceylon, India, Java, Mexico and elsewhere, thus changing the previous conception of a static “population maximum” in such areas.

The adverse effect of malaria on engineering projects and industrial development generally is widely recognized: the delays in the building of the Panama Canal, the Alexandra Docks at Bombay, and the Bengal-Nagpur Railway, are examples commonly cited. Less dramatic but more insidious is the effect of malaria as a constant factor adding to costs of manufacture and of mining in tropical and sub-tropical areas. Since malaria is mainly a rural disease, quantitative figures of its repercussions on industry are very rudimentary. However, with the accelerated pace of industrialization in the economically less-developed countries, the effects of malaria on industrial development and production are becoming more important. How malaria affected in India a few years ago would be evident from Table II.

Table—II

What Malaria costs India ?

Total sufferers	..	75,000,000
Total deaths due to malaria	...	800,000
Cost per annum for medical attendance during malaria fever	... Rs.	20,00,00,000
Loss per annum on account of wages not earned owing to malarial attacks	... Rs.	12,40,00,000
Loss on account of post malarial inefficiency	... Rs.	29,70,00,000
Wastage of capital due to value of lives lost	... Rs.	50,00,00,000
Total losses to individual and the family due to malaria	... Rs.	110,00,00,000

PROBLEMS FOR ERADICATION

For many years malaria remained a mysterious affliction, and upto the first quarter of this century malaria patients had been treated with cinchona bark, its extract and, later on, its active principle, quinine. The people also remained alert about unhealthy areas, and kept themselves away from marshy lands and poor drainage zones. For anti-mosquito campaigns oiling, spraying with Paris-green, screening of dwelling places, and many other systems were followed to achieve a goal in eradication of malaria. Some success was achieved in 1936 in South India by the spray-killing of adult mosquitoes in villages with pyrethrum insecticide. It was the discovery of D.D.T. by a Swiss, Paul Müller that completely changed the outlook in the fight against malaria from the middle of this century. It transferred malarial control into a simple operation of spraying this "residual" insecticide on the inside walls of dwellings, where the mosquitoes rest after feeding on human blood. The poison killed off the mosquitoes. The malarial patients were given medical treatment, and the spread of disease was thus halted. The D.D.T. was used in the State of Bombay in 1945. Since 1953 the National Malaria Control Programme financed jointly by the Indian and the United States Government came into being as part of the First Five-Year Plan. It has been estimated that the eradication campaign from 1958 to 1965 has cost some 125 crores of rupees. The estimated expenditure on National Malaria Eradication Programme during the Fourth Plan is Rs. 22.50 crores.

The need of insecticide, the volume of drugs, the number of spraying pumps, doctors, physicians, vehicles and the total man-power would be quite large. There are other social problems too. The majority of people live in villages, some of which are not easily accessible. Such people again do not welcome those who come to spray the walls of their homes. In certain places the houses have no walls, and mosquitoes go away to a distant place in order to digest the blood of their victims. Or, the mosquitoes may not even have settled long enough for the poison to be effective. A still more serious problem develops on account of the resistance of the mosquitoes to the insecticide due to some genetical changes caused by the prolonged use of D.D.T. Development of a thicker cuticle (outer skin) that is less permeable to the insecticide or a large fatty body where the insecticide would accumulate without reaching the nervous system, may be the cause for this resistance. Here again chemists will have to think over the synthesis of newer products and move in co-operation with entomologists for the battle. The whole work would again need examination of blood samples for malaria parasite under the microscope. The magnitude of the problem may be guessed simply by the number of slides which will be

several millions and by the huge number of full time microscopists that will be required for examination.

NEED FOR ANTI-MALARIAL DRUG

In the control of malaria, there is need for anti-malarial drugs as well. And they may play an important role in the following circumstances: (a) where any factor precludes the application of anti-mosquito measures or renders the response unsatisfactory to them; (b) where residual spraying has been discontinued but there is still need to deal effectively with relapsing cases or infected immigrants; and (c) where malaria has appeared in an epidemic form. Treatment with adequate doses of quinine is usually effective in controlling the fever and other unpleasant manifestations of the disease. The troublesome feature of malaria, however, is the tendency of the disease to relapse. The occurrence of relapses over a variable period of time permits the accumulation of large reservoirs of cases infective for mosquitoes, from which the man-mosquito cycle of malaria propagation may commence at any moment. Quinine and other synthetic anti-malarial remedies are effective in controlling the blood-stream infection, but they do not sterilize it. Modern chemotherapy is trying to elaborate a specific chemical agent which would attack the malaria problem at the vital point of the sporozoite (infecting) development stage. The sporozoites infecting stage of the parasites in human blood soon pass to liver tissues and appear about 10 or 15 days later as an occupant of the red blood corpuscles to exert the characteristic malarial activity through schizogony and gametogony cycles.

The search for newer anti-malarials other than the cinchona constitutes a thought-provoking chapter in medical research which demands a team spirit between chemists, pharmacologists and clinicians. These new methods of collaborative investigation by a society of scientists have now become the fundamental prerequisite in chemotherapeutic research in general, and have been responsible for the discovery of many synthetic drugs such as sulphonamides and anti-biotic remedies like penicillin. Here the Germans had led the way and shown to the world what combined efforts of man in the field of science can do for the society. An elaboration on the production of any such remedy would again indicate the economy developed in a country. For example, quinine which is being produced in the States of West Bengal and Madras, has served mankind for several years and today it is even a good foreign exchange earner. Considerable acres of land have been occupied for cultivating cinchona plants for the production of quinine. This plantation has accommodated approximately 25,000 labour population (including members of their families) and provided provisions to over 5000 people. It has produced about 45 tons of quinine along with other cinchona products. The total revenue earned in 1966-67 is about

Rs. 14 million and has enabled us to earn foreign exchange to an extent of Rs. 10 million. Besides the plantation in Darjeeling District affords 70 tons of tung seeds, 6 tons of coffee seeds and about 10 tons of cardamom and some eucalyptus oil and geranium in Madras. Science may enhance the above economy further, if we convert some of the alkaloid of cinchona to afford quinidine which is much in demand for relieving the distress of human suffering.

EFFECT OF ERADICATION

It is not easy to realise the beneficial effect of eradication of malaria on society. The individual victim is made free in body and mind. The output and quality of his work is improved. It induces maintenance of healthier and happier people in a nation. It leads to far reaching social and economic changes. The loss of income caused by malaria is serious, because the disease mostly affects social groups whose earnings are not large, i.e., small farmer, agricultural worker, and common labour force in industries. An early death would lower the productive period and would incidentally cause a heavy financial loss for the whole country. The loss that may happen in India on the basis of the estimation by a W.H.O. consultant is that an attack of malaria causes absence from work for 6 days a year at a minimum salary of Rs. 2 per day, and that some 25% of the people affected are salary earners, then the annual loss amounts to 150 million rupees in income alone. Further, if it be considered that malaria decreases the output of the individual by about 25% a year, the total loss on this account would be about 2,250 million rupees a year, making a total loss of 2,400 million rupees a year. The cost involved during 1958 to 1965 has already been indicated. It would be found that the Malaria Eradication Programme, now in operation in India, is considered to be one of the greatest public health efforts ever undertaken, covering as it does an area of 1,266,900 square miles with a population exceeding 475 millions (now 500). India will be much benefited by this action of man when the people are entirely freed from the burden of malaria. Already the mortality rate due to malaria has dropped from 8.79 per 1000 people in 1944 to 0.29 in 1962. A reduction by about 99.5% in the proportional rate of malaria as compared to the figures of 1953-54 has been possible. Here is a glaring example how the application of science has done immense good to the society and the nation.

EFFECT OF ANTI-MALARIALS

The natural drug quinine, whose economy has already been indicated, still maintains a position of importance in the treatment of *falciparum* malaria. Further, an intravenous injection of quinine salt is absolutely necessary in acute attacks. The production of other anti-malarials for the chemotherapy

of malaria is also essential from other considerations. The drug of choice is chloroquine, and it is now being manufactured in India. About ten tons of other chemicals are required for the production of only one ton of chloroquine. On the other hand, various equipment and appliances are needed for its production. Fabrication of all these equipments and the production of several intermediates will again give employment to many skilled labourers and a number of qualified scientists and technologists. Considerable amount of foreign exchange may be saved by indigenous production. For example, for meeting the total demand of 50 tons of an intermediate, 4:7-dichloroquinoline, there would be a saving of about 3 million rupees in foreign exchange.

The problem of malaria eradication will be adversely affected if the occurrence of the resistant strain of *Plasmodium falciparum* be not checked and controlled. The advantage gained by the indigenous production of chloroquine will then be nullified, since the drug is ineffective in such cases. The W.H.O. accordingly recommends the need for basic and applied research in the field of chemotherapy of malaria, and the bio-chemical action of anti-malarial drugs and of the mechanism of drug resistance. Various suggestions are being placed for moving against resistance. An attempt was made in Guyana to incorporate common salt with 0.43% chloroquine base, but the success was short lived as chloroquine resistant strains entered from Brazil. The resistant strain has been noticed in Cambodia, Colombia, Malaya, Thailand, Vietnam and some other places. For counter-acting this resistance the use of other known drugs alone or in combination such as sulphone, sulpham, pyrimethamine, quinine etc. is being advocated. All these tend to indicate that when a therapy is well established, fresh conditions may develop leading to stimulation of further thought and study. Reference may be made to the observation of Basu and his collaborators on the synthesis of a new compound patented by the Council of Scientific and Industrial Research (Indian Patent 52003), and the clinical findings on the same by Chaudhuri from the School of Tropical Medicine, Calcutta, may be of interest. A detailed study of the compound may be of interest in the present circumstances.

The eradication and control of malaria as narrated above is only one among innumerable examples how science has benefited man and society. Science to-day is influencing the living conditions of man, offering him immense material comfort and providing him with plenty of food and other amenities—nay, it is shaping the future society. Given science more chance and applying it for the welfare of man, it is possible to create a world where man will be free from hunger and will not suffer from the curable diseases.

MARGARET CHATTERJEE

Of Maps and Navigators

THE analogy which runs through this paper is a frankly maritime one. Enough is known about the effect that science and technology have on society in general for a map to be made of some of the prominent features of these troubled waters, for troubled they no doubt are. Some of the features of the map we may not like at all. But this is all the more reason why we should be aware of them and why we need to bear them specially in mind as we navigate. By the time I am through I shall have made a plea for navigating and for not cruising and shall have also suggested that it is fair neither to the scientist nor to ourselves to expect him to do the navigating. Much of the resentment with which the man in the street views the experts stems from the misguided belief that his own responsibility can be shifted on to the experts' shoulders and from a sense that when things go wrong it is the experts' fault. The scientist, for his part, finds himself involved, say, in branches of research such as chemical warfare, terminal decisions over which, neither as a scientist nor in his capacity as private citizen, has he any ultimate control. When something goes wrong, and we have plenty of drugs through the development of antibiotics, tissue destruction through radiation and so on, we tend to blame either the scientists or the politicians, if not both. Such a reaction, natural though it be, amounts to an abandonment of the task of navigation. But to this I shall return later. It is first necessary to look at the map.

Science enters into the pattern of social change in many ways—as cause of change, result of change, and as a way of dealing with change. But the transforming agencies in society are by no means all to be found in

science nor when science exercises a transforming influence does it do so directly. Much of the time when we speak of 'science' and attribute something to it we should properly speak of industrialisation, of mechanisation or of techniques. Factors like availability of talents, raw materials, finance, patronage, public demand, are also to be taken into account. There is a tendency for us to look on the abstraction 'science' as a kind of invisible hand behind the intricacies of modern life.¹ Some of the change we impute to science and technology strike us as an advance on what we had before and others not. Film techniques condition us to accept ketchup substitutes for the blood of the Roman arena. On the other hand, we have sacrificed the spontaneity of the 'ghotul' for the cramped discomfort of the parked automobile. Instead of the face to face bayonet encounters of 1914-18 trench warfare we have the mass deaths of Hiroshima and Nagasaki. To say that science is 'responsible' for all these is to oversimplify. The fact remains, however, that recent events have made the attitude of the non-scientist to the scientist most ambivalent. Instead of our regarding science as the most potent tool for the promotion of at least the material aspect of human welfare we now look upon it in terms of the alternating poles of promise and threat. That which is itself the instrument of control seems to require controlling and so the question is raised, 'Who is to control the controllers?'

Certain characteristics of the new science may be mentioned here. What is meant by 'new science' is best elucidated by reference to the three stages of modern technology represented, respectively, by the steam engine, by electricity, and by atomic power. The new science is that which is associated with atomic age technology. The spirit of Christopher Columbus leads us now in a flight from mother earth as if proclaiming we are no longer earth-bound creatures. Instead of the umbilical cord which links us to nature, the umbilical cord of the space-traveller links him to a human artefact, the satellite. The space-traveller quite literally floats weightlessly in the infinite spaces that frightened Pascal. Not content with letting loose elemental natural processes the scientist handles energies that belong to the universe at large. A concomitant of this is a transformation in the concept of 'experiment'. Writing in 1956 Guenther Anders points out that the term 'experiment' in the phrase 'nuclear experiment' is perhaps inappropriate, for the space of the experiment proper is limited and isolated whereas the effect of nuclear explosions is so great that "their laboratory becomes coextensive with the globe".² This unboundedness of the impact of nuclear fission means that the consequences of atomic research are an unknown quantity. Wernher von Braun writes "...basic research is when I am doing what I don't know what I am doing".³ Processes are started whose outcome is unpredictable.

Research in atomic physics requires such a big outlay that only big foundations, if not the state itself, can undertake it. The scientist thus becomes directly associated with power politics whether he desires it or not, especially with Government-sponsored research into lethal weapons, for the simple reason that only the State can command the requisite resources on a sufficiently big scale. Political motives determine the specific lines of research the State sponsors, and because a scientist devoted to his work is ever in search of 'facilities' he becomes willy-nilly party to research into sophisticated forms of warfare. The scientist thereby at once becomes involved in the arena of international conflict, the arena of fear, imperial rivalry and the like. It was long before that the possibility of nuclear warfare was envisaged that Gandhiji wrote "...scientific truths and discoveries should first of all cease to be mere instruments of greed".⁴ The more research proceeds in this direction the further is the gap between scientific achievement and the satisfaction of human needs. There is no doubt that, as far as technique is concerned, enough is known to enable a decent modicum of food, shelter and clothing to be provided for all. The fact remains, however, that in each country, even so-called affluent ones, developmental budgets are always pruned down to make room for increasing defence expenditure. Furthermore, branches of research such as medicine and agricultural science not only attract relatively fewer funds but there is a painful time-lag between discoveries and the availability of the discoveries to the public, a time-lag which does not seem to exist in the case of, say, researches in chemical warfare.⁵

We come now to three special features of the map which I have singled out in view of their importance. They are the transformation made by science in three concepts, the concept of the object, the concept of work, and the concept of power.

THE CONCEPT OF THE OBJECT

To begin rather far back, a close connection between things and the possibilities of human action in relation to them seems to be built into the thought of ancient Greece. 'Pragma' means 'thing' and the word which Protagoras uses in his famous dictum 'Man is the measure of all things' (chremata) means use-things. It seems to have been assumed by Plato that contemplation is superior to the action which deals with things—although he is a strong advocate of wisely-guided political action where the thinker deals not with things but with other men. The artist is in a peculiar position. As a fabricator he is a transformer of things but he is redeemed through his being directed by the inner eye, the same faculty which expresses itself in philosophic vision. The sense of the relation between thinghood and utility was lost in the period of philosophical his-

tory which began roughly with Descartes. To geometrize the object is to see it in abstraction and not in its relation to the affairs of men. It was anomalous that for centuries following philosophers should have discussed objects in the context of the problem of perception, that is to say, objects as the termini of a process of mere awareness, while during that same period of time the scientific attitude to objects was altogether different. In no branches of science was this more evident than in mechanics and chemistry. To investigate a substance is by no means to be aware of it in an illuminatory flash of observation, but to manipulate it in controlled conditions in the laboratory so that its various properties (and these are relational properties) become manifest. This aspect of scientific technique was not appreciated by philosophers until the coming of the pragmatists.

With the application of science to industry the philosopher's term 'sensible object' became even more obsolete. The word 'object' now straddles four concepts which need to be distinguished, natural object, tool, artefact, machine. All of these belong to the level of perceptual experience but there are important differences between them. Beyond this level if we operate with a concept like that of 'energy' the notion of 'object' itself needs to be dropped.⁶ The scientific viewpoint treats the natural object (selectively of course) as raw material. The tool is a fabricated object of a special kind—its differentia being its instrumentality with regard to the fabrication of other objects. The tool in its relation to man is an extension of organs like the hand, the foot and the eye. The tool is an instrument or servant which can be put down at will. The machine is, in a sense, a sophisticated tool in so far as it is instrumental in the performance of tasks. In a sense, however, it is different from the tool in respect of its relation to the human body. Tools like the pick, the axe and the plough enter into the rhythm of the human body without any difficulty. The machine, however typified in the assembly line, has a rhythm of its own which is not necessarily in step with the body's rhythm. When I am tired I can lay aside my axe, but I cannot refrain from making the monotonous movement that the moving assembly line requires of me. The machine worker is in bondage to the object in one sense and the toiling labourer using primitive tools is in bondage in a different sense. We shall come back to this again in the discussion of the concept of 'work'.

From the point of view of the consumer applied science transforms the 'object' most noticeably in the case of sophisticated consumer goods and gadgets. Gadgets have positive and negative powers. We have to 'learn to use them'. Because of the prestige value of some of these objects they arouse the acquisitive instinct to a high degree. Because of the level of expectations associated with them there is an inordinate disappointment when gadgets fail as they do when electricity supply goes off or by reason

of mechanical defects, etc. The gadget is not only a use-object (as a simple tool would be) but a status symbol. More than this, an 'object' like the television set acquires an even further function. In western sitting rooms the hearth and mantel-piece (with its household goods in the shape of family photos, holiday bric-a-brac and the like) was at one time the centre of the room. This pattern was broken up with the advent of the portable electric fire—few sitting rooms in the west now have fireplaces. The centre of the room now is the television set.⁷ In this way, one might say, not too fancifully, the focus of family attention in the symbolised history of the family on the mantel-piece has given way to a completely external focus—what flickers on the television screen. The television set has for some almost the place which the tokonoma has in the orthodox Japanese household. For others it takes on a life of its own, possessing magic powers, an inscrutable capacity to please or displease. In this way an object which represents the height of scientific invention can become, oddly enough, a focus of almost superstitious concern.

Apart from the phenomenon of gadgetry applied science in a variety of ways multiplies the mediation of objects, albeit of sophisticated kinds, in human activities. Two examples of this will suffice, contraceptives, and the other, military weapons. To consider the latter—gunnery was one of the first spheres to 'benefit' from scientific discoveries, in fact in early times as now, military requirements were often the motive power behind scientific advance. The military weapon counts as a tool, a lethal tool—an artefact designed by man to have the maximum destructive effect on his fellows. So extensive and far-reaching had military preparation become that even in the first Great War people spoke of the 'war machine' Awareness of the destructive potential which the new science has put into our hands is built into contemporary consciousness. In terms of our analysis of the scientific transformation of the object atomic power stands for the release of undreamt of energy in the most infinitesimal of objects, along with the possibility of the complete destruction of all men and all objects. Science continues to be object-dominated and its influence in this respect is seen even in our present-day attitudes to planning, that is to say, planning in relation to raw materials instead of in relation to man-power. Another limitation may also be mentioned here: in a world of scarce use-objects science no doubt bears the key to increased production, whether this be in industry or in agriculture, but it has nothing to say about distribution, and it is perhaps there that our biggest problems lie.

THE CONCEPT OF WORK

The concept of labour and work⁸ in most languages is associated with pain, travail, the bearing of a burden. Aristocratic societies regarded work

as the business of slaves.⁹ Even the Christian attitude does not glorify labour. Thomas Aquinas says "...only the necessity to keep alive compels to do manual labour".¹⁰ The Benedictine rules recommended labour to keep down the temptations of an idle body and a positive recommendation of manual labour was made by St Augustine in order to fight odium, to enable the monasteries to fulfil their duties of charity to the poor and as a means of contemplation since manual labour does not engage the mind. It is curious to notice that the same assumption of the unpleasantness of labour has continued even in modern thinking. One of the main benefits of modern science has been considered to be its introduction of labour-saving devices (via the mechanisation). Technological progress breaks down fabrication into a number of sub-operations which have no meaning in themselves. We therefore have the paradoxical phenomenon of a substitution of a toilsome primitive tool-drudgery by a different drudgery, that of monotonous mechanical operations. The privilege of leisure which belonged to the aristocratic class which did no work is now claimed by all, the assumption behind the demand for a shorter working day and working week being, I repeat, that under the conditions of modern industrial life joy is to be found not *in* work but *outside* work.

Even Marx's thinking seems to have been very confused on this issue. I say, even Marx, because for him labour is the source of value and it is only labour which distinguishes men from animals. The revolution, however, will emancipate man from labour for 'the realm of freedom begins only where labour determined through want and external utility ceases', where 'the role of immediate physical needs' ends.¹¹ The conception of occupation envisaged for the classless society is a naive replica of what the eighteenth century aristocrat did with his time. We would be people who 'do this today and that tomorrow, who hunt in the morning, go fishing in the afternoon, raise cattle in the evening, are critics after dinner, as they see fit, without for that matter ever becoming hunters, fishermen, shepherds or critics'.¹² At this point we need to be careful not to confuse science with industrialisation and not to confuse industrialisation with a faulty economic system. But even when these provisos have been made the fact remains that the impetus of technological advance even in a socialised industrial economy will involve the factors mentioned above, monotonous mechanical work and, thanks to automation, a relatively short number of working hours.

We have, then, seriously to ask ourselves what precise role labour-saving machinery should have in a country where there is no shortage of labour, seriously to ask whether work is in fact an evil. To those who are unemployed, destitute and starving, work is the greatest good. As Gandhiji wrote in 1921, 'To a people famishing and idle, the only acceptable form

in which God can dare appear is work and promise of food as wages'.¹³ The success of industrialism depends on absence of competitors and on markets, neither of which can be counted on by latecomers in the field. Rapid technological change involving obsolescence requires fluid capital available for reinvestment and consumers whose wants (going far beyond needs) can be indefinitely maximised in order to absorb the flow of products. The kind of work that an industrialised economy provides for the millions is so monotonous that in such conditions leisure naturally appears to be the highest good. That the released energies liberated thanks to shorter working hours will be engaged in 'higher activities' has been belied by the experience of the west. The 'saved' time is frittered away in the fantasy satisfactions provided by mass media.¹⁴

I have stressed above that the impact of science on the concept of work in the west has in the main been based on the assumption that man's main satisfactions are to be found outside his work. Moreover, whereas the notion of labour-saving makes sense in economies where labour is scarce and where demographic trends are towards still smaller populations, in a country such as ours we need to think in terms of productive employment for the masses rather than of labour-saving. As far as both of these are concerned, the notion of joy in work and the notion of productive employment, no one has more pertinent things to say than has Gandhiji. The impact of science on society in India will benefit only the few unless we are able to evolve labour-intensive programmes both in agriculture¹⁵ and in industry.

THE CONCEPT OF POWER

Among the Ashanti there is a belief that the chief must not be without his sandals lest the powers which are within him collide with powers which are in the earth. This seems to me to express in a mythological way a profound truth. The powers which are in things are not the same as the powers which are in man. The point is not the demoniac character of the one or the other as their difference in kind. Now the business of the natural sciences may be described as the investigation of the powers in things. This investigation, terminating in description, provides opportunities for action. To simplify one could say that the powers are generated by division (this would perhaps be a correct simplified description of the origin of nuclear power) and interplay of properties. The powers in man, however, are generated in a different way. The potency of human action is not in division but in unity. Science is not directly concerned with releasing the powers which are in man at all. But it so happens that because scientific techniques themselves confer power that some of the powers in man are thereby

released and that not always in a responsible manner. All this takes place very indirectly. One example may suffice. The post-industrial, post-Keynesian era marks the end of the thrift economy which went along with the cultivation of certain virtues like self-denial and the limitation of present wants in the interest of future satisfactions. The mass production brought about by the technological revolution in affluent societies requires for the absorption of its production artificial stimulation of wants which releases the powers of acquisitiveness in the people in those societies. Satiation and boredom reach such a point that the consumer cannot say 'what he wants' simply because he *wants* nothing. In such a society creativity is stifled because of the sheer multiplication of 'objects' as has been analysed earlier in this paper. In a country such as ours creativity is stifled because even the most elementary needs are not provided for. In both types of society science by itself is incapable of releasing the powers in man.

Because of its concern with objects science has but indirect concern with the 'subject'— that is the whole man, who lives, works and suffers and who has a capacity for happiness.¹⁶ Utilitarian thinking in the first half of the nineteenth century took place in the context of a keen awareness of the impact that science was having on society through the vehicle of industrialisation. But even the Utilitarians with all their interest in the concept of happiness found that the practical task of the legislator was confined to the removal of *obstacles* to happiness, that is, to the alleviation of pain and suffering. At a time when the west is discovering that it is not possible to promote happiness positively by the taking of drugs like LSD we have not yet got to the stage of eliminating the misery of starvation, disease and premature death. Ours is a failure not of knowledge but of implementation and of heart. The powers in man are stifled here for a criminal cause—the failure to provide the necessities of millions of our people.

WINDS AND TIDES¹⁷

The time has come in our investigation to lay more stress on the specific characteristics of our own situation. For the sake of brevity these are summarised below:

1. The application of science in Indian conditions goes along with only partial industrialisation. This affects not only the content of change but its momentum, the level of expectations, etc.
2. We have here the coexistence of the scientific and the pre-scientific, e.g., the fridge in the dining room and the Neolithic chulah in the kitchen.

3. There is a connection between gadget-using societies and literacy. What exactly this correlation is is worth investigation. In any case it would seem that, unlike in the west, here gadgets are coming before literacy.
4. The problem in India is not to save labour but to provide it. Consideration of the human resources¹⁸ available should be the main point of departure for finding a proper balance between a scientific agriculture and industry. The consideration does not seem to have been uppermost in the past.
5. Our problem is not the provision of a sophisticated standard of living for the masses. The question of scale is therefore constantly before us. Science makes happiness manipulable to a certain extent. But we have to think of the happiness of all and not only of some.¹⁹ Beyond a certain point needs are not fixed. But minimal needs *are* fixed. It *may* be (and this cannot be discovered theoretically) that because of our problem minimal needs can only be satisfied for all if *some* scientific advances are not implemented.²⁰
6. An aspect of the present situation, the danger inherent in which must be stressed, is this—we are rapidly acquiring the products of technological advance but we are not acquiring, *pari passu*, the scientific attitude. It would be a mistake to think of science just in terms of its products. More important is what can be described as the scientific spirit. This I take to involve the following: appeal to the facts, belief in success and industry, truthfulness (the rejection of confuted hypotheses), the abandonment of prejudice and superstition, discipline (the discipline of the laboratory), the concept of 'controlling' a situation.²¹ Two examples of the absence of the scientific attitude in our country may suffice. In spite of all that is known about the balanced diet our thinking in regard to agriculture is by and large geared to the goal of increasing cereal production. In spite of the importance of leather goods as an item of India's exports there are those who advocate a ban on cow-slaughter.

There is point in consulting a map when the journey is still unfinished, when one can still choose where to go, when one can, if necessary, change one's course. Science gives us the means of transforming the actual. It presents possibilities and possibilities are the basis of choice. Technological changes have their own momentum. For this reason what we are greatly in need of is what I would describe as the navigatory attitude. This is to be distinguished from cruising on an even keel unadventurously and distinguished from the behaviour of Edgar Allan Poe's mariner who descends into the maelstrom, figures out the velocities of the current and only just saves himself in time. To have faith in the capacity of men to navigate is far both from a type of materialism such as Bukharin's

which underplays the role of ideas, the conscious intervention of man, and from the militant behaviourism of a psychologist like Skinner who holds that a scientific theory of human behaviour "must abolish the conception of the individual as a doer, as an originator of action".²²

Science, which has given us so many tools, is itself a tool. To expect from it an automatic solution of all our problems is to let ourselves in for disappointment. Family planning techniques are necessary but they bring no guarantee of tenderness in human relations. Nuclear power can be used in medicine. It can also be used to erase cities. It is wrong to expect scientists to make our decisions for us. Our whole range of experience is like the skin and scientific method is a boiler suit which we put on for special tasks.²³ But inside we are men and our decisions are made by the whole man, and scientists in their common humanity are involved in these decisions as well. We have a map, and in spite of this, as in all voyages, we may often enter uncharted seas. But the navigators can be none other than ourselves. "We, mankind, contain the possibilities of the earth's immense future and can realise more and more of them on condition that we increase our knowledge and our love."²⁴

NOTES AND REFERENCES

1. The ivory tower has given way to the control room. The man who presses the button is locus of authority and object of fear. This is the theme of quite a few recent films.
2. *Die Antiquiertheit des Menschen*, p. 260.
3. Reported in the *New York Times*, December 16, 1957.
4. *Young India*, 13-11-'24.
5. "There ought to be much more research organised from the consumption end—directed towards the needs of the individual citizen as an individual and as a citizen". Julian Huxley, *Scientific Research and Social Needs*, p. 256-7.
6. Niels Bohr's work on complementarity shows how the concept of objectivity and its conditions replaces the concept of object—an insight which was anticipated, in epistemology at least, by Kant.
7. It will be curious to see what happens when the *punkah*-oriented grouping in the Indian middle-class sitting-room adjusts itself to the presence of the television set.
8. I have not, in order to avoid complication, introduced a distinction which is sometimes made between labour and work.
9. Socrates was accused of quoting Hesiod's line 'Work is no disgrace but laziness is a disgrace'—that is to say he was accused of fostering a slavish mentality.
10. *Summa contra Gentiles*, iii, 135.
11. *Das Kapital*; III, 873.
12. *Deutsche Ideologie*, pp. 22, 373.

13. *Young India*, 13-10-'21.
14. Modern research on 'work' (topics like fatigue, accident-proneness and the like) has almost exclusively been done from the standpoint of efficiency. This is so even in the case of a subject like work—satisfaction.
15. The experience of Japan is especially relevant in this connection.
16. I have deliberately avoided reference to the science which deals with man. Social scientists who carry over the quantifying techniques used in the natural sciences in an unqualified manner indicate their bias towards objects. To the extent that a social scientist uncovers tendencies and directions his findings are important bases for action. The analogy between social science and medicine in respect of a common concern with diagnosis is not too inappropriate. The uncovering of a stereotype in social thinking is like the uncovering of a complex in individual psychology. The dangerous momentum that certain social processes may have is like the momentum of an undiagnosed disease. Knowledge of the elements in complexes of factors, awareness of directions and possibilities and the scientific belief in the possibility of controlling a situation are among the many important things which the social scientist offers.
17. John Stuart Mill makes an interesting comparison of 'the sciences of human nature' with Tidology in his work *Logic of the Moral Sciences*.
18. E. Gellner in his book *Thought and Change* assumes that 'man is an industrial animal'. Can we make this assumption?
19. Gandhiji's criticism of the utilitarian majority principle is a penetrating one.
20. There has been a concern in leftist circles of late about the effect of installing computing machines and the like on the labour market. In conditions of full employment automation does not cause unemployment (you have a shorter working day, alternative avenues of employment etc.). In the absence of full employment, however, without adequate training programmes, alternative sources of earning, etc., it *does* cause unemployment.
21. J. C. Smart claims even more "...the scientific temper can be psychologically conducive to an ethics of generalised benevolences." *Philosophy and Scientific Realism*, p. 155.
22. B. F. Skinner, *Cumulative Record*, 1959, p. 236.
23. I owe this analogy to Alex Comfort's article on 'Technology of the Emotions' in *The Rationalist*, January, 1967.
24. Julian Huxley, Introduction to Pere Teilhard de Chardin's *Phenomenon of Man*, p. 28.

M. K. CHAUDHURI

Role of Social Organization in the Utilisation of Science for the Benefit of Man

THE purpose of this paper is to put emphasis once more, keeping in our mind the recent experience in India and elsewhere, on the questions which have been raised and discussed continuously for more than a century. The belief that social organisation is intimately connected with the release of potential productive forces developed by the sciences and just distribution of goods produced by society has inspired revolutionary changes throughout the centuries.

Even if it is granted that the aim of science is knowledge for the sake of knowledge, it can not be denied that the pursuit of knowledge has often been inspired by the consideration of consequent benefits derived from it for the individual or the society. In our time the pursuit of knowledge has become so expensive that it is beyond the means of an individual to carry out a serious scientific research programme on one's own in the fashion of romantic alchemists of the medieval period. Scientific research to-day is carried out not by an individual but by a team of experts, often from various fields, requiring coordination and management of a very high order. These developments have increasingly led to result-oriented research financed by the society. Even fundamental research is carried out with the conviction that the results of such research will bring benefit to human society, if not immediately, certainly not in a too distant future. Man's quest for knowledge of space and the depth of oceans at astronomic expenses is being justified not only militarily but also in terms of contribution to development of productive forces of society.

It is, therefore, of prime significance to scientists to investigate the

factors which retard or accelerate the application of scientific knowledge for the benefit of man. The question that is raised here is whether or not social organisation has any role to play in it.

If the degree of application of scientific knowledge in any society can be approximately measured by the level of productivity of human labour, the rate of increase of the same indicates the speed at which scientific knowledge is being successfully utilised. Of various aspects of social organisations, one that is relevant to our purpose in this connection is the mode of production that exists in a society. We shall examine if there is any relationship between the development of productive forces and the mode of production in a society.

Economic historians are more or less in agreement that the level of productivity achieved in slave-owning society was higher than that in primitive societies and yet lower than the productivity achieved in a feudal society. They also agree that the modes of production in these three societies were different from one another. The question is whether higher degree of productivity was achieved automatically because of the growth of technical knowledge with the passage of time or it had also something to do with changes in the modes of production in these societies. The answer seems to be that the growth of scientific knowledge creates a potential for further increase in productivity but for the fullest exploitation of the potential thus created certain changes in the existing mode of production are necessary. Economic historians are in general agreement that production relationships of slave-owning society were found to be inadequate for further release and development of productive forces in the same way as feudal relationships were found to be inadequate for a full scale industrial revolution led by the bourgeoisie.

Let us take the question of automation and illustrate concretely the relationship between productive forces and mode of production. Automation is just a step further in the continuous process of man's endeavour to reduce labour input (dead and living)¹ per unit of output. As such, this should be a boon to human society because it creates the possibility of producing more volume of goods at the same total labour cost.² Why then do we witness political strikes against automation in India in the same fashion as it was during the Chartists' movement of the nineteenth century England? It seems that there is certain similarity between the situation in India today and the situation that prevailed in the nineteenth century England. The similarity lies in the outmodedness of the modes of production of both the societies. Automation is a boon only when its contribution to lessening of the cost is shared by the whole society in the form of less working hours for the same or more pay packet. But this is not possible if automation is sought to be introduced by accom-

panying unemployment and increasing profit for the entrepreneur. This is the case in India. Automation here is a boon to industrial magnates and a curse to labour, because, the mode of production prevailing to-day allows the appropriation of a large part of the fruits of labour of the working population by those who own means of production though their contribution to production may be nil. The more efficient are the means of production owned, the more intense is the exploitation of the society by the owning class.

Since the introduction of automation and the establishment of large industrial concerns, it is being witnessed everywhere, including the U.S.A., that the owners of means of production have nothing to contribute to the running of giant enterprises, as their managers can run them in a much better way through efficient organisational set-up. J. K. Galbraith, the noted American economist, has drawn our attention to this trend in his widely discussed book entitled *The New Industrial State*.

Thus the myth of incentive needed for the owners of the means of production has been exploded by the experiences both in the Soviet Union and in the United States, and the attention has been drawn to the incentives to be given to the working population and their manager-leaders.

Those who are aware of the modern management practices know that there is hardly any distinction between the principles of management practised in the giant concerns of the U. S. and Western Europe and the management practices in the state-owned industries in the Soviet Union and the other socialist countries. It has been conclusively proved that with the growth of any enterprise the contribution of the owner of the same tends to become negligible, thus removing the ethical justification for private ownership of means of production and appropriation of a part of the labour on this basis.

How should we describe the social organisation in India in this respect? In India to-day we are witnessing the transition from the feudal to the bourgeois mode of production in agriculture and we have already a firmly established capitalist industrial sector. The process of planning in India has not been extended beyond the creation of infrastructure of national economy and the establishment of production units in such sectors where the initiative and the capacity of the infant bourgeoisie were found to be inadequate. The pricing-policy followed in the state sector enables the bourgeoisie to appropriate the total profit of all capital invested in the economy, though they have invested only a part of it. There is no serious attempt to regulate the main economic processes, namely, the production, the exchange and the distribution of commodities. Planning targets are stated in financial terms and not in physical volumes.

The result of this policy is self-defeating with inflation followed by recession in the economy. Thus we allow ourselves to be dependent on market forces in the same way as a pretty grocer in a village market does. This grocer's attitude to planning, instead of that of an enlightened concern, which always pays the most attention to its marketing department that discovers, develops and even creates markets for its products, has been disastrous. After almost two decades of planning of socialistic pattern we acknowledge that not only our rate of growth of national income has been amongst the slowest in the world, but also we have not been able even to avoid the recession—a typical feature of unplanned crisis-ridden capitalist economies and unknown to any centrally planned socialist economy.

The recession is caused by demand lagging behind production capacity, that is, unutilisation of productive forces. In a country like India where production facilities are extremely inadequate and where unemployment exists in an unprecedented scale, this situation is particularly unfortunate. If the recent recession is the result of the gap between purchasing power of consumers and the capacity of the society to produce, that is because of the appropriation of disproportionate volume of profit by the owners of means of production, though they are neither able to invest nor consume their income; if the recession has been caused by the sectoral imbalances, this points out to the inadequacies of planning in India and establishes a strong case for strengthening planning processes accompanied by revolutionary changes in the existing mode of production and social relationships. This seems to be the only way to guarantee the highest possible rate of utilisation of scientific and technological knowledge for increasing labour productivity reflected in the fastest possible growth of national income, thus benefiting the teeming millions in India to the maximum degree.

Let us also point out another concrete example. In Vietnam the U.S. are spending as much as one and a half times the national income of India per year to fight the national liberation forces there instead of utilising the same amount to remove the pockets of poverty from the otherwise affluent society. This certainly has something to do with the social-economic organisation prevailing there. For, it allows certain individuals to appropriate profit to the tune of 4.5 billion dollars a year from war productions, thus letting there thrive a war lobby of the hawks.

Changes in the modes of production for proper utilisation of science for the benefit of man, for the employment of science for production and not for destruction, are thus a universal demand and the hope of human existence in peace and prosperity rests on the successful accomplishment of the same task.

NOTES AND REFERENCES

1. By dead labour is understood capital which is nothing but accumulated past labour. Living labour is current labour that goes into a production.
2. Total labour cost = cost of capital + cost of current labour.

N. P. DANI

Economic and Social Aspects of Technological Innovation in Industry

IN any country, the support that scientific activity receives from the Government and the public depends largely on the awareness on the part of the decision making elite about the usefulness of research and development. The magnitude of the research potential and the demand for output made of the existing research, influence the decision making process. The decision makers' own estimate of the role of R & D and its social effect will have a direct bearing on policies followed by the nation. Similarly, the actual or the potential users of the results of research have to be aware of the need for continuing a scientific effort. There is very inadequate realisation in this country that science-based technology is the key to industrial progress, and that such growth depends largely on the investment in R & D in the most effective manner.

A few years back, Prof. Steven Ledijer, an eminent Swedish scientist, remarked, "So-called applied research results obtained in the 27 National Laboratories remained pure academic research because industries were not prepared to utilise them. Patented processes were not sufficiently worked out. Industries purchased foreign patents by preference."

In a recent study conducted by the Economic and Scientific Research Foundation, it was pointed out that the contribution of national laboratories as technical know-how and other services is only one eighth of one per cent of the total industrial output in the country. It asserts that Government Research in India had turned out to be a "totally fruitless activity", because it is not market-oriented. Coupled with this, the oft heard criticism that having spent crores of rupees in the last decade and a half over scientific

research, Science in India has not delivered the goods. However well intentioned this criticism may be, it does not take cognizance of the fact that the progress of science and technology is intimately interlinked with social organizations and economic systems. Under foreign rule no attempt was made to create avenues for developing and advancing technology. It is also necessary to understand the process by which the result of research are transferred to industry and the obstacles to their utilisation.

There is much discussion on the factors that affect the research and development activity but very little is written on the subject of social, political and economic conditions that make possible the application of results of research. As Dr Ward Morehouse has pointed out, one of the most critical problems confronting scientific research in India is what might be called the "development gap". This is a very complex process as the translation of a useful idea into a workable industrial process is long and laborious, entailing much additional research.

In order to understand the role of science and technology in bridging this gap, it is necessary to know what Prof. P. M. S. Blackett has called "Innovation Chain." The process of utilizing science for production extend over six stages: 1. Research. 2. Development. 3. Design. 4. Production. 5. Marketing. 6. Sales.

The first three factors consume wealth while the last three stages of the chain produce wealth. The latter stages of the innovation chain may cost five to ten times as much as the initial research.

The time lag between fundamental discovery and successful research may be as much as 30 years. It takes 5 to 12 years for a useful invention to pass from the research stage to successful commercial production. Very often technical success does not guarantee its commercial acceptance, nor is it necessary that discoveries be exploited immediately after they become available.

During the current decades of the 20th century, the introduction of technological innovation into economy has become an important entrepreneurial function, and this has come to be regarded along with traditional factors of production as the fourth factor in economic activity. The innovation in industry through extension of technology has led to a more efficient use of capital giving rise to increased earning. To quote Schumpeter: "The slow and continuous increase in time of the national supply of productive means and of savings is obviously an important factor in explaining the course of economic history through the centuries, but it is completely overshadowed by the fact that the development consists primarily in employing existing resources in a different way, in doing new things with them, irrespective of whether those resources increase or not".

The results of research give rise to invention in the form of products

(new or improved), techniques and processes. These are employed by entrepreneurs for industrial production for producing goods and machinery. The investment in research itself does not give rise to economic growth. The investment in science and technology becomes embodied in the first instance in machinery and capital goods, or in improved forms of the organization of production. Ultimately, it results in more or improved consumer goods and services.

Research and development also increases productivity through increasing efficiency of product and process or equipment, and higher productivity in turn brings about increased GNP. It is stated that in USA, 90 per cent of the rise in output per man-hour between 1918-1955 is attributable to technological change.

In the innovation process, the possibilities of commercial application are ultimately determined by market considerations. The final say in the matter is exercised by the consumer. There are factors which affect the research and development activity like availability of scientific skill, planning, and selection of research projects, allotment of resources, etc. However, as scientific invention reaches a stage of commercial exploitation an entirely new set of criteria determines its success. There is no real alternative except to deal with the problems of development and exploitation in a commercial way. Technological development should only be undertaken to fulfil specific needs, and only if the proposed new developments give promise of being economically justifiable as well as technically sound.

The technological innovation includes the introduction of a new product, opening of a new market, introduction of a new production method, utilisation of a new source of raw material, or the adoption of a new form of organization.

Kuznets talks of three crucial factors in applying new technological knowledge to commercial realities:

1. Adequate capital for financing the new techniques and products must be available. Some innovations require substantial capital, and generally diffusion of those requiring less capital is more rapid.
2. Entrepreneurs with adequate talents, skills, and motivation must be available.
3. Potential users of the new products and processes must be responsive to change so that widespread adoption and mass production may ensue.

A technological innovation also depends on the availability of adequately qualified technicians and engineers who would design, construct, and operate the machine, and training of these personnel is also an important factor. In economically backward countries, cost reducing innovations have a greater chance of success. Exploitation of patents and developing a process

for a known product are highly significant areas where R & D effort should be directed.

In Industry, any improvement in manufacturing process will have a greater chance of adoption than an invention which will require large capital investment. A new product or a process will have a lesser possibility of exploitation in a slow-growing industry like drugs, chemicals, etc. The ratio of adoption of innovation is the quickest in science-based industry like electronics, aviation, and computer building. Where traditional techniques are used, the adoption of innovation depends predominantly on social factors. Low purchasing power, lower literacy, traditional patterns, and lack of quality consciousness make it very difficult to introduce innovation, and research carried out in disregard of these social factors has very little chance of being utilized.

Without supporting-services like design, engineering, feasibility studies, and market research, the research utilisation lags behind. It has become difficult to separate these activities from what is called 'development'. However, adequate resources are not allocated for this purpose. A fully developed invention has better chances of commercial success than a product resulting out of imperfectly carried out research.

How does government policy affect R & D? In almost all countries of the world, after World War II, the government has emerged as the most important single supporter of R & D activity. In USA, the Government supports directly or indirectly 60 per cent of the nation's scientists and those engaged in research. In underdeveloped countries, government alone has the financial resources to implement its R & D programme. It is very obvious that in India, which has adopted planned economic growth, the objectives of planned development should be closely linked with R & D effort. The Prime Minister recently remarked, "Association between research and planning is loose and ornamental and not as purposeful and functional". In fact, in a planned economy, the role of science becomes more important. It is not only in the formulation of scientific policy that the government is concerned. It should also be associated with implementation of these policies.

The government should take upon itself the responsibility of supporting and financing indigenous research efforts in industrial development, particularly at the development, design, and production stages. It must be realised that this type of work is much more costly than the laboratory research at present sponsored by the government. Indian scientists have produced research results, but have not had the material resources to complete the development and additional work. The skill and experience to undertake complete design of a project were perhaps lacking but they are being developed slowly. Marketing studies are still a rarity. A large

number of high quality, nutritious, protein food have been developed out of the raw material resources available in under-developed countries. However, very few, if at all any, have been commercially produced. With low income, choice becomes limited. The low literacy, traditional pattern, etc. make it difficult to accept new patterns of consumption. The marketing studies and the promotional campaign that is needed for their popularisation had been hardly attended to. Many well executed research projects like development of cardiac drugs, were ultimately exploited by foreign firms who not only recognized their scientific merit and potential uses but also had all the resources at their command to take them upto the commercial production stage.

This leads to the most controversial subject of relative roles played by indigenous technology and importation of foreign 'know-how'. That indigenous technology has not been associated with the industrial growth can be seen from the record of foreign collaboration in the past 10-15 years. It is necessary to know, as Professor Blackett has put it, (i) what existing technologies have to offer, (ii) to consider what research may be needed to meet the specific requirements, and (iii) to leave possible new technologies out of our short-term planning. In developing countries, more emphasis should be laid on application of existing knowledge of the local problems than on working out the newly fashionable and highly capitalist region of pure science. Luxury of research for research's sake is too costly for a country like India. It may be remembered that until well into the 19th century, the United States was an apprentice nation, learning, imitating, and sometimes improving upon the machine technology that had developed in western Europe. The strategy of research planning has to be, however, related to the stage of industrialisation. In the initial stages of industrialisation, a poor country has no alternative but to borrow from rich countries both capital and 'know-how' for a rapid rate of industrial development and social progress. However, while borrowing the technology, careful attention should be given to the condition under which a particular technology developed.

There are certain technical advances which are of universal application, like hybrid seeds, improved fertilisers, L.D. process of steel production, etc. Such innovations will be economic under any conditions as they make the best use of available resources. But there are certain innovations which are developed as an adaptation to economic conditions of the more developed nation, and, therefore, may be unsuitable to the underdeveloped country.

During the early stages of economic development, when a country has to rely on borrowed technology, the emphasis should be on training of scientists and technologists. But sooner or later, they will be needed to

develop the technology further. They will also be needed for choosing and evaluating new technologies borrowed or developed indigenously, but this buying should be to stop further borrowing. Our record is not satisfactory. The large industries in public sector have imported plants and have not thought of further development and expansion. As Jawaharlal Nehru said, "Operating a steel mill or a chemical plant set up by foreign assistance hardly makes the country an advanced and industrialised nation, any more than using a car or an aeroplane purchased from abroad". China, under similar conditions, had made remarkable progress developing indigenous technology. All the three steel plants set up so far have been dependent on foreign collaboration. Without a strong cell for designing and building, technical self-reliance will not be achieved. We may gain some advantage in the short run, but it will never create a self-reliant and self-generating technology. Even the rich nations of Europe are worried over the technology-gap between USA and themselves. One of the reasons for this widening technological gap is that USA spends about ten times more per capita on R & D and four times as much together as Europe. Without a sufficient base in science and technology foreign collaboration can not shorten the take-off stage.

It has been pointed out by the late Dr. Bhabha that there are many examples of foreign collaboration resulting in badly engineered plants or technical mistakes. If Indians had made these mistakes, we could have profited by correcting our failures; but this advantage was reaped by foreign consultants.

But even here, what is necessary is a consistent policy. If a decision is once taken to develop an indigenous technology, whatever may be the risk involved, whatever little wastage that may occur, the process should not be judged by narrow criteria of business economy, but allowed to run its full course till the end. There are also in a sense the social overheads of an underdeveloped country which has embarked on economic growth through planned scientific and industrial efforts.

Although Japan has shopped in the world supermarket of technology, it spent 3,82,000 million yen (Rs. 8,022 millions) on research. To maintain its present position in international market, it will require an advanced scientific technology. For every 100 yen spent on import of technology Japan spent 400 yens on R & D, never borrowed the same technology twice.

Another area where the impact of government policy decision is felt adversely is the field of import substitution. When importing foreign 'know-how', the foreign collaborators insist on maximum quantity of imported raw materials in agreement in order to avoid risks. When large capacities requiring imported raw materials, spares and parts were established in industry, it was envisaged that the imported components would be reduced

gradually in a phased programme. But due to shortage of foreign exchange required for the imports of basic materials, large-installed capacity could not be fully utilized. If a few hundred crores could have been spent on import substitution by using the idle capacity, we could have reached self-reliance quite early. If the problem of finding out suitable import substitution had been handed over to National Laboratories well in advance, the present situation could have been avoided. This has a stifling influence on the R & D work oriented in developing import substitution.

The industries that produce goods for export have been encouraged to earn the valuable foreign exchange the country needs for industrialisation. When due to fluctuations in international markets, the prices fall and demand for Indian goods is reduced, the industries suffer crises and make a clamour for subsidies and cheap imports which are often granted. But why not plan in advance instead of depending on import and foreign markets? Since 1951, the urban population has increased from 62 millions to 79 millions (28%). A vast potential market is developing for a variety of consumer goods. The National Laboratories have 'know-how' on many items, but if only foreign goods sell, or foreign brand name alone appeals to the public mind, the indigenous technology will remain underdeveloped. All these points can be illustrated by concrete cases but the main aim of emphasising these factors is to show that the public policy decisions have a good or bad effect on R & D effort.

The next important question that is always debated is the role of small-scale industry, handicraft or cottage industry in a developing economy: If a country like India invested all its capital in modern high cost manufacturing plant, it would create a problem of unemployment. However, any large-scale investment in a small industry-sector which will create more employment, with low productivity, will have worse repercussions. It is best not to talk in terms of small or large-scale industry, but to select proper project-size where an uneconomically high rate of employment will not create major difficulties for further progress. In an underdeveloped country, certain labour-intensive schemes may be economical and profitable for sometime, but ultimately they have to be replaced by a modern industry.

It is quite a great problem to select the one correct technological solution which will at one and the same time (a) be feasible with available capital and expertise; (b) create adequate employment; (c) produce marketable goods that fetch a profit; and not impede further technological development. The great proportion of R & D can be directed in developing intermediate technology, i.e., technology with less capital intensive and labour oriented, but not necessarily less productive.

In underdeveloped economies, the social environment influences the innovation process and may inhibit its adoption. It is interesting to note

that although very important inventions were produced in China, "the full and reckless exploitation of these inventions were reserved for the looser, less ordered society of Western Europe where no over-reaching bureaucracy and no unchallengeable social hierarchy inhibited their revolutionary application".

For a long time in the history of India, poverty has been accepted as a fate and even exalted in lore, literature and religion. Without sufficient motive for earning higher income and a high standard of life, there will not be a psychological climate to pursue science and technology for creating wealth. Another major impediment to scientific progress is that secular outlook and rationality have not been ingrained in the society. A scientific discussion of any problem is impossible without these critical faculties of the mind.

Social backwardness very often conflicts with economic objectives of scientific effort and discourages further initiative on the part of the scientist.

Discussion of technological innovation, diffusion of scientific knowledge and outlook are also equally essential. And here, we meet the greatest question posed before us in the post-independence decades. What should be the language of science? In any case, the language of science should not be unintelligible to the people. A farmer in the field and the worker in the factory must understand the implications of advancing scientific technology for themselves and their work. If the language which people speak is also the language in which they learn science, it would lead to better appreciation of rational decisions arrived at on scientific considerations, and then unscrupulous politicians will not be able to exploit the people in the name of caste, religion or region to further their own personal ambition and economic gains.

The Catholic Church opposed birth control and Darwin's *Theory of Evolution* till upto the present century, and we still hear echoes of these controversies here and there. But the Church fought a losing battle, not because of material progress achieved through science-based technology but because of the gradual percolation of scientific attitude among the people. The issue came to be judged by objective criteria rather than by scriptural injunctions. Modern genetics has long back disproved the theory of blue blood or racial superiority, but the concept has much currency even in educated circles in India. The farmer in India must know that rains are not caused by celestial bodies, and that it was better for him to listen to weather bulletins broadcast on the radio than consult a village priest for the sowing time. Similarly, an office going administrator, a scientist and a worker in a factory should know that starting work at auspicious or inauspicious moments has nothing to do with daily happen-

ings, and that no amount of propitiations of the deity would change the course of events in their favour. A rational interpretation of a phenomenon like this releases untapped energies of mind for increasing creativity and productivity in work. It is a generally held view that economic compulsions will gradually erode the social resistance to change, but, however comforting such a view may be, it will never bring the country close to the frontier of progress which is an essential prerequisite for modernising society and quickening the pace of development. If the scientific community itself tries to rationalise its observance of traditional rituals, etc., what effect will it have on the caste-ridden, tradition-bound, and poverty-stricken Indian masses ?

The base for modern science and technology is the scientific revolution which started 300 years ago in western Europe. It is not through borrowing but through self-generating science that developing nations can hope to bring about economic and social progress; "...it is upon the qualities of science as a structure of communication, of philosophy, of faith that the deepest reason rests. Without a living science, the new countries will be denied the cultural world-fraternity that the fabric of scientific understanding implies...an original science demands, as it also stimulates, those critical and creative habits of mind so essential to the new nations in every field—the unfettered, flexible, empirical view so essential to their growth and indeed to their very survival as independent states, and still all too rare among them" — Caryl Haskins.

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Scientific and Technological Progress

with special reference to food and nutrition

SCIENTIFIC knowledge and its application in technology have revolutionised our whole way of life in this century. The values and importance of scientific research and technological development have drawn the attention of all classes of people and are moulding the pattern of government policies in all countries as well as in international organisations such as UNESCO, OECD, and others. Technology through industry is thus not only influencing the economic growth and standard of living but its rapid development is creating simultaneously newer problems usually resulting in dramatic upheavals in the way of life of the societies which create them. If we fail to adjust ourselves to such rapidly changing conditions as created by our technological efforts it will be difficult to take full advantage of the new scientific or social order which they bring here or there. In such a state of affairs it is not only necessary to keep pace with the scientific progress but a good deal of our attention must be shifted to social sciences in order to maintain some sort of stability and balance in all our efforts. Agriculture, for example, with all its present day technology has become a full-fledged industry. An attempt will be made in this paper to find how the different facets of food production, its storage and distribution and consumption for the maintenance of optimum health and nutrition are constantly influencing the economic growth, standard of living, social pattern, educational system, management pattern, etc., both from national and international points of view.

Although man is born with some genetic characteristics his environments play a great role in developing both the body and the mind. The

food one takes, the profession one holds, the culture of the community to which one belongs and one's socio-economic conditions—all are important in determining the real nature and performance of a man. Among all the environmental factors food or nutrition is the most important single factor which determines health. Food habits are thoroughly immersed in culture and they affect food intake as importantly as do the soil, the climate and agricultural development. The history of man has been one of continuing adjustments to different environments and diet is one of the most important factors in these adjustments of man to environment. Nutrition is thus involved in understanding the specific relation of man and his behaviour and the environment that nourishes him. Food directed behaviour thus involves much more than the physiological need. It includes appetite, sharpening of brain, aesthetic enjoyments and longevity of life. India is a vast country with varying climate, soil conditions, food availability, food habits, custom and taboos in its different zones, and we are to bring unity in diversity to create a homogeneous unit with the help of modern technology and management.

Even at the beginning of the present century food was not considered a very serious problem in this country as it is today, probably because people were satisfied with whatever could be produced locally by the primitive methods from the available resources and according to their traditional habits, customs and usages. But with better facilities of communication and rapid rise of population, food requirement has increased tremendously both in quality and quantity. Much information has been available during the past few decades regarding the increased production of foodstuffs through science and technology but we have not been able till now to utilise the knowledge fully with our conditions resulting in that our yield per acre is very low and our production is much behind our requirements. Although we had managed to increase our production by about 60% since independence, our population also increased by almost the same ratio leaving the overall shortages in almost the same relationship if not worse when qualitative aspect is considered. Even in the year 1966 we had to import 10.4 million tons of foodgrains and in the year 1967 about the same quantity at the cost of heavy foreign exchange and national prestige and often under the threat to national security.

The rapid pace of scientific progress and technological development in agriculture have thus marked the turning point in the life of our man and society from the old and the traditional to the new and changing world. But we are to gear up our economy on a more productive basis so as to achieve self-sufficiency and self-reliance in the requirement of our food and our defence and in the matter of development and economic growth in general. A glimpse of the developments in other parts of the world

will indicate that it is not yet one world politically and economically. It is more so in food production. While in some surplus countries like USA, Australia, Canada, New Zealand, Argentina, France, and others where a great proportion of land has been kept reserved for other purposes than for production of food, there are countries like Great Britain, Germany, Holland, Belgium and Japan which depend heavily on imported food in exchange for manufactured goods. In India and many other developing countries of the world again where 60—75% of the people are absorbed in agriculture, foods are not still grown to meet the requirements primarily because technology has not sufficiently developed, and there is still a great deal to do to meet the tremendous challenge of applying science to food production and its conservation. Over and above, labour efficiency is very poor in these countries.

Now, if we discuss critically the necessary change required for the full-scale application of present day technology which is again being developed over our traditional conditions, we are to consider so many facets of our life and society in order to achieve the best. For instance, the question may be raised whether the pattern of our agricultural holdings is compatible with traction power or more with animal power. In developed countries the recent emergence of over-abundance of energy like water, coal, petroleum, oilshale, natural gas, etc., has replaced human and animal power by mechanical power in all aspects of agriculture. The replacement of beast of burden and draft animals, however, sets free for food production the land needed to feed them. One working horse consumes the food equivalent approx. to that of 8—12 people. India needs 5—6 crores of bullocks to cultivate her 320m. acres of lands. With the increasing animal population the already adverse land-man ratio is becoming worse, and we are of necessity to remove the burden of unwanted cattle. On the otherhand, our industrial potential is not yet so developed as to make soon sufficient tractors (about 30—35 lakhs) available to our farmers, and supply of oil and diesel or gas will also present problems. Should we then switch on to these technological changes? Another aspect of good farming is to use sufficient fertilisers. Our soil conditions in many places need along-with inorganic manure sufficient organic matter as well, and our cattle are adding million tons of such manure which is again many times that produced in Sindri. Such a situation is further complicated by what is coming next as a result of newer technological development. There are already indications that chemicals can be used as an alternative to machinery and techniques 'used on new herbicides, 'ploughless farming' may help poorly equipped farmers to cultivate a higher proportion of their land. After all, the shortage is also of the ability to cultivate. So the technology is leading us to a constantly changing development with which we hope

to create a better world but its rational application demands a great deal of foresight and judgment so that its utility may be derived for the fullest benefit of mankind.

Food grain production varies greatly from place to place throughout the world. Apart from the soil and climatic conditions there are various other factors such as availability of fertilisers, supply of water (irrigation), mechanisation and control measures against plant diseases, weeds and pest and strain of seeds on which yield of food crops greatly depends. Attempts are being made in various agricultural research stations throughout the world to develop high-yielding strains of cereals. 'Taichung Native I; for example, developed from the International Rice Research Institute, Manila or certain new variety from Mexico has been shown to produce about 5 tons of rice per hectre in irrigated and properly fertilised land. But the development will not stop there. When applied to different soil and climatic conditions such varieties may fall victim to new types of harmful fungi or other pathogenic organisms, and we are to think in advance and plan accordingly when going for the utilization of a newly made technology ; otherwise, we may at times jump into newer and greater problems and troubles.

Technology is thus leading us from one development to another changing constantly our relative position in society, and it is not only difficult to adjust ourselves to such changing circumstances, we do not even know whether the change will be more constructive or destructive in all of our affairs. This is also true with other facets of food production and management. In India, for instance, more than 10% of the food crops is wasted due to plant diseases, weeds and insects, and at least another 10 percent due to spoilage by insects and rodents as well as due to contamination by bacteria during storage. About two hundred chemicals to be used as herbicides, insecticides, rodenticides, miticides or fungicides have been discovered till now. Their proper use can greatly increase food producing efficiency by lowering the damage pests or other bodies do, cutting the cost of control measures and reducing labour requirements. But many of them are not equally non-toxic and may often be dangerous if misused or carelessly used. Further, the residues left or mixed up with foodstuffs may often find way to human consumption leading to large scale havoc and disaster. Here we observe that unless the society is well-acquainted with or educated about such technological advancement it will be a source of destruction, whatever good it might have brought at the initial stage or whatever good objectives there might be. Researchers are, therefore, continuing to develop newer methods for food protection. One such new approach is the imaginative sterility technique. Instead of sterilising the insects with gamma radiation, sterilising them with chemicals has been

visualised. This will open up the possibility of controlling various pests by inducing sterility in the natural population of them. Another approach is the development of attractants that attract insects to places where they can be poisoned or mechanically destroyed. This idea is based on the principle that insects are attracted to host plants and animals, to the opposite sex and to lights, sounds and other types of radiation. All these remedial measures including chemicals are not absolutely free from drawbacks and they should be tried with wisdom, not simply to meet the present needs but keeping an eye for future consequences. After all, these techniques are to be applied for improved production and protection but with full consideration for the existence and health of every one concerned—agricultural workers, consumers of foods as well as crops, livestock, fish, wildlife and beneficial insects.

For increased production the question of changing the pattern of food items has been raised. The main cereal crops like rice, wheat, jowar, bajra and pulses cover about 80—90% of the total cultivable area for food production. Depending upon the changing food habits of our people in different sectors of the country and considering various economic aspects of production it is high time that we revised the pattern of production. This is more true of the production of subsidiary foods like roots and fruits. When we consider the yield per acre of various food crops it is evident that in case of potato, sweet potato, banana, papaya and even tapioca, the return in terms of total calorie is much higher than that of rice and wheat. At the present moment we raise these crops in only 0.8% (2 - 2.235m. acres) of the area under total cereals, yielding approximately 6 - 7 percent of the total cereals. In most of the western countries like Denmark, East Germany, Netherlands, Spain, Poland and in Ghana these crops cover 20 - 30% of the area under total cereals, yielding root crops several hundred times of other cereals.

In the field of protection and preservation of food, there are many changes in recent years affecting the quality and quantity of foodstuffs which include the chemicals and substances such as antibiotics and others to preserve food materials and control diseases in plants and animals, defoliant to make harvesting easier and herbicides, fungicides, insecticides and hormones of all types for their use at different stages. But such an approach is also creating newer problems. Unless they are used rationally foods such as meal, flowers, fruits and vegetables may at times be contaminated with various types of pesticides which usually contain poisonous chemicals. Through consumption of such contaminated foods, these chemicals may be stored in fatty tissues in a concentration that may cause serious illness and even death. In processing industries again there is a wide variety of chemicals called food-additives which are deliberately added to foods

to improve their texture, stability, attractiveness and taste, and to preserve against microbial attack thus preventing wastage. They include preservatives, anti oxidants, colouring and flavouring agents, emulsifiers, thickening and stabilising agents, bleaching materials, clarifiers and others. While innumerable such chemicals are being synthesised by the ingenuity of chemists for use by the food manufacturers in the economic production of food, the technological aspects of many of them regarding the limits and conditions under which they work best as well as toxicological, biochemical and metabolic studies for their safe use, have not yet been completely worked out. Reports are being published in many countries regarding the carcinogenic risks arising from the addition of many such chemicals. Further equipments and machinery are not available to handle both processed foods and perishable foodstuffs safely.

The large-scale production of various types of food has also raised a newer problem of considerable dimension regarding the equitable distribution. This is more so because of the constant shifting of people from the rural areas to urban areas. The interest of the farmers in the rural areas and that of the city people engaged in industry and other profession are not identical. As a result the government have to take up the burden of food distribution with their own machinery. Buffer stocks are being built up with the help of imported food materials plus those collected by procurement. But without the co-operation of growers, consumers and traders, the success of proper distribution is not possible and social upheaval is bound to arise. While many old problems remain as yet unsolved, new ones have been emerging which are connected with increase in population, shifting of profession from agriculture to industry and the need for increased production of food and fuel.

The above trends are also changing the pattern of food availability and as such people are to change their food habits. The actual consumption of food again depends on various factors such as food habits, socio-economic conditions and culture of the community to which one belongs. In developing newer types of food either from the natural sources or through industrial processing it is necessary, however, to consider the importance of the dietary patterns that exist in different sectors in the country. These patterns are the result of age-old experiences and accumulated wisdom and any drastic and sudden change may lead to manifold troubles and to destruction. Modifications must take place but recommendations should be made with the full knowledge of both the immediate effect and later consequences. But we are accelerating our technological development and progress at a very increasing rate. It is difficult for the people to adjust the custom, attitudes, food habits and approach to life in such a rapidly changing environment at the same speed as shown by their technology nor is it

possible for them to respond to the problems created by technology as quickly as these problems arise. Most people are by nature very conservative. This is why habits, customs, values of life evolve very slowly usually over generations. We usually like the comfort of habitual routines, traditional values and familiar patterns of behaviour and there is no wonder, therefore, that we meet with considerable pain in accommodating ourselves to the changing circumstances. But the fact remains that our ultimate success depends primarily upon our ability to acquire good habits, although at the present moment even our survival depends a great deal on our ability to change our attitude and habits under changing conditions.

In this scientific and technological age, the relation between man and his environment has greatly changed, and is continuing to change at an ever increasing rate. These changes are producing complex problems of profession, housing, food supply, health, etc. due primarily to increased density of population, accelerated urbanization, and continuous industrial expansion from newer development of science and technology. Our world is now in the midst of a fundamental transformation from agricultural rural life to a highly urbanized life with industry as the chief source of livelihood for progressively larger number of people. It is likely that fewer farmers will now produce greater quantities of food and the pull caused by the expectations of more stable employment in the city, better education and other social facilities will generate a growing shift of people from the village to the city. This social and physical growth is creating a situation with bad housing and poor community services, absence of sanitation, choked up city traffic, and various forms of group and personal maladjustments. As a result of technological and industrial development newer problems—say on environmental health—have tremendously increased. Man has artificially added various sources of radiation to his environment, e.g. medical irradiation, radio-luminescent paints, radio-active and radio-elements in conventional industry, radio-active fall out and nuclear energy which may cause somatic lesions affecting the irradiated individual himself and genetic lesions affecting his descendants. Pollution of air of towns and cities is another pressing problem. Pollution by smoke and sulphur dioxide from the burning of coal is very notorious. A high proportion of deaths are due to the stress caused by irritation of the respiratory tract. The increasing use of the motor cars and diesel traction is altering the environment. The petrol engines emit unburnt hydrocarbons and carbon monoxide. This latter pollutant may react concentration in the air of the streets well in excess of that permitted in industry. The occurrence and outbreaks of non-infectious respiratory diseases in relation to air pollution deserves immediate study. Similarly, water pollution is also increasing day by day. The next most important change is associated with the develop-

ment of new industries providing disposal products for use in different branches of industry. We are heading towards a situation that entire area of technology is likely to go out of the human control unless counter techniques are simultaneously developed to counteract the conditions brought about by earlier technological advancement.

The young scientists of today have, however, immense opportunities and have tremendous advantages over their fellows of a generation ago. Horizons of learning have broadened, the depth of knowledge is greater and the equipments and techniques now available make possible results of greater significance. The demands for continuous vigour will go on. Public esteem and support have come to scientists as never before. With them also has come a kind of political power, essentially new. Such currents are bringing greater expectation from the public, greater distraction, greater intrusion and at the same time greater risk of public condemnation. In struggling with these common hazards of the environment there is a new need and therefore a new opportunity for the talented individuals not usually used by nor even expected from the scientists of earlier epochs. But the pace of advancement makes difficult the position of the relatively older scientists who have not tried hard to keep abreast. The advantages of today are in time becoming out-of-date and obsolescent tomorrow. As a matter of fact any system that has been successful for ten years or so and has been thus accepted is soon being looked upon as obsolete. As they change relatively to the past they bring with them many of the greater and newer elements of struggle necessary for making a successful career. Paradoxically, one may say that a scientist of today cannot be sure that his so-called successful effort will always improve or benefit mankind. Although technology remains as the most important determinant in this age to help mankind in improving living conditions and in bringing other benefits to enjoy the fruits of science, it should not be an end in itself; it does not exist to serve itself, it must serve man and his world. We must help, therefore, where we can to accelerate social adjustments and to guide scientific progress in the most beneficial manner to render mankind retain control of destiny. This is more so because the world is not always running on a single rationale. The new knowledge developed through scientific research may make possible remarkable technology, it is true, but man may ignore or use either to improve the race or to turn against it.

Engineering and technology are not only the means of application of scientific principles but they are also vitally concerned with and regulating the motivation and organisation of people. With increasing scientific knowledge and technological development there is increasing affluence, it is true, but this is again creating an environment with newer personal ambition and purposeful existence. Even the moral standards are chang-

ing and all these again will have wide effects on social behaviour. Along with our investigation in science and technology we are to think about other fields, such as human behaviour, economics, and sociology. At times one may think that we are probably advocating too much professionalism of technology, and thus curbing an individual's power of imagination, perception and reasoning. We should not allow students and people to become mere parts of machinery, but opportunities should be given to them to participate in all stages of planning and management. Only in that way it is possible to tap the full potential of the human resources in order to form an organisation and society with unlimited and unblemished strength.

The world is being reshaped by the powerful and dynamic development of science, which is again creating a form of society dominated by the idea of democracy. For this social structure, newer forms of education and newer types of management are needed. Management, for instance, is the 'most creative of all arts', because it is the organiser of talents, and, therefore, the pattern of an efficient management to befit a particular social structure is the most important single factor needed to be altered during a change due to technological advancement. Lack of adequate management is likely to be the primary cause of failures in so many of our nation-building projects. We are going to face a sort of challenge—a challenge of technological growth before a society to utilize and control that growth, and we are to mobilise national wisdom to meet the challenge intelligently and effectively, otherwise destruction is inevitable.

ARABINDA PODDAR

Specialization and the Problem of Integrated Personality

I AM not a scientist, and so, I have little apparent competence to talk about a scientific subject. But if science is an exploration of truth regarding our spatio-temporal environment and its purpose intensely human, then I, a student of literature, may well discover common grounds with the men of science. For, both science and literature are explorations of reality; both aim at an imaginative recreation of it, and at visualising conditions for the improvement of human society, a point so convincingly emphasised recently by Jacob Bronowski.

But here I am concerned with that particular characteristic of our modern civilization which has caused serious distortion in our thought and feeling—I mean, specialization. In science it has called into being a great many worlds within worlds, a hundred fields of investigation within one particular field. In philosophy it has produced systems which do not require any universal test for the verification of the truth of a statement. In literature, it ends in an obsession with forms where real men and their real emotions do not count but the imposing edifice of the form. Similarly, economics has ceased to be the study of men, but has become the science of numbers. Each of these small worlds within different systems of enquiry is individual, independent, and exclusive; so much so that it often becomes difficult to discover its relationship with the broader systems of thought or of expression. Such specialization has no doubt led to the promotion of those studies, and has also contributed vastly to human knowledge.

But the point which many scientists and philosophers and literary theorists are worried about to-day is: Has specialization in any field of ex-

ploration in any way made possible the growth of an integrated human personality? Is it any help to the development of what we literary men call "a fully human mind", a mind "which is occupied with the human state, as an individual in a living community" ?¹ This question may be given a surer intensity through the words of the Spanish philosopher Ortega. In his book *La rebellion de las masas* (the rebellion of the masses), written in the late twenties of this century, Ortega has depicted the specialized scientist as "the typical representative of the brute ignorant rabble", who is dangerous to the survival of civilization. In his words the specialized scientist "is a person who, of all the things that a truly educated person ought to know of, is familiar only with one particular science, nay even of this science only that small portion is known to him in which he himself is engaged in research. He reaches the point where he proclaims it a virtue not to take any notice of all that remains outside the narrow domain he himself cultivates, and denounces as dilettantist the curiosity that aims at the synthesis of all knowledge."² Ortega, it may be said, writes with a vengeance; but this applies equally to the specialized philosopher as also to the passionate devotee of semantics.

This craze for specialization, one is inclined to believe with Prof. Toynbee, was a nineteenth century phenomenon, which has produced striking disbalance in the specialist's personality in the twentieth. By his exclusiveness from the rest of his environment the specialized thinker has succeeded in compressing his idea of the universe into a few formulae or a few statements. As a result, there has occurred an unfortunate disassociation between thought and being, knowledge and experience, which again has culminated in alienation of the specialist from the other human beings, which is neither desirable nor fruitful. Crises after crises occur in life, men are killed in thousands, conspiracy to extirpate entire nations are hatched by forces of evil, but the specialized scientist, philosopher, and literary technocrat remain absorbed in their studies. Rarely do we find them taking any interest in the general human affairs or raising their voices against tyranny and oppression. These do not fall within the specific fields of their study, and, for them, the matter ends there. Their gain in knowledge and power has undoubtedly been immense, but this has been achieved at what I would prefer to call a great loss—loss of the tie of unity with the rest of mankind. The concept of the social unity of man has been sacrificed at the altar of specialized exclusiveness.

It has however to be remembered that this applies only to the specialized elite of the capitalist countries, and not to those of the socialist countries. In the case of the latter, since they are guided by a different outlook on life and society, the problem of alienation does not really arise.

But the question is: Granted that the specialized thinkers and scientists

are not interested in saving humanity, but can they save themselves and their dearly won love of freedom? I am afraid the answer will be in the negative. For, a person who is not aware of the suffering of humanity may not be aware of his own suffering even, and may easily be duped into the belief that his mission lies in strengthening the hands of authority, who provided the money for his research and maintenance. When this happens the intellectual freedom of both the specialized thinkers and their fellow human beings is irrecoverably lost. History bears good evidence to this; and, since we are meeting in a seminar on Science, I hope I will be pardoned if I illustrate the point from recent scientific history. Einstein, in 1951, said that "the man of science has retrogressed to such an extent that he accepts as inevitable the slavery inflicted upon him by the national states. He even degrades himself to such an extent that he obediently lends his talents to help perfect the means destined for the general destruction of mankind".³ These words are a straight-forward statement of a painful fact, which, perhaps, rendered Einstein entirely helpless. This helplessness and, I would also add, shock at the behaviour of a good number of his co-workers found expression in his desire to become "a plumber or a peddler", if he were given a chance to re-live his life.

Einstein's indictment points to the fact that the name of the scientist has become tarnished, during the last few decades or so, even though the store of human knowledge has increased a thousand times during this period. Ever since the beginning of the Scientific Revolution, science has been dreaming dreams of limitless human prosperity, of happiness, and of end of wars. It has always stood for us as the symbol of our spiritual liberation, for truth, rationality, and for human dignity. But now it loves to dream quite different dreams; with dreams of human prosperity, go dreams of death; with dreams of human dignity, go dreams of an irreverent indulgence in experiments which have no Schweitzerian "reverence for life". An absolute faith in such experiments and a somewhat unprincipled acceptance of what "Nature has in store for mankind" (Fermi), without any reference to human dignity or good, is indeed a sad transition from earlier faith in the rebirth of humanity through science.

It is said of a section of German scientists that they abandoned their scientific ethic to imbibe the philosophy of the Nazi storm troopers. But many of us perhaps do not know that the behaviour of a section of scientists in America during World War II had been equally suspicious if not worse than that of their counterparts in Nazi Germany. We do not perhaps know that the decision to use the atom bomb against Japan was also approved by the top Scientific Advisory Panel, consisting of such great men as Fermi, Lawrence, Oppenheimer and Compton, that opposition and regard for human values came not so much from the scientists as from the military

chiefs. Admiral Leahy declared with force that to adopt such a policy was to follow "an ethical standard common to the barbarians of the Dark Ages...I was not taught to make war in that fashion". General Eisenhower refused to introduce into war something "as horrible and destructive"; even General Marshall had moral compunctions regarding the use of the bomb. But the Scientific Advisory Panel advised and concurred with the decision of the Administration to use the atom bomb, and that at a time when Japan had already begun to lose the battle and had begun sending peace overtures. That is to say, when the scientists got involved in the said decision, there was little military urgency and no moral justification whatsoever.⁴ What followed is common knowledge. This sad history should have a lesson for all of us.

The conduct of those scientists had added much to the gradual diminution of the scientist's personality. The image of the man of science to-day has altered greatly. He is an estranged being, more feared than loved. No halo of glory is now attached to his name. Recent sociological surveys conducted in the USA reveal that high school students there regard the goal of science as not only humanitarian but also "destructive (. . . destroying enemies, making explosives that threaten the home, the country, or all mankind)", the scientist is regarded as engaged in pursuits of personal gain; he is no longer the embodiment of disinterested motive or of freedom. If he works for a big concern, he is just "a cog in a wheel"; if he works for the Government, he is nothing better than "a morally irresponsible stooge".⁵ The scientists as a community do not enjoy the reverence which those of earlier generations enjoyed in huge profusion. This perhaps explains why Ortega complained that the specialized scientist was dangerous to the survival of civilization. It has of course to be remembered that the social and political systems are in a large measure responsible for this, but the specialized elite's disinclination to get involved in the human problems has also to be taken into account.

The same dissociation and disregard of human values may be illustrated from the history of philosophy also. A typical example is supplied by the Navya Nyaya School of Bengal. In its attempt to determine very precisely the various relations of knowledge and being, it evolved a specialized system of logic which, according to many teachers of philosophy, surpasses even Hegel's system in rigidity and minuteness. Volumes were written in an attempt to ascertain the relationship of the container and the contained, the arid subtlety of which bewildered even the most comprehensive of minds. But, again, for what purpose? or to what end? Could the specialized advocates of that system solve any of the living problems of the day? Or, could they save the then society from disintegration and decay? No, they could not. For, they were totally estranged beings, absorbed in

their own specialized study, for whom the real human world hardly ever existed, unless as the source of their sustenance. They preserved a masterly autonomy in the world of thought, but allowed themselves to remain fatalists in the more important world of action. As a result, they remained idle spectators of the withering away of their world, they themselves being carried away along with it. In the present century also a generation of philosophers, poets, economists, and other members of the specialized elite remained spellbound by the magic of their own exclusive interests, while a gloom prevailed over the destiny of men. And the same story was repeated once again.

All this is sad, perhaps extremely sad. But if we ponder over it, we will have to conclude that the desire to remain bound within the specialized field of study is to a large extent responsible for this. Because this desire, as we have seen, stands, in the way of the development of an integrated world view and keeps its votaries blind to the human problems involved. It obliterates the world so to say, and kills the very idea of belonging together.

Of course, in these days of interrelated and very complicated scientific investigations certain amount of specialization is unavoidable, nay, inevitable; but the point is that it must not be prized above all other considerations, intellectual and moral. We cannot blindly follow where Nature may lead us, as Fermi said, and remain indifferent to its effects on the human community. Morality may, however, invite different interpretations, but it is commonly agreed that it lies not only in the devotion to one's own work, whatever be its nature, but also in the love of human life and of its happiness. This is the response which is expected of a fully grown human mind, more of the scientific intellectuals than of others, since it is they who largely determine the destiny of mankind to-day.

In this connection, I believe, we may profitably remind ourselves of two ideals evolved in earlier centuries. The first of these is the ancient ideal of the fully-formed human personality which envisaged an all-round development of a personality, agile, alert, responsive, and responsible to all the demands or questions of life. The ideal sought to release a man from his personal therefore narrow world into the broad human situation, the individual and the community together forming a whole. That principle may yet be cherished. It offers us a solution of the problem of alienation and of confrontation. By developing such a broadened outlook the estranged specialist can happily return to the bosom of the community. The love lost may be regained by a steadfast belief in belonging together.

The other is the advice the scientists themselves had given to their co-workers on different occasions. It is that science should never be taken as an individual quest or a selfish pleasure, that it has value only in so

far as it gets linked with the welfare of the human community, that the scientists themselves should step forward to put their knowledge at the service of humanity. Or, in the words of Schrödinger, "Never lose sight of the role your particular subject has within the great performance of the tragi-comedy of human life; keep in touch with life; ...and, *keep life in touch with you*".⁶

Here, in this advice, one is tempted to conclude, do philosophy and science and literature meet. Following some ethic of the veracity and force of Schrödinger's sentence, can the specialized intellectuals of to-day conquer the problem of alienation. Specialized thinking rests on the dualism of thought and being; this dualism has to be eliminated, if we were to restore the balance between the specialized individual and the society.

NOTES AND REFERENCES

1. Probably Dr. Leavis's definition, which Jacob Bronowski himself has used in the speech of Dr. Harping in his interesting dialogue "The Abacus and the Rose", included in his book *Science and Human values*.
2. Quoted by Erwin Schrödinger in his book *Science and Humanism*, p. 6.
3. "Einstein on Peace", quoted by Lewis S. Feuer in, *The Scientific Intellectual*, p. 400.
4. Lewis S. Feuer, *The Scientific Intellectual*, pp. 394-398.
5. *Ibid.*, pp. 399-400.
6. Schrödinger, *op. cit.*, p. 8.

P. S. SARMA

Impact of Science on Human Nutrition

THE problem of the choice of food has been with man since ancient times. In olden days man's selection of food stuffs was governed not only by geographic and climatic limitations, but also by popular beliefs—right and wrong—and social and religious taboos. Hence the choice of a nutritionally adequate diet was mainly a matter of chance and this was rendered less likely by the prevalence of certain cooking practices which, we know today, destroy or diminish the content of some of the nutrients essential for growth and maintenance of sound health. It is only during the last hundred years that experiments with animals and humans on a sound scientific basis have revealed the importance of fifty nutritional elements, and there has grown an increasing awareness of the necessity of choosing the correct diet under conditions of health and disease. This has been the outcome of the significant advances made in the sciences of nutrition and food chemistry.

Ideally, the food chosen must be one which helps to build up a man with the best physique by supplying in the correct proportion all the nutrients required for body growth and maintenance. To these are added the exacting requirements of periods of rapid growth and pregnancy. However, it would appear that given a variety of foods, men and animals choose the correct assortment of nutrients. This is not due to the existence of a food instinct but due to a process of learning (acquired or transmitted). It has been shown that animals learn to associate the consumption of the right food with the feeling of well-being induced by it. If the effects of a food are not felt sufficiently quickly, the animal fails to recognize the

correct food. For instance, an animal rendered deficient in thiamine (vitamin B₁) learns to select the food containing thiamine since the sense of well-being is induced fairly rapidly, whereas a vitamin D deficient animal fails to spot the correct food, since correction of the deficiency does not produce improvement rapidly enough for the animal to learn to associate the improvement with the food which gives rise to it.

However, there are several instances in which man cannot be relied upon at all to make a wise selection of foods. These are brought about by religious and social customs and man's own idiosyncrasies. High incidence of Beriberi has not taught Asians to prefer parboiled or unpolished rice to polished rice. Religious scruples prohibit the consumption of meat in India and in many other parts of the tropics. Some African tribes avoid fish. Even milk is taboo in some areas. Again in some societies, the importance of the wage-earning male has led to the practice of a major portion of the protein-rich food being reserved for the male, whereas growing children and pregnant women in the families get poorer rations of this much needed nutrient. Such nutritionally unsound practices continue to pose serious problems to the scientist and it is only in the recent years that the impact of the findings of the science of nutrition has begun to be felt.

The spectacular advances in the field of nutrition were sparked off as a result of the dramatic cure of diseases like Beriberi, Scurvy and Pellagra by the simple expedient of adding some missing dietary factors to the rations. This stimulated the interest of nutritionists who started experimenting on animals producing similar deficiencies in the laboratory and looking for the foods and nutrients which can cure the deficiencies. Systematic chemical analysis of foods had revealed carbohydrates, fats and proteins as the chief constituents. When animals were reared on synthetic rations made of these pure nutrients, they failed to grow and died eventually after exhibiting several deficiency syndromes. Addition of small quantities of foods from natural sources, e.g. a small quantity of hay, resulted in a marked improvement in growth indicating the existence of unrecognized growth factors in natural foods. Since then it has become a standard practice to grow animals on synthetic foods of precisely known composition, observing the resulting deficiency symptoms and finding out what nutritional factors will lead to the disappearance of such symptoms. It was in this way the importance in nutrition of vitamins like thiamine, niacin, pyridoxine and essential fatty acids, essential amino acids and trace elements was established. Thus the use of experimental animals has unravelled a large spectrum of nutrients which are vital for the maintenance of the body in a state of perfect health. Some of these are needed in such microquantities that it is almost impossible to create the deficiency using natural foods at all.

Thanks to elaborate and painstaking research in the field of nutrition, we are now in possession of a great mass of information on nutritional requirements of man. His needs are two-fold. (1) Nutrients that are essential for the formation of body structures such as bones, muscles, skin, hair etc. (2) Nutrients that supply the energy needed for the performance of work—voluntary and involuntary muscular activity, maintenance of body temperature and the like. In addition we need minute quantities of the vitamins and trace elements which participate in the above processes with a catalytic, or, so far undiscovered function. For instance, the vitamins like thiamine (as thiamine pyrophosphate), niacin (as nicotinamide adenine dinucleotide derivatives) and riboflavin (as flavin adenine dinucleotide) permit smooth combustion of foods in the body and trapping of the energy so liberated for the performance of useful chemical and mechanical work. They also act catalytically in the synthesis of several body constituents.

As a result of these advances, the housewife is now in a position to think in terms of the calorie-requirements of the members of the family. There is a growing consciousness among us these days of the need for balanced food and vitamin and mineral adequacy. We recognize that children and expectant or nursing mothers need special nutritional care and their diets should contain more protein than the normal diet for adults who need protein only for the repair mechanisms. There is an increased requirement of iron in the early months of pregnancy and children need extra calcium in their diet—such examples can be multiplied. Having understood the nutritional needs of the body, it becomes a simple matter to select our food since we now have at our disposal the proximate analyses of most of the commonly available food stuffs. One can select the vegetables that assure him his supply of vitamin C or fish liver oils which supply vitamins A and D. In protein nutrition, a single protein may often prove inadequate to meet the body requirements on account of its low content of one or two amino acids. Knowing the amino acid composition of different proteins, one can select a combination of proteins which will meet the essential amino acid requirements.

Let us turn our attention to what science has done in avoiding nutritional diseases and hazards. Since the classical demonstration that the deficiency diseases like Beriberi and Pellagra are caused by the deficiency in diet of thiamine and niacin respectively, these scourges which afflicted humanity through all ages have been eradicated and they are no longer baffling to us. Similarly, we should soon be free from scurvy, rickets and dental cares, simply by supplementing our food with some vitamins and minerals.

Science has taught us that a careful choice of diet can largely alleviate or prevent the onset of certain disease conditions such as galactosemia, obesity, diabetes and atherosclerosis. Galactosemia is a hereditary disease

characterized by the inability to metabolize galactose. Until recently, there was no cure for this disease. Since the nature of the disease is well understood now, if the diet is freed from galactose and lactose the infant can be saved. Obesity results purely from indigestion of more food than is necessary to meet energy requirements. Hence obese people should choose a diet which is deficient in calories and having an adequate supply of vitamins. Carbohydrate and fat must be avoided. In cases where the patients cannot control their food intake, remedies such as cutting off segments of the intestine to decrease absorption have been resorted to. Likewise, diabetic people can combat the disease by choosing diets which will keep their blood sugar within safe limits and by avoiding sugar and fat. It is now established that atherosclerosis is intimately connected with increased cholesterol level in blood which results in the deposition of this sterol on the inner lining of the arteries which consequently lose their elasticity. The propensity to this dreaded disease can be diminished by carefully regulating the diet and by periodic checks on serum cholesterol levels.

While Nature has been bountiful in the liberal supply of plant proteins, she has also contaminated these foods with some toxic factors whose consumption may be deleterious. The trypsin inhibitors of soyabean decrease the nutritive value of the bean. Soyabean also contains hemagglutinins which affect the proper functioning of blood. However, it has been found that the trypsin inhibitor is inactivated by heating and the heated bean acts as a good source of protein. Supplementation of methionine also overcomes the poor nutritive quality of raw soyabeans. Other toxic factors present in common foods are the lathryogens, toxic glycosides and other substances like gossypol from cotton seed, the metal-binding factor and the causative principle of favism present in the broad bean. The scientific approach to overcome these deleterious effects is the removal of these toxic factors from foods prior to distribution, and decreasing the content of these deleterious factors in the seeds to non-toxic levels by methods such as the development of mutant strains. In the case of neurolathyrism caused by the consumption of Khesari Dhall (*Lathyrus sativus*), the toxic principle can be removed by roasting the seeds or by boiling the seeds in water and washing. In several instances heating diminishes the content of the toxic substances. Knowing the hazards associated with plant proteins, suitable treatments must be made prior to consumption of these foods.

Another significant contribution of science is in the development of food processing and storage. Most fruits and vegetables are richest in nutritive values when freshly picked, and they tend to deteriorate on standing. Modern practices of refrigeration and storage help preservation of these nutritive values for a considerable period of time. Cold-storage and quick-freezing

techniques have done much to conserve nutrient quality. Thus we are no longer worried by the unavailability of some foods in certain seasons, thanks to modern processes of dehydration and canning. Pasteurization has helped in a large measure to avoid diseases caused by the consumption of milk containing harmful bacteria.

We know to-day that polishing and washing of cereals result in the removal of the water soluble vitamins predisposing man to Beriberi and other diseases. Cooking destroys some vitamins which are heat liable. Taking of raw eggs results in the unavailability of the vitamin biotin in the food. Thus it is obvious that we have to take care in the cooking methods employed for various foods. Or, if this cannot be helped, the diet should be supplemented by the nutrients which are either unavailable or deficient.

In this regard science has come out with a significant contribution by introducing the practice of enriching foods with the missing nutrients. This is particularly important in view of the fact that people tend to ignore or disregard the hazards of faulty diet-planning and often cling to a limited choice of foods which leads to a chronic deficiency. The only way to help them is by enrichment practices. For instance, it has become a general practice now to enrich bread with vitamins and to add as much as 6% of non-fat milk solids. Vitamin A and D are added to hydrogenated oils and fats. A remarkable achievement has been the reduction in the incidence of goiter by the practice of adding iodine to common salt. As if by a miracle goiter ceased to be a health problem. Irradiation of food stuffs to increase their vitamin D content is widely followed in the preparation of baby foods.

The most serious nutritional problem in underdeveloped countries is protein-malnutrition, clinically referred to as "Kwashiorkar". It is encountered in children whose diet consists mainly of carbohydrates and is deficient in protein. This disease is currently well recognized and dramatic cures have been effected by putting these children on a diet with adequate protein and milk. But the problem is not just clinical, but economic as well. The world over, the children of the poorer classes of people are under threat of protein malnutrition mainly as a result of their inability to afford a protein-rich diet. The role of science is, therefore, to find suitable new protein sources which will provide them the protein needs at a very low price. Progress is already under way and hitherto unexplored sources of protein are coming to light. In addition to the conventional sources, scientists and technologists have turned their attention to the isolation of protein from lower plants including algae and bacteria. Protein from petroleum will be a reality in the near future. Plant biochemists and geneticists have co-operated to develop new strains of maize and wheat that produce protein of a much better quality. Several high-yielding varieties of

sorghum and corn have been developed and these should go a long way in satisfying the increasing demands of large segments of population in various parts of the world.

While science has led to the recognition of several problems of nutrition and offered solutions to overcome them, it has not succeeded in making people change their nutritionally unsound food habits. Most of us still cling to our ancient customs in food selection and processing and thus walk blindfold into the clutches of nutritional diseases. Unless scientific education in nutrition from childhood can help overcome prejudices and callousness, nutritional disorder will continue to be a pestilence to human welfare. It is in this direction, that scientific efforts must be made in future to enable people to realize that the correct choice of food is as important as prevention and cure of diseases.

JAGDISH SHANKAR

Social Implications of the Recent Developments in the Peaceful Uses of Atomic Energy

THE discovery of nuclear fission has placed at the disposal of man a source of energy much larger in magnitude than any known before 1940. This was demonstrated in a rather dramatic way by the bombs exploded over Japan in 1945. This energy can, however, be released in a controlled manner in nuclear reactors where a chain reaction can be established and sustained in naturally occurring uranium. The main components of a nuclear reactor are (a) fuel (e.g., uranium), (b) a moderator (water or graphite), and (c) a coolant to carry away from the site of fission the large amount of heat developed during the process. It is also possible to synthesise two new nuclear fuels, (a) plutonium 239 from the naturally occurring uranium 238, and (b) uranium 233 from the naturally occurring thorium available in the abundant monazite sands found on the western coast in the states of Kerala and Madras, and on the eastern coast of India in Andhra Pradesh. Besides the nuclear reactors of the conventional type using uranium or plutonium as fuel and water or graphite as moderator, a new type of reactors known as "Fast Breeder Reactors" are now being set up in different countries. The latter are very efficient in converting thorium into uranium 233, the new nuclear fuel.

Irrespective of the type of reactor, the heat energy given out during the fission process can be extracted and employed in raising steam with the help of which one may either turn turbogenerators to produce electricity or drive a ship. A by-product of such nuclear reactors is an abundant supply of radio-isotopes which find uses in medicine, agriculture, industry, and pure research. My talk, therefore, will deal with the consequences of the

availability of the large source of electric power which the nuclear reactors provide, and with the use of radio-isotopes and radiation in various aspects of human activity. Both these have potentially a tremendous social impact.

The industrial development of a country can be judged reasonably accurately from the amount of electricity produced in the country. In this respect, the USA ranks as the most highly developed and India among the least developed. Despite the fact that the generation of power has nearly increased three times during the last 15 years, the population has also increased and the per capita consumption of electricity remains very low. Even if we wish to achieve the rate of production which obtained in Europe in 1960, we have a long way to go. To achieve this goal we will have to harness all available energy resources. The most obvious and easily accessible sources of hydro power have already been harnessed. The remaining ones will not contribute much to our requirements. The choice is, therefore, between power from coal and that from nuclear sources. If we were to produce it all from coal we shall exhaust all our known resources in 25-35 years, besides straining our transportation to a breaking point even after investing large sums of money on tracks and railway wagons.

It is now fairly well known that electric power can be produced through nuclear reactors at prices comparable with those at which it may be produced from fossil fuels or hydro-electric stations. The capital cost is, however, much higher in the case of atomic power stations than it is in thermal or hydro-electric stations. Hydro-electric power is perhaps the cheapest source of electricity, both in terms of the lower capital investment per installed kilowatt and the rate per kilowatt hour of electricity produced. However, hydro-electric stations can only be set up in places where abundant water is available and the terrain will permit the building of large storage dams. The water can also be used for irrigation (multipurpose dams). Thermal power stations, on the other hand, are more expensive, both as regards the capital investment and the unit cost of electricity. Also, in thermal stations, the cost of power produced increases as the distance of the generating stations from the coal mines increases. In a series of articles written by the late Dr. Bhabha, who laid the foundations of the atomic energy programme in India, he had shown that, at distances more than 800 kilometers from the coal-fields, electricity from nuclear reactors could not only compete with but be actually cheaper than that from thermal stations. Thus atomic power stations are being built in places like Tarapur (80 kilometers north of Bombay), Rana-Pratap-Sagar (about 50 kilometers from Kota in Rajasthan) and in Kalpakkam (about 50 kilometers South of the city of Madras). The first two of these stations would each have two nuclear reactors generating approximately 200,000 kilowatts of electricity each, while Kalpakkam will for the present have one 200,000 KW reactor.

Before I proceed further, it will perhaps be of interest to tell you something about the organization of Bhabha Atomic Research Centre which has enabled us to take such rapid strides in this field. As early as 1955 (only one year after the Department of Atomic Energy was formed as a separate ministry under the Prime Minister), it was decided to build a small experimental reactor so that scientists and engineers could be trained within the country and to provide a modern tool for research. It was, therefore, decided to build a simple reactor of the swimming pool type, later named Apsara, and this was designed and built without any outside assistance. The fuel elements for this were loaned by the U.K.A.E.A. because we did not then have the plants to make them. This reactor went critical in about one year only from the date it was decided to build it. The scientists and engineers responsible for this were all young men fresh from universities, except for the most senior ones who had perhaps 5-8 years experience of research and who had had a chance of a tour to similar establishments in France, the UK and the USA.

To meet the increasing requirements of scientists and engineers and to see that we do not take away people from the staff of universities or other sister organizations, it was decided to start a training school to impart general and specialised training in physics, chemistry, and different branches of engineering. The first batch of about 140 trainees was taken for a one year course in 1957 and this programme has continued ever since, the eleventh such course being conducted at the moment. Although the Research Centre at present employs over 9000 men (including all categories), the number of graduate scientists and engineers is about 2500. Training at the rate of 120 to 150 per year in the training school, it is obvious that over 50% of the existing scientists and engineers have been trained at Bhabha Atomic Research Centre to meet our needs.

Under the guidance of the late Dr. Bhabha, the Establishment has always planned our research and production schedules so that the needs of the programme could be met indigenously, as far as possible. For example, a plant to separate uranium and thorium from the by-product cake of the Indian Rare Earths plant in Kerala was set up in Bombay in 1955 and the pure uranium metal produced in 1959. The facility for making fuel elements from this uranium metal went into operation in 1959-60 to provide the fuel elements for the large experimental reactor CIRUS which was built in collaboration with Canada and went critical in 1960. This fuel fabrication facility also made the fuel elements for the third experimental reactor ZERLINA which was commissioned in 1961 and is used to carry out experiments on design of new power producing nuclear reactors. In 1965 was commissioned a fuel reprocessing plant, called the "Plutonium Plant", designed and built entirely by our own scientists and

engineers at a cost of about 3.5 crores of rupees. Apart from the fact that the plant was designed and built by our own people, it is a matter of satisfaction to note that we built it at half the cost at which a plant of a similar capacity was built at Mol in Belgium by EUROCHEMIC.

Although monazite sands contain a small percentage of uranium which we have recovered and used in our programme, it was necessary to set up a bigger uranium mill to meet the needs of uranium for the nuclear power programme. In the south of Bihar, the country has some large deposits of low grade uranium ore. Work on developing methods for the extraction of this uranium had been in progress at this Research Centre for a considerable time. On the basis of the results obtained by our engineers on the pilot plant, a full scale mill to treat 1000 tons of ore per day was designed, built, and has just been commissioned near the mines about 25 miles east of the steel city, Tatanagar.

As the country launches on a bigger nuclear power programme, it has become necessary to set up larger facilities for fabrication of new type of fuel elements using uranium oxide instead of the metal, to set up a larger plutonium (Fuel Reprocessing) plant and a larger heavy water plant, since the one in existence now at the Nangal Fertilizers is inadequate to meet the present and future needs. These plants are in various stages of design and will be built up once again entirely by our own engineers in different parts of the country. The engineers designing these plants have had now several years of experience, running smaller plants at Trombay, as already mentioned above, and therefore feel fully confident of their capacity to handle the larger projects.

Most of you already know that we have started on building large atomic power stations at three locations. The plant at Tarapur is nearing completion, the one in Rajasthan is due to be completed in about two years and the one at Kalpakkam, near Madras, will be completed in about five years. Each one of these power stations will require about 200 scientists and engineers. Some of these have been trained abroad in the United States and Canada and others have been trained or are undergoing training in our installations at Trombay. It has also been decided to set up a fast reactor centre at Kalpakkam in order to obtain first hand experience in these new type of reactor systems so that at the appropriate time we shall not be found wanting in experience and in trained personnel.

It will be seen from what has been stated above that the training of engineers, scientists, and operators has gone ahead at Trombay for the last several years and can now be said to be a self-generating system. I have particularly mentioned this at length to bring home the fact that as far as personnel is concerned, we have not taken people away from universities or other institutions but trained them ourselves, and as far

as designing and building of nuclear power plants are concerned, in just three steps from Tarapur to Rajasthan to Kalpakkam, we would become completely self-reliant and not need any foreign collaboration. This is also the case as far as the various materials which go to make power reactors are concerned.

As has been said above, the Tarapur Atomic Power Station is scheduled to be the first to begin operations and will feed power to the Maharashtra-Gujarat grid. Likewise, the other two stations will be connected to the other two regional grids. In India none of the grids is capable of taking very large power-loads (they can take approximately 1000 to 1500 MW load). For this reason atomic power stations of larger size could not be contemplated, particularly in view of the fact that atomic power reactors are generally used to take the base load while the thermal and hydro-power stations are employed for taking the peak load. As in many other industries, both the capital cost per installed KW, as well as the unit cost of electricity, come down considerably if the size of the power station is substantially increased. For example, if a 400 MW station can produce power at 4 paise per unit, a 1000 MW station might produce it at 2.5 to 3 paise per unit.

Now we can ask ourselves what building of large nuclear power plants means for the economic future of our society. It could mean that

- 1) low cost electricity will accelerate its use in preference to other forms of energy and will encourage its use for metal refining not only for the production of superior quality metal (such as steel), but also for the production of larger quantities of metals such as aluminium, and of new metals such as magnesium,
- 2) availability of low cost nuclear energy will permit us to conserve our fossil fuels and reserve them for more vitally needed functions, such as for transportation and the production of chemicals and plastics,
- 3) low cost nuclear energy can also provide us with the process heat required for desalination of sea-water and the purification of brackish waters, for recycling of water, and for pumping it up from tube-wells. This, in turn, can lead to the setting up of dual purpose plants producing cheap electricity and water for agriculture.

Since the grids in India cannot take large blocks of power, such large power plants can only be considered at present provided the power is not fed into a grid but used up in a localised region in its neighbourhood.

Some recent studies made in the United States indicate that such large power stations could profitably be built in areas capable of being developed industrially and agriculturally when this power becomes available in the region. There are many areas in the world which are either deserts

or otherwise have little or no agriculture or industry because of lack of water and power. Some of the desert areas are very near the sea, like the Sahara desert in Africa, or Israel, or Kutch in India. Although plenty of sea water is available, it cannot be used for agriculture because of its large salt content. According to the US studies, areas of this type could be developed by setting up large nuclear power stations as source of cheap electricity which could then be harnessed for producing water for agriculture and for developing industries in regions in its immediate neighbourhood without having to transport the electricity through any large grid system. It has been estimated that in such a large-sized power station, electricity could be produced sufficiently cheaply to encourage its use for agriculture and industry. It may be emphasized that the main point is that electricity must be produced cheaply either from fossil fuel or other sources. The choice of heat source is based purely on economic considerations and it is found that nuclear power is more economical in larger sizes.

One of the most promising processes of large scale production of potable water from brackish water or sea water is distillation. This process requires quantities of low temperature steam. One of the places where steam of this temperature is found in quantity is in the turbines of modern thermo-electric power plants. In these plants high temperature steam is produced to turn the large turbo-generators that produce electrical power. As steam passes through the turbine, its temperature decreases until a point is reached where it is low enough to make it possible to use it for saline or brackish water distillation. Thus, the steam used for producing electricity could also be used to provide energy to the water distillation plant. The plant economies are enhanced by using the higher temperature steam for power generation and the lower temperature exhaust steam for desalting. By combining the two processes in one plant, large heat sources can be used. Economies are also affected by sharing equipment and facilities, such as water intake and discharge lines, control rooms, maintenance shops, etc..

In one study for desalting sea water, calculations show that potable and agricultural water can be produced at the equivalent of about Rs. 2.50 per thousand gallons (This compares with Rs. 4-5 per 1000 gallons at which it is being made by some industries in Kutch). A million KW electrical station, set up in a region where the land is reasonably fertile but does not grow anything due to lack of water, can produce enough water (400 million gallons) through desalting to irrigate 300 sq. miles (2 lakh acres) of the land. For example, in Egypt, in the immediate neighbourhood of the river Nile the land is extremely productive. If water were similarly made available in other parts of the desert, through desalting

of sea water, much more of the desert could be made to yield food-crops which are badly needed in the region and throughout the world for the ever increasing population.

Since electricity produced in such a conceptual power station is not transported through any grid, it inevitably follows that it must be utilised by setting up industries in the immediate neighbourhood of the power station. As the total amount of electric power available is quite large, power-intensive industry must be given preference in this region. With the availability of desalted water for agriculture, it will also be necessary to use adequate quantities of nitrogenous and phosphatic fertilizers to sustain modern agriculture with crop rotation. A plant for manufacture of nitrogenous fertilizer, like ammonium nitrate, using electrolysis of water can, therefore, be considered as one of the major industries to be set up in this complex. As phosphatic fertilizers are needed in approximately the same quantity as the nitrogenous fertilizer, it would also be necessary to set up a plant for making phosphorus or phosphates. The arc process for making phosphorus can compete in costs with the other wet methods if electricity is cheap. Since cheap electricity will be available, manufacture of phosphorus can be considered as a second industry for this region. An economic size of such fertilizer plant will be able to produce quantities of fertilizers well in excess of those required in the farm lands irrigated by the desalted water; the balance can be exported easily by ships because of the nearness of the sea. Many other industries of a similar nature can be considered for this region. Even if the raw materials are not indigenously available, they can be imported at cheap rates by sea. An industry which would be worth considering would be the manufacture of aluminium which requires large amount of cheap electricity.

After desalting, the more concentrated brine resulting from this operation could be used for obtaining a number of other materials such as magnesium, bromine and potassium, etc. We thus see that a whole group of industries could be built around such a large source of electric power. In principle this could be done with any large source of electricity, not necessarily nuclear. However, as has been pointed out before, it will be difficult to set up such a large station based on coal (except at the mine head, because of the difficulty in its transportation). One could perhaps base such a large power station on oil, if it were available in the immediate neighbourhood, but the total available oil in the world is so small and the needs growing so rapidly that one would not think of setting up large power stations based on oil for desalting sea water. This, therefore, leaves the field clear for nuclear power stations. The nuclear power stations have the added advantage in that the total amount of fuel

used up per year of operation is an insignificant fraction of the weight of coal required in a thermal station of a corresponding size. Compared to millions of tons of coal, a million KW station based on atomic energy will only consume about 300 tons of uranium per year.

In the above concept, besides desalting of sea water for agriculture, power-intensive industries are envisaged to be built around a large nuclear power station, as a commercial proposition. There are also places not near the sea where fertile land remains unproductive because of lack of adequate amounts of surface water. If underground water is available in such areas, it could be pumped up for irrigation. Pumping water from great depths costs large sums of money for purchase of suitable pumps. It also involves considerable running expenses as pumping consumes large amounts of power. If sufficient cultivable land which can be irrigated is available, a large nuclear power station can provide the needed power for pumping water at cheap rate. Here, part of the generated electricity could be used for pumping underground water for agriculture, instead of desalting of sea water. Other industries could be built up as in the previous case considered above. For example, with a one million KW electricity station, one can irrigate 5 million acres of land and still have more than half of the power available for industries like the ones mentioned above. An area where such a project may be considered is western Uttar Pradesh and Bihar, since it is reported that there exists an "underground lake which is probably the largest and potentially the most productive in the entire world".

It is easy to see from what has been said before, that this concept of large power generating units used for either desalting of sea water or for pumping underground water for agriculture, and for setting up large power intensive industries, can influence the social structure in the area to a considerable extent by providing food in plenty and employment to many in the field, factories and plants. The US studies show that investment, although large, could yield reasonable profits both from the industry (10%) and the agricultural enterprise (about 20%). Profits apart, the most important change that such an agro-industrial complex can produce in the area is, as stated above, that it provides work for the people and produces food enough not only to sustain the regional population but perhaps to export it to the neighbouring areas.

I shall now attempt to highlight some of the extensive applications of atomic energy in augmenting agricultural productivity and in conserving against agricultural losses. The importance of this can be better appreciated from the fact that there is

- 1) imbalance between agricultural output and increase of population,
- 2) acute fertilizer deficiency, and

- 3) wastage of food-grains and other perishable foods, augmented by inadequate pest control measures.

For the above reasons, the increase in our annual output of food-grains has not outpaced the needs of the increasing population. On the other hand, there is considerable wastage due to plant diseases and rodent ravages in the field and further losses during storage. Some estimates put the losses of food-grains at about 8 million tons per annum in the field in addition to 2 to 3 million tons during storage. The production is also dependent upon the use of disease resistant and high yielding seeds, modern farming practices including adequate use of fertilizers. It has been estimated that we use only 6 to 10 pounds of plant foods per acre compared to about 200 pounds per acre in Japan.

The second problem which needs attention and corrective action is the rapid spoilage of perishable and consumable food. These are caused by the present indifferent methods of harvesting, handling, transportation, and storage of foods, such as vegetables, fruits, sea foods, poultry and other meat products. Their quality as they reach the consumer is often sub-standard. Frozen and cold storage facilities are very meagre.

Atomic energy could be harnessed to meet most of the situations mentioned above and used to increase agricultural produce and improve its stability on storage. In the next few paragraphs an attempt will be made to show how significant progress to the point of practical application is being made in these areas in Trombay during the last five to ten years.

Mutation Breeding: By far the most economically important application of atomic energy to agriculture has been in crop improvement programmes to obtain varieties with better disease resistance, stiffer and shorter straw, better food value and higher yield per acre. Conventional methods of selection and cross breeding are tedious and time-consuming. The breeders set out to select or cross breed new varieties with carefully chosen stocks, but the radiation mutation breeder has to depend upon the random nature of the mutations. However, the latter has the advantage of enhanced mutation rates and therefore greater chances of a rare success.

With the commissioning of the Apsara reactor, two important crop plants, rice and groundnut, were chosen and work started on an exploratory scale to apply radiation to crop improvement. High yielding and promising strains were evolved and released to other research stations for testing. In the rice variety Pattambi, a number of mutants were obtained by neutron irradiation. Three were found to be superior to untreated ones and one of these yielded 45 to 60% more than the original untreated one. Another variety TR 1 was found to come to harvest three weeks earlier than the parent variety. This mutant is now being widely tested in several states.

In the second economic group, groundnuts, a large pod mutant has been isolated. The oil content per unit weight is the same, but since the weight of the kernels is 20 to 40% more at Trombay (20 to 60% more in other centres), the total yield is more. Trials conducted over the last few years have also shown 30 to 40% higher yield over the untreated control.

Grain Disinfestation: It has been mentioned above that another problem in the country is the spoilage of food-grains by pests during storage. In this connection efforts on radiation disinfestation are of special importance. Insects cause considerable loss of stored grain, flour and other cereal products. Chemical fumigation is effective on larval or adult insects, but is not very effective on their eggs. Fumigation has to be repeated to destroy the insects hatched from eggs. On the other hand, gamma radiation has the advantage over chemical fumigation in that it not only destroys the insects, but also sterilizes the eggs and does not leave any toxic residues. For this reason insect sterilization and pest control aspects have received considerable attention at Trombay. Detailed investigations have been carried out on the effects of gamma radiation on various development stages, viz., eggs, larvae and pupae. A feasibility study on grain disinfestation is being carried out with a view to adoption of grain storage methods using gamma radiation in a practical way. For this purpose, two facilities have been recently installed, viz., a 100,000 curie package irradiator and a 28,000 curie through-flow irradiator. The former will be used for fish, fruits and vegetables and has a throughput of 100 pounds per hour while the latter about 500 pounds of grains per hour.

Conservation of Perishable Foods: The enormous potentialities for conservation of a variety of perishable foods through the use of radiation are also noteworthy. The technological aspects of radiation preservation of such foods have been extensively studied and it has been shown that this is a useful and practical process. The main advantages of radiation processing arise from the fact that ionising radiations are lethal to the micro-organisms, parasites and insect pests, and they can be applied without causing appreciable rise in temperature, and, finally, that the products can be packed before exposure to radiation, since the latter are penetrating. Radiation processing also has the advantage that it can be applied to foods in the uncooked state. It is, therefore, clear that preservation of foods by this technique would introduce a new dimension and flexibility into processing, transport, storage, and marketing of foods with many resultant economic advantages.

Co⁶⁰ is used as the radiation source, since it offers the advantage that it is available in adequate quantities from nuclear reactors and will become available in even larger quantities from our nuclear power programme. The gamma rays from this isotope are very penetrative and can therefore

be used for bulk irradiation. The technology associated with its use is now well developed and once the installation with its biological shielding and product conveyor mechanisms are completed, little expert attention will be further required.

Results of food irradiation: As a result of experimentation, it has now been established that meats, such as bacon, ham, chicken and beef, sterilized by irradiation, can be preserved at room temperature for a year with little degradation of quality. Potatoes, onions and garlic can be prevented from sprouting and the shelf-life of a number of varieties of fresh caught fish, fresh fruits and vegetables can be significantly extended. The organisms which cause fruits and berries to rot can be sterilized, resulting in their improved shelf-life. In some cases, besides the above advantages, radiation preservation could result in product improvement.

It has been demonstrated on the basis of long term animal feeding experiments (involving rats, mice, dogs and monkeys), that a wide variety of irradiated foods are safe for human consumption. The study of the effect of radiation on the nutritive value of foods has shown that no losses in the macro nutrients, proteins, carbohydrates and fats occur. Although some decrease in the vitamin content may result, it is not significantly more than in other methods of food processing such as canning, dehydrating and cooking.

Experiments at Trombay have shown that the shelf-life at room temperature of potatoes, onions and garlic could be extended upto 6 to 7 months by use of mild irradiation. The technique has also been used to delay the ripening of mangoes and bananas, thereby spreading their seasonal availability over longer periods under normal storage conditions. Worthy of special mention is the work on Bombay duck, a fish of commercial importance, which in the sea-fresh form does not keep for more than a few hours at room temperature, for 2-3 days when packed in ice, and is not amenable to heat treatment or deep freezing. Mild doses of radiation can extend its shelf-life to three weeks at 10° and to 6 weeks at 0-4°. Similarly, shrimps or prawns can be preserved for 8 to 10 weeks, whereas the untreated ones may spoil in 7 to 10 days. A combination of partial dehydration and radiation processing has also been tried on fish and potatoes with resultant products of excellent texture, colour, flavour, and nutritive value. Such combination processes also offer possibilities of practical adoption. Combination processes using low doses of radiation and mild heat-treatment have also been developed for sterilization of fruits like mangoes, sapotas (chikkoo), gauvas and for peas, resulting in products superior to the normal commercially available ones. Spoilage caused by moulds on bread and chapathies can also be controlled

by gamma radiation and such products have stored well in sealed plastic packages for 10 to 50 days without any spoilage.

On the basis of the work done at Trombay, some cost estimates have also been made and it has been found from the available data that food from radiation processing would not cost more than conventionally processed foods, and that it may actually work out cheaper depending on the scale of operational facilities. While considering costs, it must be borne in mind that the major economic factor is the avoidance of wastage and wider distribution of perishable foods.

Other uses of Isotopes: The use of radiation in the treatment of cancer is already well known. More recently isotopes produced in nuclear reactors have been employed both for diagnosis and treatment of a variety of diseases. One of the very notable examples is in the diagnosis and treatment of thyroid malfunction and goitre. Many other similar uses are now fairly well known and I would not therefore like to go into any details, but I should mention that the recent developments in atomic energy have provided us with a powerful tool for treatment and control of disease, which was unknown until only a few years ago.

More recently isotopes are coming more and more into use in industry, in measuring the flow in rivers and in determining the movement of silt in harbours. Many such investigations have been successfully carried out during recent years in various parts of India with extremely valuable results and saving of large sums of money.

I hope I have been able to impress on you the fact that the more recent developments in atomic energy have a profound influence on the lives and welfare of the society as a whole. They can be harnessed to produce more food and to keep it in storage in a fit condition, to build industries to provide employment to large numbers of people, and in many other ways used for their welfare. These developments, therefore, have an impact on society for the better.

P. S. SUNDARAM

Science and the Classless Society

AT the end of the Third Act of Shelley's *Prometheus Unbound* occurs a description of the world transfigured when Jupiter the Tyrant is liquidated :

The loathsome mask has fallen, the man remains
Sceptreless, free, uncircumscribed, but man
Equal, unclassed, tribeless, and nationless,
Exempt from awe, worship, degree, the King
Over himself ; just, gentle, wise : but man
Passionless ? — no, yet free from guilt or pain,
Which were, for his will made or suffered them,
Nor yet exempt, though ruling them like slaves,
From chance, and death, and mutability,
The clogs of that which else might oversoar
The leftiest star of unascended heaven,
Pinnacled dim in the intense inane.

This is the golden age as conceived by a great poet and idealist—where all men shall be equal, unclassed, tribeless, nationless, exempt from degree. There will be no sceptres, but there will still be Kings—each man king over himself. All men shall be free—but there will still be slaves ; chance and death and mutability which each man shall rule, and keep underfoot. For the problem is eternal : there will always have to be controls. And if external control disappears, all control does not disappear—each man has to control himself.

Does external control create and perpetuate inequality, or is it the fact of inequality which requires a measure of external control ? “Man is

born free," said Rousseau, "and everywhere he is in chains." It is Jefferson who is responsible for the statement—"All men are created equal," a statement he regarded as a sacred and undeniable truth. But are all men created equal? Do heredity and environment have nothing to do in the shaping of the human being? When one of the Murderers tells Macbeth,

"We are men, my liege",

"Ay, in the catalogue ye go for men,"

says Macbeth,

"As hounds and grey-hounds, mongrels, spaniels, curs,
Shoughs, water-rugs and demi-wolves, are clept
All by the name of dogs: the valu'd file
Distinguishes the swift, the slow, the subtle,
The housekeeper, the hunter, every one
According to the gift which bounteous nature
Hath in him clos'd; whereby he does receive
Particular addition, from the bill
That writes then all alike: and so of men."

Does man not belong to the animal kingdom, and is it not true that there are as many differences between man and man as between dog and dog, horse and horse?

There is a great danger to-day that in the name of equality all differences are destroyed and denied. We are so intent on levelling, that if we cannot level up we are quite happy to level down. The concept of the classless society has so permeated our thinking that not only do we want the abolition of every kind of hierarchy—including that of Professor, Reader, Lecturer—but we even want to reduce the number of classes in publishing examination results, imagining that if we abolish the third class in M.A. or M.Sc. we shall thereby solve the unemployment problem, because no one can fail to get a post as a lecturer on the ground that he is only a third class M.A. or M.Sc.¹ In countries admittedly more democratic than ours, e.g. England, there are four classes at Oxford, and nominally three but really five in Cambridge in which the Honours List and the Tripos examination results are announced. We wasted lakhs of rupees in the first flush of independence reclassifying the accommodation in railway travel, narrowing seats, removing bulbs, and finally are back at the old four-fold division which we now call with different names. In Russia, the utopia of classless society, there is not only one single class on the railways.

These changes and choppings in the matter of furniture and upholstery, which are admittedly annoying do not greatly matter. But when an Honours course which picked up the best students and expected them to do in three years what was normally done in four is, in the name of

All-India uniformity, abolished, then the result is certainly serious. Every one cannot afford to send his child to a Public School. Instead of ensuring that the child comes up to a certain level of ability which will fit him for the school and in that case can have his schooling free, we proclaim that the public schools perpetuate inequality, are relics of snobbery and imperialism, and should be abolished. All children do not have the same capacity for learning a foreign language. Instead of trying to find out where the difficulty lies and how it can be removed, we declare that the foreign language is both unnecessary and undesirable, and anyone who learns it is a traitor to the country and should be dealt with accordingly.

As scientists and educationists our first business, I feel, is to clear our minds of cant. Whatever the reason, men have not been created equal and are not in fact equal. Different men have different potentialities and from those to whom much has been given society has a right to expect much. The parable of the talents contains great wisdom, and any community which wants to make the most of its resources must understand the true nature of justice which, Aristotle said long ago, is the expression of proportion.

Everybody except those who themselves want to destroy others has the right to live. I shall not say, like the philosopher mentioned by Rousseau, "I don't see the necessity." Food, clothes, and shelter also have to be given to everyone, and by all means equality of opportunity; but not the same pay or the same status as for the obviously more gifted or useful citizen. This, which should be obvious to any unprejudiced mind, gets in practice to be overlooked more and more in our democratic set-up. The fashionable world today is "frustration", and all kinds of atrocities take place and are permitted to take place because someone or other feels "frustrated" and wants to smash up everything. The decent citizen has been so injected with a feeling of guilt for the maladjustments that exist in society that he thinks it is old fashioned to talk of crime and punishment, authority and respect for law, and sheer mad destruction has become a way of life.

It is time that we started questioning some of the statements that have been repeated as though they contained the quintessence of wisdom. If good government is no substitute for self-government, is self-government a truly adequate substitute for good government? A self-government which is not also good government is to that extent a failure as a government, and only ignorance and sentimentality can see any virtue in failure. When Milton makes his character say, "It is better to reign in hell than serve in heaven", is there any reason for us to assume that the words are not dramatically appropriate, that this is said by Satan, a proud rebel and the personification of evil, and is meant to be in character?

Not only the sages and saints but all truly wise men, poets and philosophers, have recognised the need to surrender to someone obviously wiser than oneself. "In his will is our peace", "Thy will be done". What is wrong with telling our children, "We needs must love the highest when we see it, not Launcelot nor another" ?

The Gītā by which all Hindus swear contains verses which require a lot of glossing over. One of the most inconvenient is the following.

श्रेयान् स्वधर्मो विगुणः परधमोत्स्वन्नुच्छिन्नात् ।
स्वधर्मो निधनं श्रेयः परधर्मो गयावहः ॥

"Better one's own duty, though destitute of merit, than the duty of another well discharged. Better death in the discharge of one's own duty; the duty of another is full of danger."

No one today will seriously suggest that every cobbler should stick to his last, that society should for ever remain stratified:

The rich man in his castle,
The poor man at his gate,
God made them high or lowly,
And ordered their estate.

The desire not only to excel in the particular job you are doing but to go on voyages of discovery in strange seas and unknown lands is as truly God-given as the talent which can make the best out of the circumstances in which it finds itself seems specially God-approved. Indeed the divine spark is more visible in a Keats or a Benjamin Franklin than shall we say, Pitt the Younger or John Stuart Mill. But to say that career must be open to talent is also to acknowledge that there is such a thing as talent. And a well-ordered society is one which encourages every citizen to realise himself.

"Aristocracy" like "nobility" and indeed even the word "gentleman" is a term which no longer evokes admiration or respect. All that is signified by an "aristocrat" is one who was born in a good family and has inherited a lot of wealth or landed property; it is understandable why to a modern man he should symbolise only the idle rich who exploit the poor and cannot live without their labour. But "aristocracy" meant originally government by the best, and was contrasted with "monarchy" on the one hand—rule by one person—and "democracy" on the other, rule by the many. No one to-day believes that landed property or money made in business automatically fits one for rule, and the higher classes are the ones who are the natural leaders of men.² Neither does anyone believe that the Brahmin and the Kshatriya having descended directly from the mouth and the arms of the great Purusha are the repositories for all time to come of all wisdom and strength. But when Plato in his *Re-*

public assumes a natural division of mankind into those who are wise and those who are otherwise not fitted by nature to become philosopher-kings, is he saying something purely mythological and bizarre? When Carlyle in his *Latter Day Pamphlets* talks of a Parliament talking through reporters to Buncombe and “the twentyseven millions mostly fools”, he may for his unchristian contempt be in danger of hell-fire but surely he cannot be accused of falsehood or even exaggeration?

“To be honest as this world goes,” said Hamlet, “is to be one man picked out of ten thousand.” We in India living in a Raj of rations, permits, and licenses know this only too well to our cost. Ability is not less rare than honesty. And to be both able and honest will in the circumstances be one man picked out of ten thousand into ten thousand—an astronomical figure too dizzy for the arithmetic of memory.

A democratic set-up based on the naive assumption that one man is as good as another is in no mood to pick out this rare combination of honesty and ability. Indeed the able man is suspect, and the honest man is an enemy of the people, too good for human nature’s daily food.

“Over the past thirty years, we have made it easier and easier for young people to enter our colleges and universities. We have scattered colleges so liberally that no student need go far for an education. We have lowered the financial barriers in the hope of easing the way for the qualified boy or girl who could not possibly pay for higher education. Many of our institutions have held academic requirements as low as possible in order to salvage talented young people from poor secondary schools, and in the hope that able youngsters who loafed through high school would ‘wake up’ in college.”

This whole paragraph which I have just read, I must hasten to tell you, is not mine. It is taken verbatim from a source which deals not with conditions in our country but in the United States of America. If John W. Gardner in his pursuit of excellence finds the state of affairs in the USA lamentable, what shall we say of the state of affairs here in our country where politicians proclaim their determination to have a college in every village and a university in every district, and the inadequacies of the school are compensated by a progressive reduction in the syllabus and lowering of the minimum marks for a pass or a class in the examinations of the university? We take comfort in the thought that in the initial stages when education is expanding quantitatively and larger and large numbers have to be catered for, quality is bound to be affected: when this phase is over, we shall tighten up standards. But do we really believe that we shall be allowed to do so? It is easier to open a college or a university than to close it, and those who imagine that they can withdraw concessions once granted are living in a paradise of their own.

America, the great land of democracy which has no use for classes, is also the land of the Common Man. Henry Wallace, an American, declared in 1942: "The century on which we are entering can be and must be the century of the Common Man." It is a declaration that sent a shiver down the genteel back of Max Beerbohm. "We are all of us to go down on our knees", says Max, "and clasp our hands and raise our eyes and worship the Common Man. I am not a learned theologian, but I think I am right in saying that this religion has at least the hall-mark of novelty... well, I am an old man, and old men are not ready converts to new religions. This one does not stir my soul. I take some comfort in the fact that its propagators do not seek to bind us to it for ever. 'This', they say, 'is to be the century of the Common Man.' I like to think that on the morning of January the first, in the year 2000, mankind will be free to unclasp its hands and rise from its knees and look about it for some other, and perhaps more rational, form of faith." Sir Max was too impatient: he would have had to wait till 2001 A.D. for the century to end. But knowing the incomparable Max as we do, his wit, his incisiveness, his contempt for claptrap, his aristocratic disdain for the demagogue, his refusal to flatter the man in the street to secure his vote, should we be surprised at the impatience?

Prof. Carl Friedrich, author of *The Image of the Common Man* has been at some pains to explain his conception of the Common Man. His Common Man is not the average man, nor the mass man. He is not the tool of the demagogue or a marionette of passions and prejudices set in motion by interested adventurers. He is best represented by men like Tom Paine and Abraham Lincoln, rational and intelligent people, who are not taken in by the so-called experts and are not unduly impressed by the specialist. Somerset Maugham, a physician turned author, points out that the so-called normal man, all whose limbs and faculties function as they should, is the rarest and therefore the most abnormal of men. Tom Paines and Abraham Lincolns are not as common as blackberries: if they were we should have no problems at all.

America, which asserts that all men are created equal and one man is as good as another, is also the place for private enterprise and unchecked competition. Those who assert that one man is as good as another also say "Let the best man win"—which means that there are degrees in goodness. The desire to look out for and improve quality need not result in any theory of racial superiority, or ruthless destruction of the lesser breeds without the law. All that I am pleading for is a recognition of facts as they are—which is what is expected of scientists and educationists—and the application of the latest discoveries to the improvement of quality. No country today can afford waste, least of all a poor country like ours. And

putting square pegs in round holes on the theory that one peg is as good as another is both wasteful and frustrating, as we are dealing with human materials not dead wood.

Do I want that babies should be produced in test tubes, or human beings conditioned by means of gramophone records or propaganda in the manner set forth in *Brave New World* or in *1984*? No. But I do believe that the human capacity is infinite and the way to get the best out of it is not to mollycoddle it, or feed it on fairy tales, but to confront it with problems that will stretch it to its utmost, and give it the necessary motivation to do the best it can. "On a recent visit to Holland", Gardner says, "my wife asked a Dutchwoman why children and adults in that country showed such an extraordinarily high incidence of language skills. 'We expect it of children', the woman said simply. 'We think it important.'" It is as simple as that.

The relevance of this to our present day problems should be obvious. Things cannot improve in the country unless they improve in the schools and colleges. Even if those who get education are only a minority, there is no need for them to feel that therefore they are of no consequence. "We say a candle burns," say Radhakrishnan, "when actually it is only the wick which is burning"—and only that portion of the wick which is at the top.

Brand Blanshard, sterling Professor Emeritus of Philosophy at Yale University, in a lecture entitled "The Test of a University", says the following:

"We in America have to resist the inverted snobbery that makes the educated man feel uneasy if he is not like everyone else. He is too often afraid that if he uses the language more sensitively than other people, if he interests himself in Eliot's criticism or Barth's theology, if he tries to embody his own taste in his dress or the layout of his house, he will be accused of being 'high hat'. Now education has surely failed if it leaves us like everyone else. Our graduates should not simply dissolve and disappear in the democratic melting pot; they ought to lead in every community, not as a result of their own pushing, but as a result of gravitation to the top by minds and characters that plainly belong there".

Today politics has penetrated every walk of our life, and all initiative seems to have gone to the politician. It is only too tragically true that in the words of Margarret Mead, Associate Curator of Ethnology at the American Museum of Natural History, "political behaviour is very firmly grounded in types of behaviour which are basically emotional, not rational." Our leaders who have to depend upon majority votes prefer always to lead from behind. The password is always the cliché, the acid test the shibboleth. Never more than now has it been necessary for the

educated man to give the country the benefit of his education, for the scientist to proclaim from the house tops what a rational, scientific analysis reveals.

"If everyone gets into the palanquin," runs a Tamil proverb, "who will carry it?" In the twentieth century the palanquin has rightly become the symbol of heartless exploitation, man's inhumanity to man. The railway train of the jet plane has replaced the palanquin. But it is obvious that everyone cannot drive the train or fly the plane. We must have engine drivers and pilots trained for the job.

A government, a municipality, a court, or a school are not less difficult to run than a train or an aeroplane. There is snobbery in the thought that an engine driver is inferior to a Professor. A good engine driver is anyday to be preferred to a bad Professor. "An excellent plumber," to quote Mr. Gardner, "is infinitely more admirable than an incompetent philosopher. The society which scorns excellence in plumbing because plumbing is a humble activity and tolerates shoddiness in philosophy because it is an exalted activity will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water." When I say that a classless society means only anarchy and chaos, I do not mean for a single moment that there will be a hierarchy where the philosopher will always be at the top and the plumber at the bottom, even though their respective predilections may incline them towards the empyrean and the foundations. I only mean that it is absurd to say that all philosophers should be paid alike, and all plumbers paid alike. This paper is a plea for the recognition of the natural inequality of men, of the danger of imagining that levelling is good in itself, of the duty of scientists and educationists to come out into the open and make a stand for reason as against emotion, commonsense as against sentimentality, the values which we have acquired as a result of our education as against those which are more easily marketable among ignorant and selfish men. We must not buy a little security for ourselves by tacitly accepting theories in which we do not believe. Still less, even in the company of a Shelley, should we lose ourselves in the intense inane.

NOTES AND REFERENCES

1. John W. Gardner in his book *Excellence* quotes an American parent finding fault with the so-called democracy where non-students pass and others are made to fail!
2. At the same time there is something to be said for not destroying incentives. Northcote Parkinson in his extremely interesting *Left Luggage* poses the question why it is alright for a man to say, "I am going to be Prime Minister", but entirely wrong for him to have the more modest ambition, "I am going to see that my grandson becomes Prime Minister".

Science, Politics, Political Ideologies and the State

A. APPADORAI

*Power in the Thermo-Nuclear Age*¹

THE key to a rational foreign policy, according to the realist school of which Hans Morgenthau is a well-known exponent, is the concept of interest defined in terms of power. The realist assumes on the evidence of history that statesmen think and act "in terms of interest defined as power". The national interest determining political action in a particular period of history depends, it is granted, upon the political and cultural context within which foreign policy is formulated, and the goals that might be pursued by nations in their foreign policy can run the whole gamut of objectives any nation has ever pursued or might possibly pursue; but basically the pursuit of the national interest, however it may be interpreted by statesmen in charge of the nation's affairs, is the key to the understanding of international relations.

National interest is achieved or sought to be achieved, through the optimum use of power. The content of power "and the manner of its use are determined by the political and cultural environment. Power may comprise anything that establishes and maintains the control of man over man. This power covers all social relationships which serve that end, from physical violence to the most subtle psychological ties by which one mind controls another. Power covers the domination of man by man both when it is disciplined by moral ends and controlled by constitutional safeguards as in western democracies, and when it is that untamed and barbaric force which finds its laws in nothing but its own strength and its sole justification in its aggrandizement".²

Statesmen and the realist thinkers,³ therefore, if they cannot gain pre-

dominant power for the state they come from, give primary attention to the establishment and preservation of a balance of power in international society to prevent another from gaining such predominance. Either objective demands that careful and persistent attention be given to armaments and alliances, so extensively has the power of a large and potentially expansionist part of the world disturbed past equilibrium.

Negotiations and compromise, in this view, are possible and necessary on innumerable matters that do not closely affect the relative power status, but not in a situation likely to disturb the equilibrium of power. Armaments and military alliances, on the one hand, and negotiation and compromise, on the other, are supplementary and not opposed. Ideally, the society of sovereign states should secure peace through a democratic world government, but, in the absence of world government, the balance of power system is the only other way known of distributing power so that it restrains resort to violence. No doubt it is a poor second best, but without it the will to negotiate vanishes when all can freely choose between it and the violent achievement of their ends; the courage to trust disappears when the price of miscalculation is total conquest.

In the context of the use of power in the thermo-nuclear age, with which this paper is concerned, the central question to ask is whether the various elements in power play the same part now, as in the pre-thermo-nuclear age, in the decision making process in foreign policy. Power in the theory of international relations, is the ability of a nation to ensure that other nations act in the desired direction through the compelling pressures⁴ which the former can exercise over the latter; it is a function of three factors, the ability to offer advantages which means a play upon the hope of the nation willing to be influenced, the capacity to make the concerned nation suffer disabilities in the event of unwillingness to act in the desired direction, and in the last resort, to use force (which means a play upon fear) and an appeal to the common interests and ideals of the nations concerned,⁵ or a combination of these. Pakistan might well follow the United States lead because of the hope of getting United States military aid which she could, though not by authorisation, use in getting Kashmir, just as well as India might not like to offend the Soviet Union in the hope of getting continuing Soviet support in the Security Council on the same question; Hungary might decide to continue in the Soviet bloc for fear of being attacked by the Soviet Union if she followed a different line, and Poland might follow the line of the Soviet Union for fear of losing the latter's support in maintaining her present border with East Germany. An open rift between China and the Soviet Union might be avoided even though they have differences, if only because both desire to promote the advance of communism in the world. Britain might be willing to follow

the lead of the United States as, e.g. on the Suez question (1956) because of the hope of economic assistance from the latter (as the classic instance of Marshall aid), because of the fear of losing United States' support in defending herself against a possible attack from the Soviet Union, and because the two nations share the democratic ideal of freedom.

The relative strength of the three elements of power mentioned above—hope, fear, and sense of common interests—depends, it is well known, upon a number of factors: geographical (the size and location of a country, its natural resources and the number of its population), political (the efficiency of the government and, in particular, of its diplomacy), economic (the optimum use of the country's human and natural resources in production, and, in particular, the quality of its technological research), military (the strength of the army, navy and air force) and social (the cohesion among the people).

In this paper, we shall be concerned primarily with the second element, viz., the ability to cause fear as an element of power, i.e., the ability of a nation to influence another by threatening to wage war, and, thereby inducing this fear in the latter, to influence it to follow its lead.

It will be noticed from the statement of the realist position earlier, that it allows for the content of power and the manner of its use to be determined by the political and cultural environment.

Modern war, since the application of air power in the Second World War, differs from earlier wars in two respects. First, it is total: the conduct of war in earlier days was based upon the customarily accepted distinctions between combatants and non-combatants, between belligerents and neutrals, and between the activities of governments and the activities of their subjects. Moreover, as Harris points out,⁶ "the object of the battle was to destroy, not so much the enemy as his power to resist, and it was a commander's aim to do this with the minimum loss not only to his own troops but also to those of the enemy. What he sought to do was to reduce the enemy's forces of men and material just so much as to make him surrender or withdraw. To continue to kill the opposing forces beyond what was necessary for victory was regarded as wasteful and barbarous." With air power developed in the Second World War — with disastrous consequences for the civilian population as well as production centres, not to speak of the effects on military centres, as was shown by the blitz in Britain—it became the aim of the parties in the war to paralyse the opponents with a rain of bombs on all their principal cities, "changing war from conflict directed towards the defeat of an opponent to a conflict of annihilation", no regard being paid to the distinctions between com-

batants and non-combatants, etc. noted at the beginning of this paragraph. War had truly become total—a mobilization of the total resources of the nation with a view to achieving total victory, and war affected every one in the nation in a way which had not been known before.

The second difference is this: modern war is immeasurably more destructive than the earlier wars, some having gone so far as to say that it is capable of destroying mankind.

Since the first atom bombs were dropped on Hiroshima on 6 August, 1945, and on Nagasaki on 9 August, a whole family of nuclear weapons capable of being carried by any type of modern aircraft has been developed, some of them like the hydrogen bomb being 1000 times as powerful as the Hiroshima atom bomb. To quote Einstein (he wrote these words on 12 February, 1950, when the hydrogen bomb was known to be a possibility), “If successful, radioactive poisoning of the atmosphere and hence annihilation of any life on earth has been brought within the range of technical possibilities”.

Thermo-nuclear weapons, according to a member of the United States Atomic Energy Commission, represent an entirely new kind of power: “the atmospheric contamination that results from large thermo-nuclear explosions is serious. In fact, it is so serious that it could be catastrophic. A sufficiently large number of such explosions would render the earth uninhabitable to man. This is plain fact”.⁷

Admitting that the views of such eminent authorities have to be heeded, it may well be argued, as has been argued by the eminent scientist Professor P. M. S. Blackett, that the possession of the hydrogen bomb by both the super powers itself is a deterrent to war (and, therefore, there has been no change in the political environment of the kind suggested in the last few paragraphs):

“I think we should act as if atomic and hydrogen bombs have abolished total war and concentrate over efforts on working out how few atomic bombs and their carriers are required to keep it abolished”.⁸

Quincy Wright, who is an authority on war with his two classic volumes on *The Study of War*, thinks that while the fear of retaliation is an important deterrent, it may not suffice to prevent war if political rivalries continue with mounting tensions; it is “a slender reed to lean upon” and “efforts to achieve national security by exclusive reliance on either military superiority or a military balance are likely to achieve ruin for all”.⁹

There is, no doubt, logic in this, and it may be added, “by an ironical but demonstrable law, nations which have armed themselves to preserve the peace have seldom avoided war”.¹⁰ Hans J. Morgenthau indeed argues in a trenchant analysis¹¹ that nothing in the actual facts warrants

the assumption that an all-out atomic war has become impossible ; on the contrary, "to the extent that we assume the impossibility of an all-out atomic war and act on the assumption, we increase the very possibility of such a war".

The reason is that an atomic stalemate can be such only so long as the two parties who possess the destructive weapons continue always to be equal in their power ; such an assumption can be valid if only technology is stable, but we know for certain that weapon technology is far from stable. And we should also heed the warning contained in the Einstein-Russel statement in July 1955:¹² "Whatever agreements not to use H. Bombs have been reached in time of peace, they would no longer be considered binding in time of war, and both sides would set to work to manufacture H. Bombs as soon as war broke out, for if one side manufactured the bombs and the other did not, the side that manufactured them would inevitably be victorious".

The deliberate starting of an atomic war apart, there is also, admittedly, the danger of an atomic war by accident, miscalculation or failure of communication. A New York Times story in April 1962 shows that the steps taken at various levels, military or political, which might mean a difference between peace and war, have to be taken at a very short notice and accidents can occur. At the peak of the Berlin crisis in November 1961, General Power, Chief of the Strategic Air Command, on account of a false alarm of air attack, had ordered hundreds of nuclear armed bombers into readiness for take-off ; luckily, the situation never reached the point where it was necessary to launch the forces on the ground alert, as, after four minutes, it was discovered that a communications difficulty was the only trouble.

A point relevant to this discussion is the one of limited wars. Korea and Indo-China have shown that in the absence of agreed settlements on major political issues, and so long as those who have nuclear weapons decide not to use them for solving those issues, we may expect a number of wars locally waged, without developing into global all-out wars. A limited war is fought for specific political objectives, with the consequential relation between the force employed and the objectives to be attained ; it does not attempt complete annihilation of the enemy but aims only at specific objectives, and it ends when it seems to the enemy that continued resistance is less useful than accepting the conditions which may be imposed. Though limited wars offer no guarantee against their expansion into all-out wars a mutual reluctance to expand the conflict on account of the fear of local disintegration inherent in all-out wars will be an important factor in preventing them from such expansion. Let us emphasize, however, that this mutual reluctance will be in evidence only so long

as the objectives for which such wars are fought are limited. If, for instance, the Soviet Union considers the whole non-communist world as hostile to it, as indeed she has declared several times, and if she attempts to achieve Marxism-Leninism albeit indirectly, and the other states concerned resist her attempt, the objectives become wider and unlimited. The position must be accepted that any limited war is potentially capable of developing into a general war. The support of Eisenhower, the soldier-statesman, would be sufficient in this regard; "War in our times", he said on April 21, 1956, "has become an anachronism. Whatever the case in the past, war in the future can serve no useful purpose. A war which became general, as *any limited war might*, could only result in the virtual destruction of mankind".

There has been, we suggest, a significant change in environment since 1945 to justify an elaboration of the realist theory in regard to the relative emphasis to be placed now on the three elements—hope, fear, and the sense of common interests of which power is constituted.

The question arises, what effect has the admittedly changed nature of war—not only in degree but in kind—on the content and use of power?

Here the student of international relations, dependent as he is on the published materials and discussions with a few actors in the drama, cannot give a satisfactory answer; only the leading statesmen who have used power can satisfactorily answer it. But the student has before him the results of the statesmen's action or inaction, and these provide an insight into the use of power. In many parts of the world—Korea, Vietnam, Formosa, Kashmir, and Palestine truces and stalemates exist; the final settlement of the problem involved in each of these awaits decisions by the statesmen of the leading countries, and more particularly the USA, the Soviet Union, Britain and China. The vital decisions are not made because they are difficult to make; they involve a calculation of risks involved in the use of force which may lead to a nuclear war, or contentment with the status quo either of which is unsatisfying. The post-war negotiations on Berlin also point to the same difficulty. The Yalta decision to help bring about a unified Germany is one which the Soviet Union considers it vital to prevent; and unless the West is prepared for a global war, it cannot be implemented. Truman was not prepared to risk an all-out war with China—with the Soviet Union likely to intervene on the side of China in 1950 and, therefore, he did not support McArthur's proposal to bomb the mainland of China, and so on.

Time was when war was a continuation of politics by other means, the balance of power was the ruling principle in foreign policy as Churchill

declared as late as 1936. In a sense it still is in those questions which do not touch the vital national interest of the super powers. Clashes could, therefore, occur between Syria and Israel with impunity; India could take Goa, which by justice should belong to her, without fear of a world conflagration, but she took the action—with great pain—when in her judgement, justice could not be secured through diplomacy. Indonesia could order general mobilisation to take West Irian without fear of a nuclear war. In other words, limited war can occasionally occur; but since even limited wars are potentially capable of developing into global wars as soon as the vital interests of the super powers are considered to be affected, caution is exercised by statesmen before they decide to resort to force in order to secure justice. If the United Nations placed equal emphasis on justice, as well as on peace and if, as indeed the Charter contemplated it had real power to enforce its decisions, the situation would have been different; as it is, it has emphasized peace at the expense of justice; and its effective power to maintain peace is, in fact, limited, and hence the trouble.

Two conclusions seem to emerge from this brief survey of post-Hiroshima developments: First, there is a dilemma in foreign policy in the modern world, to use or not to use force, arising from the uncertainties attendant upon the use of force. In a sense such dilemmas have always been there; but the present uncertainties are clearly of a different character due to the changed environment to which reference has been made earlier. The decision-making process in the realm of foreign affairs is impeded by these uncertainties; survival becomes the dominant national interest, though attention has also to be paid to the subsidiary national interests such as boundaries, the maintenance of trade, etc..

Secondly, alternative ways of maintaining national power—by ways other than a threat to use force—become relatively more important, and in particular the use of aid (military and economic) and diplomacy. The first of these falls within the field of the first element of power we mentioned, viz. the ability to offer advantages; the second falls in the field of all the three elements of power, viz. the ability to offer advantages, the ability to create disabilities, and the ability to create mutual interests.

The importance of aid (military and economic) in the foreign relations of recent years is now common knowledge; the following figures should give some idea of the quantities involved. From 1954 to 1961, Soviet aid to the underdeveloped countries of Asia, Africa and South America amounted to \$ 3,800 millions. It has been calculated that between a third and a quarter of Soviet loans are for military purchases, and the balance for industrial, agricultural and other projects in some twenty countries. The United States aid to the underdeveloped countries has been estimated

during the same period at approximately eight times this figure. The political implications of aid of such quantities need not be elaborated.

The growing importance of diplomacy in the changing world has been mentioned earlier: it arises essentially from the fact that force, which in earlier age could be used by most states without danger to survival, cannot to-day be used by any state without such a risk. To use a phrase of Max Lerner (a former colleague of mine), the super powers have a surplus of power which they are not able to use for fear of destroying themselves. The vital issue, then, which is raised by the foregoing analysis, is: Are the techniques of negotiation and other peaceful methods of settlement potentially capable of yielding more successful results than they have yielded so far? War has often been resorted to in the past when peaceful means of adjustment failed; under modern conditions of warfare, can we fall back on the only other alternative available to effect changes of legal rights in order that adjustment of differences is possible and some satisfaction can be obtained by the parties concerned?

Posing the question in this way may surprise orthodox students of international politics as being against the verdict of history; indeed it may be considered naive, as human nature. Such a view, I suggest would be hasty and unhistorical. The world's attention is unfortunately focussed more on the differences which have arisen between states, and less on the agreements which have been arrived at. It would, historically, be correct to say that more differences have been settled by discussion and agreement than by resorting to war; the records of the day-to-day activities in the chancelleries of the world, if available to the student, would substantiate this view. To take a few examples from recent history: truces (not peace agreements) have been secured in Korea, Indo-China and Kashmir; some progress has been achieved in nuclear disarmament, the principle of international control and inspection being also accepted by the Soviet Union after years of negotiation; the Austrian treaty has been signed. Coming nearer home, France agreed to transfer to India her possessions in India, India agreeing to safeguard for protection of French culture in those territories. The canal water dispute between India and Pakistan has been settled; and differences between the two countries over border adjustments have also been successfully resolved.¹³

The question naturally arises, what explains the fact that some success has been achieved by negotiation in these instances? The anatomy of negotiations suggests that when two or more parties disagree on a question, two factors play a part in resolving their differences, one, the fear on the part of any party to the dispute that superior force might be used to settle the difference, and the other, the sense of accommodation which suggests that while its own vital interest must be safeguarded considera-

tion must also be given to the interests of the other party or parties. It is not easy to isolate these two factors and say which has played the greater part in the final settlement of the differences at issue: there are too many variables to be taken into account in assessing the sources of fear of force on the one hand, and the sense of accommodation on the other. Thus force is a function of several factors: geographical position, economic resources, the strength of the government and the leaders in power, diplomatic finesse, armaments, alliances and the morale of the people of the country in question; the sense of accommodation is a compound of the innate sense of justice, the desire to placate public opinion at home and abroad, and the desire to have some stability in the settlement to be arrived at. These apart, another factor in the situation, invariably, is conflicting interpretations of the facts in question; this acts as a sort of brake on the willingness to use force, and as an ally to the sense of accommodation.

If this analysis is correct, it follows that where negotiations have been successful, the sense of accommodation has played a greater part than the possession by one side of superior power, and that where negotiations have not been successful, the reverse has been the case; the sense of accommodation is itself affected by the extent of the interest that the protagonists attach to the issue in dispute. Equality in power has been more favourable to negotiation than efforts of each to attain superiority in power.

In sum, the essence of an approach to successful negotiation through history, has been for each party to be prepared to settle the differences in such a manner that none of the parties suffers a significant loss; for only then would the result be stable;¹⁴ this is integral to true negotiation as such. This tradition is explicitly mentioned in the Indian epic, the *Mahabharata* when Sri Krishna was about to proceed for negotiations to bring about a settlement between the Pandavas and Kaurus, he summarised the object of his mission in the following words:¹⁵

“Yes, I will go to King Dhritarashtra, desirous of accomplishing what is consistent with righteousness, what may be beneficial to us and what also is for the good of the Kaurus.”

It is remarkable that a distinguished international jurist of the seventeenth century Gentili should have taken the same approach:

“In general it may be true in nearly every kind of dispute that neither of the two disputants is unjust”. A distinguished contemporary historian, Herbert Butterfield of Cambridge, has traced the root cause of conflict to the pride and wilfulness of the parties which make them ignore the half-right in the other. (He said “While there is battle and hatred men have eyes for nothing save the fact that the enemy is the cause of all the

troubles ; but long, long afterwards, when all passion has been spent, the historian often sees that it was a conflict between one half-right that was perhaps too wilful, and another half-right that was perhaps too proud".)

We suggest that the tradition referred to above has been the universal tradition, not always consistently followed but nevertheless more often followed by negotiations in every country than statesmen are prepared to admit. The willingness to submit a dispute to a third-party judgement, as may be seen in the numerous cases referred to arbitration, can be explained only by the existence in the disputants of that spirit of accommodation and of willingness to see the other man's point of view which is so essential in order to avoid a breakdown. The Indian emphasis on negotiation as a way to peace only highlights a well-known technique and its utility in the atomic age. Indeed, there is room for research on how to improve the techniques of negotiation and other peaceful methods of settlement so that they may yield the desired results. In a remarkable article contributed to *Diplomacy in a Changing World*.¹⁶ Dag Hammarskjöld writes that in the diplomacy of the world organisation "the quiet work of preparing the ground, of accommodation of interest and view point, of conciliation and mediation, all that goes into the winning of consent to agreed solutions and common programmes thus forms a basis upon which the United Nations can become an increasingly influential and effective force", and again, "we can register efforts to give such diplomacy the support of firmer procedures".

It is true that, in the past, negotiation has not always succeeded and hence wars have occurred so often ; wars in the modern age must be avoided if mankind is to survive ; can we, then, from a study of cases of negotiation both successful and unsuccessful, evolve general principles as to the conditions under which negotiation has been successful and can in future be successful ?

NOTES AND REFERENCES

1. This paper restricts itself to power in international relations.
2. Hans Morgenthau, *Politics among Nations*, Third Edition, New York, 1960, p. 9.
3. See, Alan De Russet in *International Relations*, April, 1959.
4. Compelling pressure is, in the last resort, exercised by the use of physical violence. This must not be taken to mean that the holders of power always want to resort to force to achieve their objectives. As G. Schwarzenberger notes (*Power Politics*, Stevens & Sons Limited, 1964, p. 14) power is distinguished from force by preference for achieving its end without the actual use of physical

- pressure. Indeed, the holders of power would prefer to achieve their ends by the use of means other than physical violence—by persuasion and by giving aid, for instance. But, it must be emphasized, the distinguishing mark of power is that its holders have force in the background and are prepared to use it, as a last resort, to gain their objectives.
5. Hans G. Morgenthau in *op. cit.*, p. 29, lists the sources of power as the expectation of benefits, the fear of disadvantages, and the respect or love for men or institutions. The present writer would prefer to term the third source as indicated in the text.
 6. Errol E. Harris, *The Survival of Political Man*, Johannesburg, 1950, p. 5.
 7. Thomas E. Murray: See, the *New York Times*, International Edition, 18 November, 1955.
 8. P. M. S. Blackett, *Atomic Weapons and East-West Relations*, Cambridge, 1956, p. 100.
 9. *Problems of Stability and Progress in International Relations*, University of California Press, 1954, pp. 312, 330.
 10. Raymond B. Fosdick in *New York Times Magazine*, 19 December 1948, p. 35.
 11. *Bulletin of the Atomic Scientists*, Vol. XII, p. 9.
 12. *Keesing's Contemporary Archives*, 1955-56, p. 14305.
 13. There are, of course, innumerable instances to illustrate the reverse of the picture, viz., that differences have not always been adjusted, the delay in coming to terms on disarmament, Berlin, the continuing dispute in respect of the treatment of racial minorities especially in South Africa, the trouble over the use of the Suez Canal by Israeli ships, the failure of the Summit Conference over the issue of America's sending the U-2 plane over Soviet Union and so on.
 14. This statement excludes stable results achieved by means of war, e.g. war did settle the relation between Britain and the thirteen American colonies more or less on a stable basis.
 15. The *Mahābhārata* (translated into English prose) by Pratapchandra Roy, Udyoga Parva, Calcutta, 1890, p. 256.
 16. Dag Hammarskjöld, "The Role of the United Nations" in *Diplomacy in a Changing World*, edited by Stephen D. Kertezc and M. A. Fitzsimons, (University of Notre Dame Press, 1959). In support, Hammarskjöld cites three instances viz., agreement on peaceful uses of atomic energy and agreement on the details concerning the operation of the United Nations Emergency Force arrived at by government representatives sitting as members of Advisory Committees to the Secretary-General and discussing in private, and the agreement among the foreign ministers of France, the United Kingdom and Egypt on the Security Council issue in 1956, discussing the issue in private in the office of the Secretary-General.

G. P. CHATTERJEE

Atom and Man

PROJECT your mind upto the bygone ages, unto that dim distant past, when somewhere in the vast regions of space, whirling and spinning clouds of cosmic particles—particles of matter and particles of energy—electrons, protons and photons—started coiling, clustering and forming “eddies” of glowing lumps of spinning galaxies of million billion stars. One among the many, the sun was born, with the solar disc spinning wobbling and eventually condensing into blazing balls of fire, into glowing comets, planets and moons. One among the many, this world was born.

The tiny electrons, spinning round the still more tiny nucleus build the atom. Atoms build molecules. Molecules build all that eventually build this world. The tiny atom, the apparently lifeless atom, builds the living molecule and the cell that builds the unicellular amoeba and eventually the multicellular Man.

Man sees, feels and thinks. From the world of atom to the world of thought is a chain of events that man, with his limited senses but almost unlimited vision, attempts to see, to feel and to understand—to understand not only the atom and the world around him, not only to understand his body but the spirit that dwells within it.

Against this metaphysical background stands the physical fact that the universe—the world of non-living matter as well as living organism—is made up of but one fundamental entity—which in the absence of a suitable word, we call the “field”—a field that may manifest itself as particles of matter (electrons, protons, neutrons and so on) and a field that may manifest itself as particles of energy (photons, phonons, magnons and so on).

All kinds of phenomena in the objective world around man and in the subjective world within him are but results of reactions between particles of matter and particles of energy—in other words reactions between different manifestations of “fields”. All kinds of behaviour of the non-living world as well as living organism, including man, are governed to a large extent by the nature of the reactions in this field, the nature of the behaviour of a few typical atoms located in the molecule of periodic lattice of non-living matter or in the “aperiodic” lattice or molecule of living organism.

The atom is tiny compared to man and so is man compared to the cosmos. Man is important and so is the atom. Within the tiny world of atom, man sees to-day a new universe, a new “micro-cosmos” as it were—the growing understanding of which has helped and will continue to help man to get a greater insight into the structure and behaviour of non-living matter, into the structure and behaviour of living organism and eventually may help him to have a glimpse into the structure and behaviour of man himself.

The word “atom” originates from “a” meaning “not” and “tom” meaning “to cut”. In other words, by atom one normally means a substance which cannot be cut or subdivided into simpler substances. This was the concept of atom even upto the beginning of the present century, when nobody could think that an atom could be broken into two or more pieces. Nor could anybody imagine that one type of atom could be transformed into some other kind. But Rutherford in 1916 first succeeded in transforming mercury into gold and, like a bolt from the blue, a completely different picture of the atom burst into view. The spectacular discoveries regarding the atom, its structure and behaviour, are without any parallel in the history of science.

An atom to-day is visualized like a miniature solar system with a small extremely tiny positively charged central nucleus consisting of “nucleons”—some of which are positively charged and called “protons” and some are neutral called “neutrons”. Round the nucleus revolve negative electrons in different rings or orbits much like the planets revolving round the sun. Compared to the planets the sun is extremely heavy. Compared to the planetary electrons, which revolve round it, the nucleus is also extremely heavy. In fact, the simplest nucleus, the nucleus of hydrogen, is about 1,850 times heavier than a single electron. Without the sun there will be no life in any of its planets. Without the nucleus similarly no life could have evolved in the present form. However, compared to the planets, the sun is very large and is a symbol of manifested

energy. In contrast to this, the nucleus does not apparently and ordinarily radiate energy and is extremely small.

If a drop of water was magnified to the size of the earth, its atoms would be no larger than a tennis ball. But the nuclei would still remain too small to be seen. If this tennis ball be again magnified one hundred thousand times, and if one imagines the nucleus to be of the size of a tennis ball, the atom will be like the entire size of a large city. In spite of this infinitesimal size, man today, armed with various equipment, has been able to enlarge the limits of his physical senses—in breadth and in depth—and probably knows more about the “atom” than he knows about himself.

Atoms are the fundamental building blocks of the entire universe. They existed millions and millions of years ago much before the present age, called the Atomic age, and will continue to exist in future years independent of any biological time as Nature knows it, or of any physical and artificial time as man knows it. Being one of the essential units of existence itself, the atom will exist as long as this creation exists. All kinds of evolutions may come and go but atoms will go on for ever.

Apart from this philosophical background, the atom is important because, although we do not see it anywhere, it exists practically everywhere, builds practically everything in the universe including the human body. To keep the body fit and active and to prevent it from decay or premature death, man is asked to take good food, drink good water and breathe good air. He is also asked to form good habits to be able to live a healthy, long, and happy life.

The question may be asked, what has the atom to do with all these? The answer is that at the base of all actions (eating, drinking, breathing, working, sleeping, thinking, and even praying and other actions), and at the base of all events that take place within and without the human body, atoms come into the picture at every instance and at every stage. In fact, the behaviour of only a few atoms often determines the whole pattern of future events in large-scale phenomena. It is the behaviour of only a few atoms, for example, at the moment of starting a chain reaction in an atom bomb, that determines ultimately the exact amount of energy released from the explosion of that bomb. It is the behaviour of only a few atoms that is responsible for gene mutation which eventually determines the pattern of the entire future chain of evolutionary process. All patterns of human behaviour—scientific or emotional—are governed ultimately by the behaviour of a few typical atoms in some of the essential organs and coordinating systems of the human organism, affecting its body as well as its mind. It is the behaviour of a few atoms that determines the

pattern of human thinking which eventually determines the direction of his desires, his actions, his evolution, his destiny on the planet.

The atom is important to-day for another reason. Extremely tiny and apparently insignificant, the atom is the storehouse of a vast amount of energy. By some mechanism, yet unknown, colossal quanta of energy, that would otherwise have spelled death and destruction, if given the opportunity to unfold and manifest itself, somehow get condensed into the tiny nucleus and lay dormant in that tiny world doing something we do not know what. This lack of knowledge, this colossal ignorance, however, has provided man with the necessary urge to know more about the atom. And in his attempt to know more, to unveil the mystery, man eventually discovered the clue to unfold this colossal dormant energy which, to this utter grief, he finds today seriously set against himself. The tiny atom awakened by his scientific touch, he finds, to his utter dismay, to rise up as a hungry menacing monster ready to annihilate himself and his civilization, and reduce all these back to atoms from which they eventually evolved. The battle between Atom and Man will be won by man in so far as he is capable of expanding the frontiers—the frontiers of his knowledge not only to know more about the atom which eventually created him, but to know more about himself.

Man to-day sees within the atom a new universe, a new “microcosmos”, infinitesimally small but infinitely fascinating. For the first time in the history of science it is the study of the tiny atom which has shaken the mighty superstructure of classical laws of science. All scientific laws have so far been based on the granite foundations of the Law of Causality and the Law of Continuity. The Laws about the atom and its behaviour for the first time departed radically from determinism. It is the study of the atom which revealed for the first time that absolute truth about Nature is “unknowable” in principle. The so-called exact sciences do not and cannot reveal the exact truth about Nature, but reveal merely the truth born out of interaction between Man and Nature, the interaction between the observer and the observed. The atom for the first time unfolds this new conception—this new philosophy of scientific truth.

It is for the revelation of this new philosophy that the study of the atom is still more important to-day, because, apart from being the physico-chemical basis of life and living processes, the atom to-day has opened up new frontiers to man in his search for the physico-chemical basis of mind, nay even for the physico-chemical basis of the human spirit.

The world of atom is a queer microscopic nebulous world in which are fused both the Relativistic Laws of Einstein and the Quantum Laws of

Dirac and Heisenberg, and yet which does not obey mathematically any one of these laws or any other law so far discovered by man. The atom with its nucleus is still a great mystery—the tiny little world almost completely unknown. In fact, for the first time in the history of science, the nucleus threatens to be even the “unknowable”. This is a great challenge which has set man to think and search deeply and seriously. Probably out of such thought would emerge not only the unified field theory of matter and radiation, not only a unified philosophy to understand the atom and its nature but to understand man—not only his body but his mind—nay even the spirit that permeates it.

A highly complex living organism, man is made up of nearly a million billion cells and a billion trillion (10^{21}) atoms and molecules and something more, yet a mystery. Man classifies the molecules as (i) inorganic, and (ii) organic.

Organic molecules are woven around that wonderful atom—the atom of carbon. Carbon is wonderful because of its almost infinite capacity to ‘polymerise’ and ‘isomerise’, that is, to combine with one another almost an infinite number of times and almost in an infinite number of ways.

The unusual capacity to polymerise and to isomerise enables carbon not only to form a large number of compounds but highly complex compounds with high specificities leading eventually to a molecule that mediates—a molecule that receives, retains and radiates messages in coded molecular alphabets. In this task, carbon is assisted by another wonderful atom, the atom of hydrogen, the primordial atom from which in fact Nature has synthesised all other atoms.

With atoms of energy (photons) emanating from the sun and atoms of matter viz., Hydrogen (H), Carbon (C), Oxygen (O) and Nitrogen (N), Nature synthesises compounds called ‘amino-acids’. Amino acids polymerise to form ‘protein’—the primary constituent of all living organisms.

Amino-acids are of two types—the ‘Levo’ or the L-type and ‘Dextro’ or the D-type, one being the mirror image of the other.

But for a few rare proteins (of fungal and bacterial origin), all forms of life (plant as well as animal), all forms of living organisms, from amoeba to man, due to some mysterious reasons, contain proteins built from L-amino-acids only. Why should nature prefer so predominantly the spin of the ‘Levo’ type, is yet a mystery. May be that primordial yet everlasting spin in the cosmic cloud of particles of matter and particles of energy, that everlasting ‘spin’ in the ‘field’ of the universe in general, from the spinning galaxies and stars in the vast depth of space to the spinning electrons in

the tiny orbits of the atom, left no option for the atom of carbon but to spin and weave the amino-acids as they are, viz., predominantly, the 'Levo' way in unison with the universe.

Proteins are giant polymers containing hundreds and often thousands of 'amino-acids'. Their primary purpose is to provide for almost all the essential functions of life—be it the virus or the man. The differences in the properties of proteins and therefore the behaviour of the organism are fundamentally due to the difference in the distributions of masses and charges both in magnitude and in orientations particularly on their surfaces. Thus the behaviour of the organism is profoundly affected by surface properties and initiated or inhibited by a process which we call 'catalysis' brought about by 'enzymes' and 'co-enzymes', which are crucially connected with the control of speed and quality of reactions responsible for the life and living process from the simple amoeba to the complex man.

Proteins with some other atoms are tailored by nature into protoplasm, which is a viscous 'Colloidal Sol' containing proteins, carbohydrates, liquids and salts dispersed and/or dissolved in water. The specific compositions and structures of the proteins present in protoplasm determine the differentiations of tissues within the same species or the differentiations in different species.

Atoms of C, H, O and N build amino-acids. Hundreds and sometimes thousands of amino-acids link together to form proteins. Atoms of C, H, O and N and P build what are called 'nucleotides'. Hundreds and thousands of nucleotides link together to form 'Nucleic acid'.

Proteins and Nucleic acids combine to form Nucleo-protein. A 'gene' which may be looked upon as the 'heredity unit' within the cell-nucleus is a nucleoprotein. It is Nature's micro-store house of almost infinite memory of hundreds and thousands of previous lives lived through the ages. This almost miraculous task is performed by the "nucleic-acid", part of the nucleoprotein, the 'gene'.

The nucleic acid (of which the most important is Deoxy-Nucleic-Acid called DNA) appears to be the ultimate seed of life. It is a living molecule in which are concealed in coded atomic alphabets, the experiences and thoughts of hundreds and thousands of lives through which the stream of evolution has passed through millions of years. Depending on its structure the DNA is the source and the seed of all forms of life. It is indeed a miraculous molecule, a living laboratory in which Nature works out all forms of life—all forms of plants and animals—all forms of living organisms including man, just from one single cell.

What is an atom? What is an electron? Or for that matter, what is

matter? These questions cannot be satisfactorily answered in human language. All that man can do in his attempt to understand matter is to set up a chain of coefficients in his quantum-mechanical laws and equations. But neither the coefficients nor the equations exist in Nature as such. "It has become increasingly evident in recent times, however", said Prof. P. A. M. Dirac, the Nobel Laureate in Physics, "that Nature works on a different plan. Her fundamental laws do not govern the world as it appears in our mental picture without introducing irrelevances." Thus Nature herself is an enigma. Man, a small but significant part of nature, is no less so.

Man is not only a community of cells, fibres and fluids, not only a body dissected by the anatomist but a balanced blend of atoms and aspirations, aspirations born out of an amazing community of atoms attempting not merely to build a body but a mind and a spirit that dwells within it.

A scientist knows that with the proper eye-piece in the microscope he can see the details—the many beautiful details of the material object. The inner details of man—the real image of the "self"—can similarly be observed if the correct eye-piece be put in the mental optical path.

There has been great advances in many of the frontiers of physical sciences from the tiny world of the atom to the vast depths of space. But none could match some of the spectacular discoveries that have been made in recent years in the science of man, in microbiology, in the world of microcosmos from which man evolves and into which again man reposes in a climate of almost complete rest, leading towards life extraordinary—a life divine. Certainly there is a metaphysical base to this life. But when such a life is lived, it is all physics, it is all science, it is all discipline.

There is no doubt that the present age of the atom and space, the present age of Relativity and Quantum, leads man eventually to a frontier where there is no escape from the realisation that apart from the physico-chemical basis of the human body and of the mind, man eventually has to be interpreted in terms of the science of human Ethics, of human spirit.

We say "Science" of human Ethics. Because Ethics is no less a basic science than all other basic sciences—Physics, Chemistry or Mathematics. Science is discipline. Ethics is more so. Science attempts to understand the nature of the "external" world around us. Ethics is an endeavour to understand the 'internal' world within us—an endeavour towards "self-realisation": Science deals with "reactions" and "responses". Ethics goes a step further—"reactions" "responses" and then "revelations"—revelations of the relation between Man and Nature—revelation of the "summum-bonum"—the highest goodness.

Man is made up of atoms—atoms of matter and atoms of energy. In his endeavour to know the atom is born the revelation—the wonderful revela-

tion that matter is not the master and that man's highest aspiration is certainly not to be in bondage to matter.

A decade ago the atom was an invisible particle taking part in physico-chemical reaction, and, if necessary, could cause chemical explosions. The picture is completely different to-day. The atom, of course, as before is extremely tiny. The nucleus within the atom is very much more tiny but very much more mighty. Within it lies dormant an energy that could virtually vaporise all—metal, man, and his machines. Man could hardly play politics with such atom.

Never before in the history of mankind did man possess such a potential source of power from the atom—an atom that could on the one hand usher in peace and plenty on this planet and eventually lead mankind to his ultimate destiny—"Divinity", the divine life, or on the other hand, lead him to discord, distraction and eventual death in a dreadful and dreary radio-active wasteland.

This is the lesson the atom seems to teach us. "Man must abolish the Atomic-Arm before that Arm abolishes man". This signal warning from the Atom beckons man to search and research not merely the Atom but the "Atman"—his inner "self".

Faith to get to know the atom through science, through the path of reason has indeed been a great adventure. It has opened up the frontiers to a faith so as to overcome that atom and get to know the inner self—the inner voice, as it were, that remains the only guide, when reason can go no further.

It is the physics of the atom that can eventually help man to weave the metaphysics of man, his mind and his spirit. The atom can do man this great service, nay even more. The atom can lead man towards a way of life away from that atom—from the world of atom to a world of thought—a world of "light and self-existent bliss"—a world divine on this worldly planet for man to live in plenty and in peace.

In the evolutionary scale man has today reached a stage where his spirit seeks to transcend the limits of his activities merely in the gross physical plane. His body however—the crude matter that it is made up of—sets him spinning round atoms of matter, round atoms of energy, round his debit and his credit, round his world of "ego", isolated from the world of "values". In such a world of conflict, man's future to-day depends on how far the physics of his intangible spirit triumphs over the physics of his tangible body—how far mind triumphs over matter, how far man triumphs over atom.

K. P. KARUNAKARAN

Reason and Faith in Gandhi's Political Thought

THERE are many scholars who consider that Gandhi's political ideas did not belong to the modern age. Criticisms of Gandhi from this viewpoint were heard in India and elsewhere when Gandhi was the most prominent leader in the country. Poets like Tagore and political leaders like Nehru were some of those who expressed the view that there were some unscientific and non-scientific elements in Gandhi's political thought. But Nehru accepted Gandhi's leadership when the Mahatma was alive, and when he was gone, he began to propagate his views. It seemed that even those who disagreed with Gandhi's method of reasoning, felt that his conclusions were relevant to our times. There are also scholars who consider that only leaders like Gandhi can now save humanity from destruction.

Gandhi himself made apparently contradictory statements on reason and faith. There was no doubt that some of them annoyed those Indians who thought that they subscribed to a rationalist philosophy and believed in the concept that man and the world were governed by rational laws which human reason was able to understand amply.

To take one instance. Emphasising the limitations of reason, Gandhi once said: "Experience has humbled me enough to let me realise the specific limitations of reason. Just as matter misplaced becomes dirt reason misused becomes lunacy". While expounding the supremacy of faith Gandhi said: "There are subjects where reason cannot take us far and we have to accept things on faith. Faith then does not contradict reason, but transcends it. Faith is the kind of sixth sense which works in cases which are without the purview of reason". It is this reference

to the sixth sense which many though had no relevance to the modern age.

Very often Gandhi made a vague reference to faith, but occasionally he made specific mention of faith in God and related it to political action. When he was asked whether those who did not believe in God could not be Satyagrahis, he replied: "I am afraid not. For a Satyagrahi has no other stay but God, and he who has any other stay or depends on any other help cannot offer Satyagraha. He may be a passive resister, non-cooperator and so on, but not a true Satyagrahi".

One of the most controversial statements of Gandhi was that the earthquake of Bihar was God's punishment to the people for the practice of untouchability. Among others, Tagore and Nehru protested against this statement. Tagore warned against the consequences of this observation, and added: "It is all the more unfortunate because this kind of unscientific view of things is too readily accepted by a large section of our countrymen. I keenly feel the indignity of it when I am compelled to utter a truism in asserting that physical catastrophes have their inevitable and exclusive origin in certain combinations of physical facts If we associate ethical principles with cosmic phenomena, we shall have to admit that human nature is morally superior to providence that preaches its lessons in good behaviour in orgies of the worst behaviour possible". Gandhi did not relent. In his reply he said: "I admit my utter ignorance of the working of the laws of nature. But even as I cannot help believing in God though I am unable to prove His existence to the sceptics, in like manner, I cannot prove of the connection of the sin of untouchability with the Bihar visitation even though the connection is instinctively felt by me".

Gandhi often resorted to fast to achieve political aims, to facilitate social reforms and to promote communal harmony. Gandhi undertook a fast in 1933 "as a self-purificatory process" for inducing in the workers connected with the Harijan movement purer spirit of service. Nehru commented: "Again I watched the emotional upheaval in the country during the fast, and I wondered more and more if this was the right method in politics. It seemed to be sheer revivalism and clear thinking had not a ghost of chance against it. All India, or most of it, stared reverently at the Mahatma and expected him to perform miracle after miracle and put an end to untouchability and get Swaraj and so on—and did precious little itself. And Gandhiji did not encourage others to think; his insistence was only on purity and sacrifice".

Thus we note that both in regard to his political action and the campaign for social reforms, Gandhi did make statements which were not in the spirit of scientific enquiry or critical reason.

Gandhi often justified some of his major decisions on the ground that

God's ways were inscrutable. He regrettedly claimed that he heard an inner voice. Explaining it he said: "For me the voice of God, of conscience, of truth or the Inner Voice means one and the same thing. I saw no form. I have never tried, for I have always believed God to be without form. But what I did hear was like a voice from afar and yet quite clear. It was as unmistakable as some human voice definitely speaking to me and irresistibly. The hearing of the voice was preceded by a terrible struggle within me. Suddenly the voice came upon me. I listened, made certain that it was the voice, and the struggle ceased".

Like most people, who heard such voice Gandhi admitted that he could not prove his claim of hearing such voices. Commenting on such experiences, the author of the book, *A Religious outlook for Modern Man*, observes: "Once the soul has been illumined, it can never view mundane existence as it did before. It now has knowledge rather than belief, certainty rather than faith, and life is henceforward viewed in the perspective given to it by the glimpse of underlying reality. As soon as religion leaves the subjective level, exposition of the new outlook to others has to wrestle with the problem of communication. How can the ineffable truth be presented to others who have not known this illumination? I cannot, except by symbols, and the most powerful symbol is the illumined person of the Founder". In Gandhi's case, the most powerful symbol was himself and he became the Mahatma — the Great Soul.

But he also has to make use of other symbols. Fasting and prayer meetings were some of them. Others were expressions such as Ram Rajya. Many of these symbols took into account the sentiments and perhaps even the prejudices of the people, particularly of the Hindus. And his influence among the Hindu masses to whom one could not reach by any other means of communication was remarkable.

Prayers, fasting, and days of silence Gandhi used not only as symbols but for self-purification. These ascetic practice gave him a self-discipline and tremendous power of concentration. And perhaps it is with this power of concentration that he intuitively came to some conclusions, which he referred to, as his Inner Voice. And as Bernard Shaw says in his preface to the play, *Saint Joan*, "There are people in the world whose imagination is so vivid that when they have an idea it comes to them as audible voice sometimes uttered by a visible figure. . . The inspirations and intuitions and unconsciously reasoned conclusions of a genius sometimes assume similar conclusions What is more, the visionary method of making the discovery would not be a whit miraculous than the normal method. The test of sanity is not the normality of the method but the reasonableness of the discovery". If the test is applied to Gandhi's actions, one cannot ignore the fact that very often they were more effective than the normal

methods of others in solving some problems and in tackling some issues. The most striking examples are Gandhi's fasts after the achievement of India's independence, in Calcutta and New Delhi to reduce communal riots. Pointing attention to Gandhi's success in promoting communal harmony in Calcutta where he fasted, Lord Mountbatten wrote to Gandhi: "In the Punjab we have 55,000 soldiers in our hands. In Bengal our forces consist of one man, and there is no rioting". Gandhi was the One Man Boundary Force which Mountbatten was referring to, and his chief weapon was the fast he undertook.

There is one major difference between Gandhi's inner voice and the revelation associated with some prophets and saints. There was nothing absolute in Gandhi's utterances. His life itself was an "Experiment with Truth". He declared: "I claim no infallibility. I am conscious of having made Himalayan blunders. I have never made a fetish of consistency. I am a votary of truth and I must say that what I feel and think at a given moment on the question, without regard, to what I may have said before on it As my vision gets clearer, my views must grow clearer, with daily practice".

Gandhi appealed to people not to turn Gandhism into sectarianism. He opposed the erection of his statues, the establishment of temples to him and all attempts to deify him. "There is no such thing as Gandhism and I do not want to leave any sect after me. I do not claim to have originated any new principle or doctrine". According to Vinobha Bhave, Gandhi repeatedly said: "Do not be authority-bound. Use your own talent".

There are many other statements of Gandhi which convey the impression that Gandhi wanted critical examination of scriptures, and that he was not prepared to accept blindly the rights of the so-called scholars and priests to interpret them.

Once he said: "My Rama, the Rama of our prayers, is not the historical Rama, the son of Dashratha, the king of Ayodhya. He is the eternal, the unborn, the one without a second". When someone asked him whether he felt the presence of living Christ, he replied: "If it is the historical Jesus surnamed Christ you refer to, I must say I do not. If it is adjective signifying one of the names of God, then I must say I do feel the presence of God. . . call him Christ, call him Krishna, call him Rama". On another occasion he said: "While I have dealt with Gurus as historical personages about whose existence we have trustworthy records, I have no knowledge that Krishna of the Mahabharata ever lived".

His approach to the *Bhagvad Gītā* was also unique. He did not think that it contained the literal utterances of God. On the other hand he maintained: "It is pre-eminently a description of the duel that goes on in our own hearts. The divine author has used a historical incident for incul-

cating the lesson of doing one's duty even at the peril of one's life". With this approach it was not difficult for Gandhi to reach the following conclusion: "The Vedas, the Upanishads, the Smritis, the Puranas and the Itihas did not arise at one and the same time. Each grew out of the necessities of particular periods, and, therefore, they seem to conflict with one another". Referring to the *Mahabharata*, Gandhi said: "To me Mahabharata is a profoundly religious book, largely allegorical, in no way meant to be a historical record".

Gandhi recognised that Hinduism, as it was practised, had not condemned war as Gandhi did, and he admitted that what he had tried to do was "to put a new but natural and logical interpretation upon the whole teaching of the Gita and the spirit of Hinduism".

This combination of faith and reason is present in Gandhi's utterances relating to non-violence. Even before Gandhi, many great men had advocated non-violent method of resistance to what they considered to be evil and injustice, and some of them practised them on an individual basis. But it was Gandhi who first provided the leadership for the use of non-violent methods in political struggles on a mass scale. And he provided a theory for it also. But there are two trends in Gandhi's thought on this matter—one connecting non-violence with religion and faith in God, and another emphasising the practical implications of the use of non-violent methods. He observed: "In the last resort it (non-violence) does not avail to those who do not possess a living faith in the God of Love".

But he often appealed to his followers to adopt non-violence on the ground that it was the law of the human race, and that it was more effective than violent methods were in achieving the objectives of freedom struggles. He maintained that "Non-violence is without exception superior to violence i.e., the power at the disposal of a non-violent person is always greater than he would have if he was violent". He also said: "A mere belief in Ahimsa... will not do. It should be intelligent and creative. If intellect plays a large part in the field of violence, I hold that it plays a larger part in the field of non-violence".

Gandhi was always aware of the strength of force implied in passive resistance and non-cooperation movements. He described it as love-force or soul-force: nevertheless it was force—in his own words, "indestructible force".

One British Viceroy could easily perceive the element of force in Gandhi's political campaigns. Addressing the Legislative Assembly he said: "The leaders of the Congress believe in what is generally known as direct action, which is an example of the application of force to the problems of politics The fact that the force applied is as a rule not physical force, in no way

alters the essential characteristic of the attitude which at the present moment inspires the Congress policy”.

Gandhi provided actions which were forceful and effective. As any military commander, he was conscious of the strategy and tactics of warfare, and he knew when to withdraw and when to advance. That was why he was justified in his claim that he was not a visionary, but a practical idealist. He knew that while non-violence was a creed to him, to most Congressmen it was only a policy. But he felt that even if the non-violent methods of struggle were adopted as a policy, it had some advantages. That was why he led the Congress party's non-violent struggles.

Gandhi told the All India Congress Committee once, “Ahimsa with me is a creed, the breath of my life. But it is never as a creed that I placed it before India, or for that matter before anyone else except in casual informal talks. I placed it before the Congress as a political method, to be employed for the solution of political questions As a political method it can always be changed, modified, altered, even given up in preference to another”.

As Professor Nirmal Kumar Bose, who was a close associate of Gandhi, notes: “Once a correspondent asked Gandhi why he tried to execute his political plans through the Indian National Congress rather than through an organisation of likeminded men which he could found himself. His answer was his association with the Congress helped it in its practice of “collective non-violence”. If he wanted to enlist only those who believed in non-violence as a creed, he might end with himself. It was much more important that he should not travel alone, but rather in the company of men who were more or less like him”.

Pyarelal, a close associate of Gandhi, wrote: “In Gandhiji, the prophet and the practical statesman met. The prophet has his eyes on the ultimate, the practical statesman on the immediate. When the latter in him came to the fore, he became the leader of men, the unquestioned general who led the hosts to victory; when the former prevailed, he became the ‘voice in the wilderness’ biding his time. Sometimes the two converged on a point of time or an event. He then performed miracles single-handed”.

When Gandhi explains in the following words the bearing of his religion on social life, even those who are not religiously inclined will not quarrel with him: “Realisation of Truth is impossible without a complete merging of oneself in, and identification with, this limitless ocean of life. Hence, for me, there is no escape from social service, there is no happiness on earth beyond or apart from it”. Elsewhere Gandhi stated that the desire for *Moksha* was the root and not the fruit. For the true (individual) itself the chief concern might be the root. “But society was concerned with the

fruit alone. It had no other data for judgment than the fruits. Was not a tree judged by its fruits?"

These were the aspects of Gandhi's thought which made tremendous appeal to the modern people in India when he led them and to many people inside and outside India even to-day. It is true that occasionally he laid stress on faith and almost demanded his authority should be accepted. But these were rare. Generally his appeal was to reason. As Nehru reports: "He attracted people, but it was ultimately intellectual conviction that brought them to him and kept them there. They did not agree with his philosophy of life, or even with many of his ideas. Often they did not understand him. But the action that he proposed was something tangible which could be understood and appreciated intellectually". He expounded his philosophy of non-violence on the ground that it was more effective and forceful than violent methods. He consistently maintained that his religion gave him inspiration to work for the society. He never accepted the authority of the scriptures and always claimed the right to interpret them on the basis of his intellect and reason. And he also admitted that he was occasionally wrong. He gave the same right to others to critically examine the religious scriptures and his own observations. He did not accept the exclusive right of the priests to interpret scriptures.

According to Gandhi all religious scriptures had the stamp of their times and it was natural that some of the views expressed in one scripture occasionally conflicted with those expressed in another.

Rama, Krishna, Jesus Christ, and others mentioned in the religious books were, according to Gandhi, not historical personages or incarnations and sons of God, but the creations of great writers and they were only symbols.

There is nothing in such an approach towards religion which goes against the spirit of the thought of modern man who has a scientific approach towards life.

One of the recent writers on Gandhi described his philosophy of action as New Machiavellism and added: "The New Machiavellism, although it is moral and functional — or perhaps because it is moral *and* functional — retains the old Machiavellian secret of serving its end by the most useful and the most direct means, by means which are this time also the most honourable The new Machiavellism is more than a concern for effectiveness and more than a concern for morality. It is a concern for the alliance of the two, for discerning effectiveness on morality and morality in effectiveness, for pointing out the connecting link between them and making it effective".

Historians like Toynbee and philosophers like Bertrand Russell are reaching more or less the same conclusions as men of action like Gandhi and Martin Luther King have done in regard to the disastrous consequences

of the use of violent methods in the modern period. While the leaders, who had to carry masses of people with them, had to take into account their heredity and attachment to certain symbols, the intellectuals could try to convince others on the basis of their logic and argument. But that does not mean that their aims are different. The means they were suggesting for the achievement of some of the ends were different. Even these differences are gradually being reduced in the Atomic Era because of the risks involved in the use of the so-called practical methods, which included the use of force and which may lead to the destruction of mankind.

C. S. RAO

Science and Politics and their Influence on Social Progress

THE onset of the industrial revolution in the West in the latter part of the 18th century ushered in the era of mechanisation in industry consequent upon the development of steam power, and this in turn led to the creation of a new class in society, viz., the industrial labour class, which, with progress in industrialisation, assumed a more and more dominant role not only in the shaping of social thought and progress but also of the economic policy, political actions, and even the destinies of the nations concerned. With phenomenal advance in science and in its application during the 19th and the 20th centuries, engineering and technology have made such rapid strides in the recent decades that they have revolutionised not only industry in general but also almost every phase of human endeavour, life and thought. Science has succeeded in shattering the atom and utilising the energy so released for the development of lethal weapons, a few of which can possibly destroy the entire human race. The same energy can also be utilised for useful purposes in the service of man. Science has also helped to bring the nations closer and nearer by making travel extremely faster. In fact, time is close at hand when man may succeed in landing on the outer planets by means of space-crafts that are being developed. Man has synthesised new materials that can replace natural products, and we are already in an era where synthetic fibres are helping to clothe mankind more and more. Synthetic drugs have helped to combat diseases. Modern warfare has become more and more sophisticated and is now as much a concern of the backroom-scientist as it is of the front-line soldier. Examples like this can be multiplied *ad infinitum* to illustrate that we are living today in an age

of science and technology which condition our way of living and thinking, as, after all, man's views are guided by his habits which in turn are moulded and influenced by his environment.

Social progress is continuous and is dependent at any period on the way of life and the mode of living of the community, and the way of life is moulded by the material environment, religious outlook, and human values. We have traversed quite a long distance from the time when human society consisted of small primitive groups, living more or less in isolation, to a stage when the whole human race can be truly considered as a single entity because of the annihilation of space by science and technology. Nevertheless, the often-dreamt of utopia of a world society and a world government is probably far off, and it is difficult to predict what is likely to happen tomorrow, if we keep in mind the unhealthy race for supremacy that is going on between the more advanced nations of the world. This is one aspect of the situation ; the other presents a complexity of problems that exist between the developed nations of the world on one side, and the developing and the backward nations on the other. It may be, therefore, more appropriate to consider the influence of these major developments in science and technology as far as they affect us in India, and to what extent the political condition in the country affects the full utilisation of the results of scientific researches and technical developments for the betterment of our society and economy.

SCIENCE AND THE STATE

(a) *Education* : There is no gainsaying the fact that the political doctrines and policies of the Government of the country do affect the way of life and the conditions of living of the people of the country. In a totalitarian state, individual freedom is entirely subordinated to the interests of the state, while in a democracy individual initiative and freedom are allowed to a very large extent to have their full play. Even then, certain aspects of social thought and progress are conditioned by the over-all political decisions of the government in power. While it is recognised that in a scientific age there must be adequate popular understanding and appreciation of the benefits of science in every day life, this understanding and appreciation can only be created by mass education at all levels. In spite of worth while efforts that have been made in our country since independence to spread education at all levels, the economic condition of a large part of the population have not helped to achieve this end to the maximum degree possible. On the other hand, in a totalitarian state like China, this mass education has achieved much more rapid progress during the last two decades. Apart from this factor, there is yet another vital consideration that is still responsible for the lack of full appreciation of the benefits of science and

technology in our country, and this is due to the persisting effects of conservatism, tradition, dogma and superstition that prevail amongst the less educated and uneducated majority of the people, for tradition and science are often opposed to each other, and the latter is nothing if not revolution, innovation, and change.

While we are on the subject of education it may be perhaps pertinent to refer to the raging controversy now going on regarding the medium of education in schools, colleges and universities, and the Government's language policy which is behind this controversy. As far as scientific and technological education is concerned and the concomitant effort needed for scientific research and technological development, there is no denying the well-known fact that none of the Indian languages including Hindi, is in a position to replace English effectively for a long time to come. As most of the world's scientific literature, including even the text books on science and technology, are available in English, there cannot be room for sentiment in this aspect in trying to abolish English or assign it a place where it is no longer useful, if we are to forge ahead and make our own contributions both in scientific research and technological development and take our rightful place in the comity of the more advanced nations of the world in this regard. This is one instance where, in spite of being a democracy, the political decisions of the Government have an effect on scientific and technological education in the country that is detrimental to the larger interests of the nation. It is perhaps unfortunate that this is happening today in spite of the laudable scientific policy resolution adopted by our Government about a decade ago in the days of the late Prime Minister Nehru. It may be argued that this resolution still represents the fundamental policy of the Government of the country, but if its effective implementation is retarded or otherwise adversely affected by subsequent decisions of the same Government, then the very purpose is defeated, and we may have to pay for it bitterly later on.

(b) *Nuclear Energy*: To take another example of how the country's politics affects scientific and technological development, the Government of India, as a matter of policy, has taken a decision to utilise nuclear power for peaceful uses only, and to that end the necessary scientific and technological effort is being directed. This no doubt is a praise-worthy decision and there cannot be two opinions about it either, if we are living in a world where every other scientifically advanced country is similarly motivated. As it is, quite a few powers including one of our aggressively-minded neighbours have developed weapons of destruction utilising atomic power, and whether all these lethal devices will only be kept in cold storage for all time to come or whether or not some madcap at some stage will think of unleashing these weapons for the destruction of mankind, nobody can

foretell ; but the possibility and the risk are there. In the circumstances, opinion is naturally divided amongst political leaders whether we should also enter the armaments race in the nuclear field or merely adopt a pacifist and peaceful role. The current decision of our Government not to be a party to the nuclear non-proliferation treaty is also a political decision bearing on the above issue.

(c) *Automation* : Yet another instance where governmental policies and political decisions affect the adoption of sophisticated scientific devices is the case of automation in industry and for a variety of other labour-saving purposes. Controversy on this subject has been going on in our country for sometime past. A discussion on this subject has also been taking place in Great Britain, although for different reasons. In India, ours is a labour-intensive economy afflicted by a staggering degree of unemployment. In an affluent society like that of the United States of America, automation has all the advantages in the saving of labour and increase of production at a cheaper cost with resulting rise in the national output. Scientific devices and their enlargement and adoption to various aspects of human endeavour result in more leisure and comfort leading to a happier living all around. But in a country like ours, where the economy is in doldrums and where the vast majority of the population do not even have the bare necessities of life and where mass poverty and unemployment are dominant factors that require to be at least ameliorated, if not totally eradicated, we cannot probably think of implementing automation on a large scale or even on a small scale, let alone the benefits that may otherwise result therefrom. Such an aspect need not necessarily disappoint us when we bear in mind the example of Japan, where even highly sophisticated industries like the electronics industry have been successfully organised on the basis of the maximum utilisation of human labour. We too have to adopt, therefore, even capital-intensive technologies in preference to labour-intensive methods by the development of the necessary techniques. We cannot just copy blindly what others have done. We can certainly benefit from the knowledge and experience acquired by others, but should utilise their technical know-how and expertise, even when we pay for them, in a manner suitable to our own local conditions and environment.

(d) *Agriculture* : A further instance of the impact of science on human effort is in the all-important field of agriculture. Here also tradition and traditional methods of agriculture have largely played their part so far in limiting the output from land. Governmental policies and assistance in this regard have been fortunately trying to combat this state of affairs by education and propaganda, so that more and more agriculturists are now trying to reap the benefits of better irrigation facilities provided by the state and are achieving considerably higher output by the use of fertilisers, pesticides,

insecticides, high-yielding varieties of seeds, rotation of crops, and so on. There is yet another important factor based on the land policy of the state which, by avoiding fragmentation of holdings and encouraging cooperative farming, can further help production in this vital sector of the country's economy.

(e) *Defence*: In respect of defence needs by way of sophisticated weapons and equipment which were mostly provided by imports till a few years back and to some extent even now, the State had taken action soon after independence to initiate the necessary steps to attain the maximum degree of self-sufficiency as early as possible. To this end, a number of Defence Research & Development Laboratories have been established with a view to designing and developing new weapons and equipment to meet the specific climatic and environmental needs of Indian operational conditions, to provide the necessary technical support to defence industries by evolving the manufacturing know-how for existing items of equipment where it is not available, to carry out research and investigations on problems peculiar to the conditions in which our fighting forces may have to operate, as, for example, those relating to mountain-warfare, desert conditions, tropical atmosphere, physiological and psychological factors relating to these conditions, and so on. We have also expanded our industrial potential and capabilities both in the defence and other public sector factories as well as in the private sector, with a view to meeting the ever-increasing and diversified requirements of the Armed Forces. Whether the level of achievement and the directional and organisational effort put in so far are commensurate with the investment in money, manpower and equipment made for the purpose, are matters on which difference of opinion is liable to exist. Nevertheless, in an area which is directly linked to the security of the country, there cannot be two opinions about the imperative necessity to achieve the maximum degree of self-sufficiency with the utmost speed, and the State has the full responsibility to provide the wherewithal by which this can be attained.

(f) *Industry*: Similarly, the Government has established a chain of national laboratories to provide the necessary base and support for the development and growth of Indian industries so that they can evolve the technical know-how, investigate the utilisation of indigenous materials, develop new processes and establish production up to the pilot plant stage, design equipment and help industries in the maximum utilisation of the results of their research and development activities. Here, again, the gap between expectation and achievement appears to be very wide. Whether this shortfall is due to the conservatism and apathy of industrialists, whether it is due to the high-brow, over-bearing and unsympathetic attitude of the scientists themselves at times, whether it is because of the missing link in

the chain which would translate a laboratory technique into practicable and economically sound production technology, whether adequate machinery exists to establish that intimate liaison and coordination between the laboratories and the industry which alone can bring forth results, are matters of divergent opinions. Whatever may be the reason or reasons responsible for the none-too-satisfactory state of affairs, the Government has the responsibility to put the house in order by eliminating the existing lacunae in organisational set-up and deficiencies in functioning. The main consideration in this, as well as in similar conditions, is that no government, irrespective of its political complexion, can afford to ignore the important role of science and the applications of science in the interests of the security of the country, the industrial strength of the nation, the well-being and prosperity of its people.

With regard to the scientific policy to be adopted in this country, divergent views are sometimes expressed as to whether greater emphasis should be laid on research in pure sciences or on applied research and technical development activities. While it is no doubt true that fundamental research can and should be pursued in universities and academic institutions so as to provide the necessary scientific capabilities to the personnel trained in these institutions, the crying need of the moment of a developing country like ours should be obviously research in applied sciences and technical and technological developmental effort, for the latter have a definite aim and clear-cut objective. As Prof. Blackett, Nobel Laureate and President of the Royal Society of England, recently said in his Nehru Memorial Lecture, "the present poverty is great and the task of dealing with a rapidly rising population is so formidable that almost everything must be sacrificed to economic growth. Economic growth is not everything, but today in India it is almost everything".

The acid test of all scientific research and developmental activity in the country today is the answer to the question: to what extent does it help promote the economy of our country? With our limited resources we may not be able to run elaborate schools of fundamental research which are quite expensive, although there is no reason why the universities and similar academic institutions which are the principal centres of basic research should not continue to carry out their activities in the highest traditions of international standards. But it stands to reason, in the light of our immediate needs and objectives, that the emphasis should be on the development of technical competence within the country so that the results achieved can be applied immediately to better and more production both in industry and agriculture, so that the country prospers and the standard of living of the common man rapidly rises, for, in the ultimate analysis, what else can be the role of science but to improve human welfare and make human

society richer and happier? Notwithstanding these considerations, it is unfortunate that the existing policy of the Government of the country in the CSIR does not permit the allocation of development grants to industry for the production of new items of equipment not so far manufactured in India, although such grants for basic research are allowed. As an applied scientist, who has made some worthwhile contributions to the development of defence science and established a new line of activity with a major Research & Development Institution to pursue the same, the author is of the opinion that such policies need to be quickly changed in the interests of the country. As Dr. Atma Ram rightly stated in his presidential address to the last Indian Science Congress: "It is time we had a clear statement of technological policy as we have of science and industrial policies".

Such a policy statement may act as a spurt for increased activity on research and development of applied sciences and technology, thereby enabling the country to forge ahead in the development of its economy. To quote further some relevant extracts from the above address: "The developmental strategy for India should consist of three essential elements: comprehensive survey of our physical resources and their exploitation, encouragement to capital formation and enterprise, and development of human resources. It is simultaneous progress in all these fields which can make our country really rich. Of these, the development of human resources is pivotal. Economic growth needs capital, technological and economic know-how, managerial ability, modern industrial skills and the will to work hard. Except capital, all these relate to human resources.... Inflow of capital and assistance from abroad in various forms can at best be a catalyst. Unless forces are generated within the country based on scientific and technical skills, entrepreneurial talents and forward looking social attitudes, we will not be able to have the proper infra-structure of development.... If investment in physical resources pays off, investment in human resources pays off many times over. Human resources development is not merely education, though education plays an important part. Education provides the basis on which we have to build a super-structure of skills and capabilities which transform physical resources into wealth. The training of scientists and technologists and engineers, technicians and craftsmen, managerial and administrative personnel and a host of professional and non-professional men of skills is essential for the growth of the nation. Have we adequately tackled the problem of development of skills, competence and capabilities which produce wealth?"

It is the obvious responsibility of the State to meet the challenge of the situation. Notwithstanding everything that the Government may do to fulfil its obligations in the matter, and even if all the physical resources for the successful development of the country's economy are somehow made avail-

able, results can only come forth if a sense of national urgency permeates the mind of the people, and the right attitude of mind, where national interest takes precedence over everything else, is developed in all concerned, if the will to work hard for the country, irrespective of individual gains, pervades all through the mass of the country's population; in short, if national character is built up on the right lines.

In this connection, the author is reminded of a personal conversation he had with one of the top executives of a leading West German concern in Munich a few years back. The German said: "After the last world war German cities were in ruins and German industries were completely destroyed. People did not have two square meals a day or even fuel to keep warm, but we were not cowed down by the disaster. The whole nation rose to the occasion as one man and every able bodied person put in an average of not less than 70 hours of work per week without observing even Sundays as holidays, because we firmly believe that 'work is wealth' and work we did to produce national wealth. And this is now we are back again in the forefront of industrial achievement and progress in the world of today." This is the kind of spirit that should prevail throughout the country if we are to achieve the well-being of its people from the present deplorable state of want and poverty that prevails almost everywhere. Let us at least try to provide the basic wants of every human being by way of food, clothing and shelter, before we think of desirable amenities of life, like a telephone and a television set in every home or a motor car for every family. Science and the scientists can help a great deal in the achievement of this desideratum, if properly harnessed and directed.

In a parliamentary democracy like ours, which is wedded to the exploitation of science and the scientists for the national good as a matter of policy, legislators and law makers naturally get more and more involved in affairs of science and have therefore to be themselves adequately briefed and advised in matters of science and scientific policy by specialists in the sciences, if right decisions are to be taken and right policies implemented. Thus, it is necessary for the scientists and parliamentarians to come together in closer contact; and the scientists themselves thereby come to play a part in the government of the country. Here it is not the opinion of one scientist, however eminent he may be, that should really matter in framing governmental policies, but it must be the representative opinion of a body of scientists of learned societies in the respective fields of endeavour, as is being done in some of the more advanced countries, like Great Britain. Such a procedure, coupled with mass education on the benefits of science through audio-visual aids, like the cinema, radio and television, will create the proper climate with popular backing for the effective implementation of State policies in this regard.

With the spread of scientific education and the creation of a large number of national laboratories, defence laboratories and numerous other scientific institutions and departments in the country, the employment potential for scientists has tremendously gone up. Apart from the industrial labour class, we have now what may be called the scientific worker class of society, as science offers both a career and a social status. The scientific worker is, therefore, often prone to think that he belongs to a privileged class of society and is entitled to special treatment and better amenities of life. This class consciousness may in turn result in a lop-sided view of things on the part of this class of people, unless they are made to realise that they have a definite role to play in fostering the country's economy and that the national interest which they should evince in fulfilling their task is the sole criterion by which they are judged by society, as all kinds of knowledge and skills are equally important and necessary for its integrated development. It is, therefore, necessary that healthy traditions should be set up amongst this class of people; and that in this respect proper advice, guidance, and leadership should be forthcoming from the various scientific and other professional bodies that look after their interests, and that the seniormost scientists in responsible positions should also provide these guidelines to the men working under them.

When all is said and done, we, in this land of a rich and ancient tradition and culture which produced modern political saints like Mahatma Gandhi, have to build up our institutions and society on lines which do not clash with the salient features of that culture. In any society interdependence between the individual and the society exists, as one has no place without the other. In fact, individual interests should be normally subordinated to those of the society. Truth and non-violence are the basic tenets of Gandhiji's teachings, both in respect of individual behaviour and social behaviour, as also in respect of the duty of the State. The attainment of self-sufficiency and dignity of human labour are yet other issues on which the Father of the Nation laid emphasis in his teachings to the people. The emphasis on 'swadeshi' movement and the teaching of simple arts and crafts as part of the basic education at the primary stage by Gandhiji was meant to promote the 'swadeshi' spirit as well as to achieve self-sufficiency in respect of the elementary needs of the people. The 'swadeshi' spirit has been more or less given the go by in the country today, while truth and non-violence as the basic tenets of life and behaviour seem to have been equally forgotten. This is an unfortunate state of affairs, because even if we advance materially and reach a level of prosperity comparable to that of the more prosperous nations of the West, without the proper appreciation of human values and the development of national character based on ethical principles, we shall not be living in a happy world.

Ours may be a secular state, but this does not preclude the teaching of ethics common to all world religions as part of the education at the impressionable age of the younger generation. Two major world wars have created a sense of cheapness of human life in men's minds. This has to be combated by proper education, if society is to achieve its aim of balanced development in all respects. The State has a moral responsibility in this aspect as it has in developing the country's economy. Let us hope that we in India at least will develop our economy and our society on balanced lines where the spiritual values receive equal prominence with simultaneous advancement in the material sphere, so that our country can be an oasis in a world torn with strife and unhealthy competition for supremacy and power.

Science, Art, Religion
and Philosophy

MULK RAJ ANAND

Relation of Art and Science

THE drama of conflict of the cultures of science and the humanities has been unfolded in recent years by Sir Charles Snow in his Rede Lecture at Cambridge. This British intellectual was thinking in terms of the antagonism which has arisen between the two branches of human knowledge and experience in the post-renaissance period in the west. As an ex-colony of the British Empire, schooled in an education system, devised in the English language over a hundred years ago, to bring India into the orbit of Imperial culture, we have, of course, inherited the two antinomies of science and humanities which Sir Charles speaks about.

Apart, however, from this basic contradiction, it may be found that in the peculiar circumstances of India, there are other conflicts between science and the various residual cultures which have come down from the 'age of the gods', to the 'age of criticism'. In our civilisation there have been and are many cultures, almost all poised against the very concept of science today. There is the culture of the dominant mystical philosophies which suspects science of trying to destroy the God-soul. There are the cultures of the main ritualistic religions which abhor science for recommending clear thinking and cleanliness. There is the culture of hagiology which prophesies that science is doomed as man's fate is already fixed by the stars. There is the culture which considers the metaphor of the Bulbul and the rose to be superior to the laboratory formula, even though the other may have a poetry of its own. There are the various hangovers of magical and superstitious feudal, folk and aboriginal cultures, which prefer the myths built on the older magics to the contemporary myth of the new magic which

is science. There is the culture of traditional art which regards the beauty of harmony to be the only beauty, and rejects with contempt the beauty of constructivism, function, form and mathematics.

Neither in the west nor in India, however, have these cultures been always opposed to each other.

I would like to point that, in the earliest parts of world history, all cultures being based on the struggle for existence against a hostile nature, began to operate, from the compulsion in the human metabolism, to create such conditions as may enable man to master his environment. And this creative urge from the human centre has been in action, in all civilisations, sometimes hindered by uncongenial political and social orders, then obstructed by the prolonged wars of self-aggrandisement of powerful tyrants and potentates, often prevented from effective expression through the ignorance, sloth, neglect, decay, and suicidal tendencies implicit in the minor causalities within the fundamental socio-economic causalities. Always, however, in renascent periods, there has been the attempt at integration through the reassertion of the capacity of man to control his destiny. And the advanceguard of all civilisation has sought to include the various developments of knowledge in the various cultures, into a *single realm*, over which man must remain supreme if the species called *homo-sapiens* is to survive in the midst of the still unabsorbed nature and conquer man's own dangerous weaknesses and aberrations, in order to usher in a future of relative balance, to render possible a just distribution of the potential plenty of the earth and other planets, and to seek some kind of harmony in man himself within the dynamic universe.

The task of integration of the different, highly specialised, and complex awarenesses of man in the contemporary period, when there has been a phenomenal multiplication of ascertained facts and adumbrations of the inner worlds, of faculty and experience, seems well-nigh impossible and beset with extraordinary difficulties.

And yet it is important, in view of the possible trend towards a one world culture (provided there is no atomic war), to relate all the disciplines, so that a *synthesis* may begin, side by side with *analysis*, and make for an emphasis on the necessity for the emergence of the whole man, radiating a sense of solidarity and fraternisation with other men, in the common pursuit of the renewal of consciousness and acceptance of the new revolutionary hypothesis, for examination, before any possible assimilations can take place.

This kind of attempt at synthesis may alone end the schisms, the bitter-nesses and divisions, and lead to the trend for the inclusion of all inquiry, knowledge and experience within the orbit of what I may call a comprehensive historical humanism, which can accept the most intense heritage of

the whole of mankind into the body-soul of unitary man, provided they have relevance to his present needs and interests.

In such an essay, there is no mere sentimental pleading for goodwill, but the belief that the postulates which have enabled man to make the most enormous strides in the acquisition of knowledge will compel acceptance of new truths of the sciences and the arts. In fact, our approach is towards the most relentless examination of the fundamentals of science, based on reason, and the nuances of experience, which are rooted in the most delicate feelings, intuitions and apperceptions, so that we are able to trace everything back to the sources of man's creativeness and relate the seeming contrarities.

What, then, are the sources of creativeness in man?

The answer to this question has seldom been attempted, because, in the intricate mesh of the complex civilisations and cultures, the fundamental postulates have been obscured by the ancillary phenomena.

But, if we look at the earliest beginnings, it is quite clear that the first urges of man were to survive in the midst of hostile nature, which meant just to find food, shelter, group life, then to define conduct in elementary ethics and politics, and later to seek the gods, from the deep urges of perfection of all the physical and spiritual faculties. Therefore, the sources of creativeness may be said to lie in man's endeavour to find the means of production. And ever since the beginnings of human civilisation, the various forms of production have determined his consciousness, except that the subtle ideas, tools and activities generated through the ages have often propelled the body-soul to link history with evolutionary phenomena. The very names we have given to the various prehistoric and historical periods, such as the Stone Age, the Bronze Age, the Machine Age, the Atomic Age, indicate the obsession of man with the attempt to provide the wherewithal of life on this earth and in the worlds beyond, to produce goods and services, to cater to his human needs and interests.

The other urge that has possessed man, above the animals, of the elemental gift of curiosity, so that he has always been trying to find out things about the universe which surrounds him, to enable him to control the organic and inorganic constituents of life. And, although the various energies, both physical and spiritual, which he uses to satisfy his curiosity, have not always been highly informed, man's instincts have often become the basis of his ideas, his knowledge of facts, and have led, in the most accomplished men of imagination, to the cultivation of faculties of the most all-embracing character, marked by depths and intensities of awareness, which have enabled gifted individuals to make new universes of discourse and to control as well as to interpret the environment.

And the tradition of all the built-in residual knowledge of the various

human orders of the ages, has been passed on by rote, or in documents of creative art, symbol and science, augmented by each successive genii, or by a whole social order, involving the co-operative efforts of gifted individuals.

The necessity of finding the means of production leads the curiosity to increase knowledge, to become possessed of the desire for beauty, which seeks absorption of vitalities in the body-soul. The development of reason, and the integration of all human experience, itself compels the 'bodying forth of the forms of things unknown' through the imagination. And these processes force man ever to seek the sources of his own creativeness in the attempt at self-perfection.

If this indication of the creative process is at all suggestive of the total nature of the inspiration behind man's endeavours, which include the various disciplines of the humanities and the sciences, then the present-day antagonism between the various cultures, may be resolved, to some extent, by the reassertion of a fact, which is visible in the past, and, which is obvious in spite of the specialism of today, the inner drive of man, at his intensest, always to be a whole man, requiring as total a comprehension of his destiny in the universe as possible.

This urge for wholeness was not possible when primitive man was fighting raw nature only to satisfy his basic needs, though in his attempt to survive, even on the most elementary plane, he developed an instinctive grasp of the methods for controlling the hostile forces around him. For instance, our remote ancestors not only made the elementary tools of stone but thump-thumped on the earth and enacted the kill of the beast in a crude dance, to a one-two-three beat, and thus laid the basis of dance, poetry and music, which were to grow later into the most intricate art forms.

Similarly, the hunches of early man about ensuring privacy, rest, adequate conditions of work, and even immortality, led to the evolution of tools, which society accepted as steps to enable itself to live a more total life. In fact, the replenishing of worldly goods, the increase of happiness as against pain, the securing of conditions which might free man from slavery to the limited routine processes of the older societies, the continual urge to improve tools, techniques and methods of inquiry, as well as the variety of metaphorical poetical knowledge, led to the earliest experiments. And this may be called the beginnings of science.

But where the means of production were controlled by a group, a priestly oligarchy, or a single monarch, or a national group, the improvements on the design for living was not uniform and was thus often frustrated in various societies. There were long periods of oppression in which the discovery of a new fact, an idea, or a truth, led the routine men, who had vested interests of one kind or another and who protected the accepted

customs, conventions and faiths against the flow of life, to kill the new discoverers.

Sometimes, the ruling circles were themselves in need of help, as in warfare, or building forts, palaces and a good life, and then they patronised the inventors, the philosophers, and the craftsmen. In this way, the tradition of scientific inquiry shifted from one part of the world to the other. And the presence of surplus wealth, either from the loot of conquest, or from more plentiful production of goods, led to the subsidisation of philosophical inquiries. Although patronage was never consistent with growth, it may generally be conceded that the civilisations of Egypt, Babylon, Sumeria, China, Persia, India, Greece, before the Christian era, initiated many advances, which later led to high achievements in the sciences and arts of Islamic Arabia, Renaissance Italy, Holland, Spain, France, and industrial Britain.

The emphasis on the total personality of man, by and large, in most civilisations of the world, until the 18th century made for a certain unity among the several branches of human knowledge. The various inquiries of the old ages seem to be conducted so as to answer the question of human destiny on the planet called the earth, in relation to other planets and stars and sun and moon, to enable man to assimilate the fruits of the earth, air and water. The methods of solving questions about the origin of life, of its ultimate destination, of the harrowing pain of existence, of the body-soul internal imbalances, through nature's cruelties, through the evil of other men rooted in self-aggrandisement, and through millions of hopes and despairs, led to new methods of inquiry, which were more or less similar. In fact all knowledge has been acquired by man for some purpose, for use in extending the range of human life, both in the struggle against outer environments and the intricate metabolism, through continuous observation, examination and assimilation of fact, idea and feeling.

In this sense, for long centuries, the inquiring attitude remained implicit in all forms of utterance. Notice, for instance, the *Hymn of Creation* in the R̥g-Veda, obviously spoken by a poet-philosopher who wishes to comprehend all knowledge:

Hymn of Creation

1. Non-being then existed not nor being:
There was no air, nor sky that is beyond it.
What was concealed? Wherein? In whose protection?
And was there deep unfathomable water?
2. Death then existed not nor life immortal;
Of neither night nor day was any token.
By its inherent force the One breathed windless:
No other thing than that beyond existed.

3. Darkness there was at first by darkness hidden ;
Without distinctive marks, this all was water.
That which, becoming, by the void was covered,
That one by force of heat came into being.
4. Desire entered the One in the beginning :
It was the earliest seed, of thought the product.
The sages searching in their hearts with wisdom,
Found out the bond of being in not being.
5. Their ray extended light across the darkness :
But was the One above or was it under?
Creative force was there, and fertile power :
Below was energy, above was impulse.
6. Who knows for certain? Who shall here declare it?
Whence was it born, and whence came this creation?
The gods were born after this world's creation :
Then who can know from whence it has arisen?
7. None knoweth whence creation has arisen ;
And whether he has or has not produced it :
He who surveys it in the highest heaven,
He only knows, or, haply he may know not.

In the Greek civilisation also, the philosopher and scientist were one and the same person. The names of Heraclitus, Thales, Pythagoras, Euclid, Socrates, Plato, Aristotle are legendary for the wisdom they brought to bear on natural phenomena, on man's inner urges and his potentialities in creative thought and action.

The tradition of maintaining the fundamental unity of all knowledge lasted out through the Chinese, the Indian, the Roman and Arab civilisations of the early medieval periods, except when the Christian church rejected the new hypothesis of men like Galileo about the earth going round the sun (rather than otherwise), because such facts seemed to militate against the dogmas of the gospels about the heaven above and the hell below.

During the renaissance which began in the 15th century Italy, with the work of men like Leonardo da Vinci, the total approach of man towards all knowledge came to be emphasised. As is well-known, Leonardo was a painter as well as a military expert, and he experimented in his various laboratories on metal work and hydraulics, observed flora and fauna and tried to make a flying-machine, as well as navigate the seas.

The notebooks of this genius betray a comprehensive attitude towards all experience. But they are not unique, because artists like Piero della Francesca researched in the chemistry of colours, and Michaelangelo worked on physiology, while Raphael carried out multifarious projects in his short

life among which were extensive researches in the science of digging, which was later to become archaeology.

In England, where renaissance learning was accepted, Roger Bacon asserted the necessity of seeing science as part of the service of man and prognosticated that the human species would prevail on the earth through knowledge. And Francis Bacon in his *Philosophical Essays* prognosticated that science would change man by bringing social amenities for the improvement of his life on earth and would create the conditions for the welfare of the whole humanity. Until the end of his life, this Ex-Advisor in the Court of Elizabeth the first carried out experiments to extend knowledge.

The progress of human society was, however, not brought about suddenly or mechanically through the application of knowledge. The gains of the first revolution in England, when the Barons had obtained the *Magna Carta* from King John and thus limited the powers of the monarchy, had been implemented through the acquisition of more power still by the scions of the baronial class, and then through the emergence of the middle classes in the 18th and 19th centuries as the leaders of the industrial revolution. And the chief weapon used by the bourgeois in its attempt to build up its factories at home and its empire abroad was scientific knowledge.

In spite of lingering obscurantism, science and material progress became synonymous in the Victorian period. In fact, in the long story of man, at no time has inquiry, invention, and experimental knowledge spread so quickly as during the various phases of the machine age. And, inevitably, this made for specialism, because few single individuals could comprehend the complex and intricate details of all the growing sciences.

Of course, the very science which helped to create the surplus wealth of the West brought its own contradictions. The self-aggrandisement of the owning classes led to the exploitation of the workers and producers of wealth. And, naturally, there arose protest movements of which the French revolution was the first highest expression. The ideas of sharing the wealth, gained ground through the doctrine of liberty, equality and fraternity, and the whole teaching of the humanities became informed by a new kind of awareness of the potential of the good life on this earth for all men. But the struggle about each mootpoint was bitter and violent and led to the disruption of final authority of the church, the state and the father of the family. The property relations changed. The pattern of the laws of marriage and divorce were revolutionised, bringing equal rights for women even against the opposition of the vested interests. In fact, the concept of the perennial revolution took the place of the perennial philosophies of the medieval periods.

The hold of the middle classes on the means of production, however, kept

the capitalist system, geared to the profit motive. The nation states of Europe, which had taken the lead in annexing empires in Asia, Africa and the Americas, spread their influence far beyond the confines of their own countries, enriching themselves in the process and passing on the burden of exploitation from their own workers, to the cheap labour of the colonies. This led to jealousies amongst the first imperialisms of Spain, Portugal, Holland, and Britain and later between France, Britain, Germany and Russia, which had come in late into nationhood. So that the bid for the last two of the new European powers, in the 19th century, armed with the method of science and technology, led to the first giant world war in the early 20th century.

During this struggle the workers and peasants of Czarist Russia opted out of the imperialist war, upset the monarchy and brought about the great October Revolution, which laid the basis of a dictatorship of the proletariat. The new state began to reorganise society on the basis of socialism, mutual help, co-operative production, joint ownership of all the means of production, and adopted science as the method of advance from a feudal set up to a system other than the profit based order of capitalism.

The historic controversy between the protagonists of capitalism and the socialist revolutionaries of the U.S.S.R., for over a quarter of a century, has been acute, bitter and homicidal. It led first to political and military intervention against the Russians and after much manoeuvring, even to alliances between the Imperialists and their former enemies in Germany, Italy and Japan, who had financed the leaderships of the most aggressive Nazis, Fascists and militarists, against the U. S. S. R. Unfortunately, for the old Imperialists, their fanatical friends felt that they must have initial gains in *lebensraum* at the expense of the established powers, and they began the second world war against the British and the French Empires. Later, the militarists attacked the U. S. S. R. and U. S. A. And this brought about a temporary alliance between the Capitalists and Communists which, after a long and bloody struggle of attrition, led to the victory of U. S. S. R., U. S. A., Britain and France over the barbaric and racialist fascist order. The hostile powers had evolved more intricate and destructive weapons with the help of science, and, even the atom bomb, the most terrible instrument of death, was used by the U. S. A. to bring Japan to its knees. In fact, the giant wars have been used to extend the range of scientific discovery because of the enormous finances found into the economy based on competition, fear and hatred.

The result of the use of the ultimate weapon of the atom bomb brought a further split between the professors of the humanities and the sciences. The suspicion that the scientists were lending themselves, willy nilly, to be sued by the politicians, had been growing between the two world wars. And

the sudden awareness of the fact that science and technology could wipe out whole cities like Hiroshima and Nagasaki, and spread radio-activity in the human protoplasm for generations, led to tremendous disillusionment about the earlier hopes of the emancipation of humanity through science.

Since then the subsistence of the cold war between the revived neo-colonialists of the west and the widespread Communist states of world, of the USSR, eastern Europe, and China, has meant the elaboration of the largest number of hydrogen bombs and atomic missiles and other scientific instruments of mass destruction, on both sides. And, though the near equality of nuclear armaments lessens the danger of an atomic holocaust, the threat of such a war starting off through some accidental madness on the part of a set of military or civilian fanatics, has plunged the thinking world into the most terrible confusion.

Especially in feudal colonial societies, which became free from the yoke of Imperialism after the second world war, the traditionalists, and even some liberal modernists, refused to believe in the beneficial effects of science. And the dread of the wiping out of the human race accentuates the suspicions and fears about science, sometimes leading to a return to the darkest dark superstitions.

At any rate, the separation of the world humanities, philosophies and religions from the world of science is, unconsciously, today more acute in our country than it was in the period of our liberation struggle, when we hoped to build up our own society, left backward by two hundred years of colonial exploitation, within a comparatively short time, with the use of science.

Now, it is likely that if humanity can avoid a possible third world war, and wishes for the year 2000 to be born, we will have to learn not to blame science for the production of ultimate weapons but eliminate the influence of power potentates on science, as it is they who order defence scientists to manufacture the barbarous instruments of death from the beneficent knowledge of science. And some effort will have to be made to reintegrate the humanities and sciences.

I believe that this can be done by emphasising the concept of 'the whole man' which is emerging in the contemporary world, as against the sectarian, dogmatic and specialist views that seem to split man, bifurcate him into various distinct parts, by using the advance of knowledge and the complexities which have resulted from the amassing of facts as an excuse for derisiveness.

If, however, we have established 'Destination Man' as the ideal of our own advance towards the future, if we wish for the release of the individual to the cultivation of his highest potentialities as our main ideal, and if we ask for satisfaction of human needs and interests, and measure our

progress in those terms, then we must share in the concept of humanism which most members of the world intelligentsia are striving for through parallel aspirations, in spite of the different sanctions they invoke for the worship of man.

In this context, it must be understood that man is body-soul, seeking the perfection of his nerves and tendons as well as of the subtle intangible feelings, emotions and moods, which compel him to evolve himself to even higher limits of achievement. And, in doing so, man seems to absorb all the relevant insights and perceptions of the past, irrespective of who found them. Also, he acquires, through his solidarity with the other searches of his age, the results of the experiments conducted in every part of the world. Thus the total consciousness of man, including the findings of the various arts and the sciences, tends to become international.

Also, the approach of the new man is inclusive. He does not say that the dichotomy of art and science is unavoidable. Instead, he seems to believe that there is no life of nature separate from man's awareness, nor man's awareness separate from nature. Both the disparate aspects of the idealistic hypothesis seem to form part of the unity of life. Actually, externalised surface existence helps to shape human destiny as much as the inner life creates us and our surroundings.

As we have already pointed out in the brief periods of creative activity, when he was not plagued by wars, feuds and small gains, man searched ardently to understand destiny in the midst of unknown forces. And, mainly by the application of his reason, he established a kinship between himself and that part of his surroundings which he had brought within the orbit of his comprehension. The instinctive awareness of the earlier phases of pre-history and history then yielded to the untrammelled spirit of man, urged him to probe his soul as well as the outer phenomena. And thus human knowledge grew, the basic postulates giving place to more complex expositions of experience. Man did not discard from his body-soul the earlier apperceptions, but illumined them from a more and more total consciousness, boldly admitting, at his freest, the limitations of past knowledge, or the erroneous hypothesis in it, and pushing forward, with increased dynamic, to recognise new energies, new relationships, and new insights. Thus he constructed the new and higher society called modern civilisation, organised the various orders of forms, and filled his spirit with aspirations towards the Beauty, Truth, Grace, Harmony and Poetry of civilisation, which are already spreading into the third culture of humanism.

The talent of the individual (and most human beings possess this in some measure unless they have congenital defects of heredity) correlates the various strains of consciousness, synthesise these with fresh experiences, ignites them with the fire of his insights. Man has thus acquired the courage

to dissent from the accepted routine knowledge and forges ahead with startling discoveries, interpretations and illuminations. The custom-ridden societies, the orthodox high priests with their vested interests in ideas, and often other men who have not seen things in the new light, or are rooted in their own special fields of inquiry, reject, condemn or deprecate the assertion of the hitherto undiscovered phenomena. But whether it is the soft landing on the moon through the most daring calculations, or the painting of an incomprehensible expressionist picture, suggesting a new sense of the space-time continuum or a new theory of speculative thought, the innovation of the creative spirit extends the knowledge and the sensibilities of our time.

Synthesis resulting from the struggle between thesis and antithesis thus becomes the method of approach towards all knowledge. This attitude is necessarily experimental. In all his undertakings, apart from a few hunches, contemporary man, at his best, looks for new hypotheses.

Compelled by the fundamental urge for inquiry, he cultivates the skills and techniques for his search, observing himself and nature. He analyses his experience. If he finds it necessary to accept certain axioms which are not proved, they remain still part of his hunches or apperceptions. For instance, Ukanawa's hypothesis of the meson began as a guess and was not proved until afterwards, even as Picasso has started many pictures with a line that has led him to a new possible organic composition by the unconscious-conscious interplay of the kinetic faculties, using causation, similarity, contrast of colour, line and structure and many other relations with intense vision and inborn skill. The resulting experiments remain suspended between actualisation and aspiration and may or may not become completely integral. But they are put forward, or communicated, when the scientist or the artist feels that he has done his best to realise his deepest intentions, his search in a variety of experiences to balance himself into some sense of cohesion and harmony.

If there is no difference between the inspiration behind a scientific experiment and a work of art or craftwork, then how is it that in our machine age, there has come about such hostility between science and art?

The answer to this question is important if we are to heal the schism between the two disciplines.

It is likely that the unity of the two in the ages before the machine civilisation was based on the fact that the tools employed in both the primitive experiment and the handicraft were simpler and could be wielded by one and the same man, who could introduce a sense of creative purpose through the involvement of his kinetic energies in the work. With the coming of the steam engine and the extension of industry in the interests of mass production, the nature of the tools became more complex, insofar as they became intricate machines and there began a sub-division of labour,

so that one workman alone was responsible for a part of the job. Thus the undivided control over the whole process of the handiwork was lost. This meant the lapsing of personal initiative, which cannot easily be restored, unless each workman understands that he is not a cog in the machine, but an important element in the total process.

Unfortunately, however, the reduction by the entrepreneur, in the 19th century, of the workman to the status of a unit in production led to de-humanisation. And only the discovery of better machines to do away with the routine of mindless physical labour, and the enabling of the reeducated worker to complete responsibility for the whole of a machine, from its making, its use and its results, can stimulate his creative energies. To synthesise the methods of science and art, the worker's and craftsman's speculative insight must be aroused by a new kind of education, by sending him for research in tool making to the laboratory or the design centre.

Moreover, he cannot any longer remain a factory hand, or a small unit for carrying out the will of the employer, but must take share in the management, so that he is aware of the total nature of the structure in which he is involved and is part owner of the means of production which determine his consciousness.

In this way the synthesis of art and technology can become the basis for co-operation of human beings. And the individual can be encouraged to reestablish the connection of his creative instincts, with the process of production itself, both with the hand and the machine.

One of the major experiments in which an effort was made to relate the inventiveness of the individual with the working process, even when dealing with intricate machines, was in the Bauhaus established in Weimer before the second world war by Walter Gropius and his associates.

The Bauhaus considered architecture to be the total process, the mother of all arts, as it is called. In the first manifesto, it was declared 'the final goal of all artistic activity is the building, whose decoration was once the primary task of the pictorial formative arts. Today they have taken up a position of self-satisfied anatomy from which they can only be rescued by the conscious co-operative effort of all artists. . . . There is no such thing as professional art; there is no essential difference between the artist and the craftsman.'

This attitude was adopted after a thoroughgoing criticism of the separation between art and society brought about by the industrial revolution. In some ways the Bauhaus went back to the integral system of creative work of the primitive and tribal society. Walter Gropius shared the view of Ruskin and Morris, as well as of Coomaraswamy, Gill and Maritain, that there is not much meaning in a work of art apart from the function it serves, and that, in early societies, the artist is not a special kind of man,

but every man is an artist, insofar as he does his work with inspired skill.

This point of view was reconciled to some extent with the importance of the talented individual, as the genius is inclined to believe that art really begins where function ends, because co-operation in any construction only provides excuse for art but does not introduce into it through the collective, the essential qualities that are aesthetic and unique to the individual sensibility. The artists, Kandinski and Klee, and quite a few others, joined the Bauhaus with the conviction that the original creative urge of the artist, the striving towards formal expression is at once subjective and objective, individual and complementary. In this way, while the autonomy of the artist was maintained, the co-operative effort of science was brought in as in a laboratory. In fact, a science of design began to emerge. Also, it was proved that the worker can avoid the sub-human degradation of being a machine-minder and regain his sense of personal responsibility by considering his insignificant part in the process to be an important element. The respect for intimate research into the knowledge of materials led to new departures and it became obvious that there was no need to get away from the machine in order to regain responsibility.

The Bauhaus experiment has inevitably brought a new concept of creative education of the child. It is accepted as an ordinary fact that the child must be encouraged to explore and come to terms with the factual as well as the fantasy world in which he lives. As far as possible, he must be exposed to all the skills in which he may be interested and not only restricted to a single aspect of a single skill. The materials, wood, stone, clay, plasticine, iron strings, straw, machine tools, in fact anything that excites the play of shape and colour, can promote in the child a sensitive reaction to form and texture. And the fundamental attitude, which may be put in the centre of this training, is that creativeness is godliness. That is to say, 'if there is a god and he has created us, then he has also given us his ability to make new things ; and if we do not use creative spirit to improve the world in which we live with art and science we suppress that part of us which is nearest to the divine'.

The hypothesis of the Bauhaus in regard to the essential creativeness of the human individual has since been reinforced by the evidence of the biological sciences, towards the integration of the human personality.

It would seem that the total process of renewal of the body-soul through creative work is itself a seeking after perfection, of the nerves, tendons, muscles and their allied processes in the body, with their own inner laws of development, allied to the feelings, emotions and spiritual urges of the human being. The research into the co-ordination of the various faculties has not proceeded very far. But, already, it is possible to extend the

child's consciousness by explaining to him the complex of human physiology in the inter-relationships of the nerves leading to the respective sensory lobes and the stages of development of the brain in the human foetus as well as the relationships of the organs of perception, i.e., the eyes, ears, nose and fingers of the hand to the various organs inside the body cavity and the thread like nerves which connect them to the brain.

The relationship of the spinal column and the functional areas has been fairly well investigated by the various Indian Yogic systems. But the science of physiology reveals almost a magical jigsaw puzzle of the inter-connections of this area with the thalamus, the cerebral cortex, cerebrum and the whole nerve system.

Prof. C. V. Raman has recently analysed the organs of perception and discovered a 'new physiology of vision'. Beyond Dalton, he proves yellow to be a basic colour and further adduces reasons to believe that the 285 primary and secondary colours in nature are also inside the retina. And the confrontation of the two creates all these optical illusions, like the Raman effect by which the water of the sea seems to change under different lights.

I have myself analysed the way in which the human organism receives the impact of a work of art with the help of Prof. Raman's new theory of vision, and I would like to suggest that many more things happen to the human being in *seeing* a picture beyond merely *looking* at it.

The first visual experience of a work of art (which involves some instantaneous discrimination between colours, lines and forms by the retina) is comparatively elementary. The memory image, from the millions of miles of film at the back of the head, confirms the outside shapes, by recognising man, woman, horse etc. The thalamus, which is the survival of the anthropoid ape brain in the human head, underneath the cerebral cortex, violently reacts to the memory image, stirring chords, both towards the brain above and the spinal column below. At the end of the spinal chord, the lumbar ganglion receives and transmits seismographic waves towards the whole body, like rhythmic shivers, stirring the whole being as the strings of a harp initiates musical patterns. The heartbeats move more excitedly or more calmly and affects the breathing to be even or uneven, thus stirring pleasure-pain. The pilot station of the brain in the cerebral cortex collects all these reactions, adjusts them and organises them into some kind of order. At the end, if the various reactions of the organism have the *vasanas*, energies and vibrations of the harmonious or formless forms, the imagination comes into play, and liberates the body-soul into what is called *Rasa*, or flavour or catharsis.

In the light of this analysis clichés like 'spiritual realisation' or 'lovely' or 'wonderful' can be shed and new and exciting methods of active contemplation of works of art can be suggested.

The new science of design, therefore, depends on a changing attitude of mind, which may lead to a fusion between science and art. This may be a slow process, but we can provide comprehensive experience from early childhood to maturity — not only in book knowledge but in the constructional attitudes of the hands and of the head and the working of the heart. Then the individual will begin to evolve a self-created environment like a cell among other cells, made by other individuals and brought into some kind of solidarity or fraternisation among creative men through the inventiveness of art and science.

It is important thus to keep the twin aspects of art and science in focus. The scientific design must make room for the private world of the artist, which emerges from the creative sources, in dreams, reveries and unpremeditated thought. The artist must concede to his colleagues in the workshop enough public discussion of his inspirations and inventions, and how they stimulate the experiences of form, rhythm, balance, light, colour and shade. This kind of co-ordination of the private sensibility with co-operative effort of science, would also need an understanding of basic politics and society, in order to bring about some adjustment between the creative men and those who are governed mainly by power urges, or economic facts, devoid of form-giving inspiration.

The revolutionary changes in the physical sciences, which have now brought the universe, beyond the pre-historic haunches about the ultimate indivisible particle into atoms, molecules, mesons, particles and anti-particles and sub-particles called mesons seem, through new physiology of vision, to reveal various harmonies or symmetries in the laboratory which are aesthetically pleasing and mathematically coherent. These have made the old-fashioned three-dimensional art obsolete. Never will the human-animal figure look the same as it was until the end of the 19th century. Because abstraction, distortion and simplification in art has become inevitable in the attempt to correlate the kinetic movement with the realities of optical illusions and the degrees of relativity which have upset exact measurement and construction. We have now to realise things in the new space-time continuum, beyond the findings of Democritus, Leonardo, Newton, Dalton and even Thomson, Joliot Curie, Rutherford, Chadwick, Eddington, Jeans, Yukawa, Bernal, Schrödinger, Raman, Saha and Bhabha.

I am not saying that every artist is to be enjoined to become a research scientist. But when the Hindus built their temples beyond the human scale and over-burdened them with sculptures, they did so to infuse the fear and reverence for the gods in the worshippers, and to show the hulk to the ardent pilgrims long before they reached the shrine. Similarly, the Egyptians designed their pyramids to subdue their subjects through fear. And the Christians evolved their cathedrals as out of the scale buildings talking to

gods in heaven with their vertical steeples. The present day distortions in architecture and the feeling of mobility of solid structures have also become inevitable through the changes brought about by science and the new materials in man's physical environment. To quote from a scientific report :

"The physical environment which the architects were invited to consider had changed, at a terrorising velocity within their working life time. The expanding universe had become the exploding universe. And time, the new fourth dimension, and become more imponderable than any of the other three. Man had changed too, but not enough. The architects assure that their buildings had felt the new decisive effect of Time and its Mirror motion — but Man emerged under their inquiring state as a creature bent by the relentless past, confused by his vestigial emotions and so handicapped by defective vision that he literally can see only what he wants to see."

There are many concrete examples, however, of the shift in emphasis from the commonsense photographic vision to the multiple planes offered by the cubist painters, Picasso and Braque. Picasso does not give two noses to a woman, one for breathing and one for snobbery, but shows the profile and the front of the face at the same time. The contrasts of relative planes is further heightened by irritants like a zigzag line among the cubes to stir the onlooker to an intenser contemplation of the picture.

Similarly, the transformation of materials in art has been affected to a large extent by the laboratory researches in plastic glass, sculpt metal, cement concrete, etc., which dictate their own forms and the new space relations, rendered possible by our emergence from the two-dimensional primitive art of the ancients, as well as from the three-dimensional perspective of the renaissance, into the many dimensions revealed by the expanding Universe. It is true, that the challenge of the new four or five dimensional space, opened up by the soft landing of the sputnik on the moon, has not yet been met by the artist. The reason for this is that the creative man has to absorb an intellectual truth in his being before he can make it a becoming. But, certainly, the sense of gravity which man had achieved through the old physics has now been lost, and no artist can refuse to face the problem of new space relations in the many new dimensions which have been opened up by science.

The flotsam and jetsam of Miro gets as near as possible to the broken universe. The sculpture of Calder attempts multiple views and balances. Moholy Nagy in his plastic glass constructions had also tried variegated dimensions. And Irene Rice Pereira has invented various planes of static columns to measure the illusion of movement of space-relations themselves. Le Corbusier successfully tried to reflect motion in space by the use of glass, so that inner space could break out for the enclosed walls into the

landscape outside and the house seemed to move. In fact, he produced space relations in his master plan in Chandigarh, so that the whole town seems to hover as on a swing between the mountains of Kasauli and the planes of Kharar, assuming different colour movements during different times of the day, which themselves heighten the optical illusions of mobility in a subtle manner.

The science of design, with its language of shapes, forms and colours, is still growing, with the human modular as a common denominator. But the possibilities are unlimited.

Only the scientist must not expect that his factual knowledge and his intellectual nuances will be the only methods used. We will have to allow for the intuition of the artist to serve as the integrating and creative factor in the whole composite process of human expression ; for, though the organisational forms involve logical reasoning, the inspiration behind the language of vision is often derived from the creative sources built up from the racial unconscious quantitative knowledge and often ignited by the spark which transcends reason.

It is true that scientific techniques are used in the interest of an intuitional experience, but the whole emphasis on geometry to eliminate the inessential detail and to get to a purity of colour phenomena, on certain contrasting planes, as in Mondrian, was an attempt to use the new evidence of the mathematical sciences for ultimate artistic experience. In fact, Mondrian tried to use abstractions as a principle of relative distraction, first of many colours, then of lines, to achieve ultimate simplicity, away from the intricate, detailed and descriptive researches of photographic imitation.

Since then some form of abstraction or the other has become a norm in creative art, and abstract expressionism of the American school has reached the limit where reduction, negation and illumination, are more important than creating some kind of content or communicable substance.

So far, however, the fear of domination of the human spirit by objective forms and patterns led to the negation of many elements of scientific knowledge. Because it is difficult to absorb scientific discoveries and ideas in the metabolism and in the emotions. In recent years, the trend towards acceptance of the facts of the sciences and the attempt to evolve a comprehensive art has, however, been clearly noticeable in the works of artists mentioned.

The latest strands in art, including 'Pop Art' and 'Op Art' seek, at their best, to combine the use of active imagination with the technical know-how of the engineer, the physicist, the cyberneticists and the mathematician. This would indicate the return from the specialism of the last century and half to the kind of total attitude which Leonardo da Vinci had projected in the 15th century.

Of course, the relationship of each artistic experiment to the sciences which may help to evolve an object of aesthetic experience requires much patience from the naive and inexperienced people, who have only been used to temple art or church art or portraiture and photographism and the mystical awareness of the private sensibility. Fortunately, photography itself has tended to become a diversified art and by the imaginative use of the camera as in Moholy Nagy, Norman Maclaren and Cartier Bresson.

Certainly, a decisive stage has been reached which is evident from the words of Autre, "In former times it was form with which we conditioned space, but now it is space through which we engender form — as if space were a wound which brings forth form."

It is likely that the earliest attempts at paintings were to absorb the then known universe of the hunt or food gathering into a man's unconsciousness. The human child instinctively makes things and puts experience into its awareness by scribbling, drawing something which he wishes to remember. In this sense the lines drawn across space are the first form of willed extroversion, a kind of gesture which crystalises movement, thus allaying it with the metabolism. If a metaphor may be used, the earliest scribbles of children are a kind of calligraphic writing energised by the inner bubbling of exuberant flourishes inside the child's body-soul.

The artist Paul Klee has described this process of kinetic movement of the child's hand, dictated solely by motor impulses as the result of urges from an inner voice. He considers this activity to be 'like writing something' which strives to become visible. We do not always know at once what flows into us, from the depths and goes through us in order to become 'manifested image'. I would like to suggest that in the child there is unconscious absorption of his own experience by realising them in outside materials.

Paul Klee, however, being a conscious artist, has defined his own absorption of lines fairly clearly in his *Pedagogical Sketch Book*. In Klee's handwriting, the line assumes several forms.

One of the important readings by this artist after his analysis of line is as follows: "The contrast between man's ideological capacity to move at random through material and metaphysical spaces, and his physical limitations, is the origin of all human tragedy."

This *sentence* crystalises the whole situation about the challenge of the new dimensions of the universe brought by the penetration of outer space, whereas man has struggled throughout the ages to relate himself to the various aspects of space which he gradually got to know about (because he had to build houses and temples and palaces). He now finds himself losing his sense of gravity because he cannot eat, digest and absorb the

four or five new dimensions of space which have been brought to his door by science.

As the most intimate part of the absorption into the inner life of man of outer experience and then regurgitating it as a confirmation of his emotional alliances, has been through the presentation of forms and images, the need to accept the phenomena of the outer space has become a challenge to the painter and the sculptor and the architect. How to extend consciousness in creative art or in the representation of the newly discovered cosmic order or, as Irene Rice Pereira calls it, 'to the ever coming-to-be'? This is the problem which faces the *avant-garde* of the art world rather dimly perhaps but more intensely in the case of those artists who are open to life and not shut in by conservatism against the expanding universe.

In his thoughts on modern art, Paul Klee has put this crisis in simple terms: 'These unsettled times have brought chaos and confusion (so it seems, though we are too near to judge)'.

The intuitions of many of the older men, who entered the industrial civilisation, led them to reject the new forms and materials. But there is an imperative need to grasp the phenomena of the broken universe and the reduction of substance to energies and atomic particles of radiating force. If that is accepted, then, like the ancient Buddhists, we can live on the plane of atomism while dealing with man as coagulated concentration of atoms on the commonsense plane. In this way the multiple views of forms in cubism and the interplay of optical illusions of objects can become part of experimental art. The aesthetic of these experiments cannot be judged in the old simple way as 'beautiful' and 'ugly', but only through the alliances of the body-soul with certain heightened moments aspiring towards balance or imbalance. The overworked concept of 'Beauty' can be kept as a sacred term to be used for ultimate satisfaction in the really important works of art.

The machine process, which has extended itself into contemporary consciousness by many significant experiments, is becoming, through Graphic art, a by-product of the sensitive print as it emerges from some of the processes of the printing industry. Of course, although still mainly allied with graphic thought in its integral relationships with the machine press, printmaking has grown into an autonomous art beyond painting, industrial graphic, or printing technology, always keeping the intimate relationship with printing technology without the fear of reproach that this is a machine art. As Bhupendra Karia has put it: "It is true that the scientific thinking of the modern graphic artists is attributable to the fact that they essentially deal with technology. But the scientific thinking and technological advantages are geared so that the modern artists have a more powerful and effective weapon to explore than before unknown aesthetic experiences.

That a machine could be beautiful, that a function when fulfilled is an aesthetic achievement, that eating a good sandwich is a spiritual experience."

Perhaps the most important contribution of science to the realisation of art forms, has come from the invention of new materials. Plastic, glass, black cement, steel and many other products of the industrial age came into use when the school of Constructivists fastened upon the object as form between the period of the two world wars.

The analysis of ultimate form, such as the circle, the cube, the cone, the sphere and the flat, in relation to perception and apperception has rendered possible the realisation, by many contemporary artists that the water colour, or the oil painting, is a useless medium expressing many modes of experience of the atomic age. This has led several artists to introduce foreign elements into painting.

In the sixties new dimensions in painting and sculpture have unfolded themselves for the use of movement in light in the hands of a number of artists. Certainly, there are sensational developments because not only do they use actual machine processes but sometimes employ computer-aided technology.

If we direct our minds towards the synthesis of the inner attitude towards art and science, beyond differences of goals, we can see how insight on which the artist relies is not against precise results but absorbs the facts found out in the laboratory and often given significance to them by revealing the beauty of the strange orders which the scientist often takes for granted. Also impatience, irritation, and violent denunciation must cease, if the practitioners of the two disciplines are to help towards the total approach to human experience which may yield the possibility of a third culture, which belongs to the whole man.

Actually, there are certain shared values which are taken for granted, but which unite the men of arts and the sciences. First of all, people in both the areas of inventiveness are marked out by a genuine *independence* of outlook. At their intensest, they always seek to discover original approaches towards materials and forms and ideas. The truly great in both fields, the highly gifted, do not refuse to accept the new. They take life in all its variegated phenomena and notice the small asides as well as the big things. They take a possibility and go in depth towards it. They are always experimenting and following the ebb and flow of experience and reject the orthodox diehards for the last ditch stand behind dogmas. Their dynamic mental-emotional life rejects laziness, unless idleness itself offers the freedom and leisure to roam in unchartered fields of fantasy, to discover new landscape. They are against arrested growths, and the prison of a static order. The tenderness, the sympathy, the apathy and humanness of the men of culture, is our only compensation for the woodenness of the

arrogant politician, the doctrinaire theoretician and the half and quarter deadness, through fear and insecurity, of the large masses of the population. The freedom demanded by the artists and scientists is the *sine qua non* of life itself which is fluent, like time, the refreshing river.

The second quality which seems to follow from the independence is dissent. The artist as well as the scientist frequently finds himself at odds with previous ideas and seeks to renovate life by his own unique vision, and is, therefore, passionately in defiance against other people's ideas, against the blind worshippers of the past at any cost, and against the established order which is seldom flexible enough to admit new possibilities. In this sense, one may say, that civilisation is often made by ordinary man, and the extraordinary man, the man of genius, is always out of joint. That is why Plato asked the poet to be put out of his ideal republic. But I think, given the assurance that the man of talent is working for the good of the community, even when he is most self-centered, it will often be found that he is totally responsible to the demands of the life-process which he loves and wishes to extend beyond the accepted values. If society could concede to genius the privilege of breaking a number of dead habits, humanity could avoid the events like the murder of Galileo — the abuse 'wild beasts' and the condemnation of some of the most rare sensibilities to live in utter penury and want.

The third important quality which marks out the great men of the single realm is their reliance on *imagination*. They may contradict themselves. They may seem fantastic in their designs. They may be told that the things they say are impossible. But, if a form, or an experiment, has been seived through the imagination of one of these men, then, given skill, comprehensive knowledge, and subtle intuition, the result is to be of the highest significance even if it lacks perfection.

Actually, the creative sources are most difficult to define, to rescue from within the universe of discourse, so uncannily replete with all kinds of loose ends of feeling, emotion, image, idea, concept, that a physically sick man may produce what is called a masterpiece, whereas an obviously healthy man cannot even release his sensibility. The inspiration comes like a wisp of air from the many siesmographic waves inside or outside the body-soul, ignites the personality in some corner, stirring the whole inner organism, or a good part of it, and the incandescence simmers through some expressive organ redolent of the perfume of realised experience, and delivers itself as a process of gestation. Perhaps, this ultimately leads to the organisation of elements or an order of relations, with or without links, or an aspiration towards the illumination of those darkneses which were originally struggling to emerge in the racial biology in our stream of consciousness.

The significant and genuine artist and scientist are both, to a large extent,

fairly good critics of their own works, knowing the weaknesses in the attempts to do the total *darshana* or the active contemplation of their creative energies, before, during and after that portion of the process of work which has been isolated from the complete process of life for transformation. And both are dimly aware, at their boldest, of their need for understanding each other, in order to bring experience of all kinds into the single realm of creativeness, inspite of the separatism, the specialism and the partial approach. And both are nearer to being 'whole men'.

PHILIP H. ASHBY

Functions of Religion and Society in the Age of Modern Science

IN a speech delivered in 1953 the late J. Robert Oppenheimer said, "we have changed the face of the earth: any beginning of a talk about science and society must take that as a fact."¹ I assume that in one manner or another every aware person today would agree with Dr. Oppenheimer. The face of the earth has changed, is changing, will change.

One could easily be tempted to spend considerable time making the obvious point that the face or appearance of the earth has continually undergone change in the eyes of man as he has confronted new external situations, or become aware of different internal personal structuring and understanding of accustomed conditions suddenly cognized in a way not thought of before. The history of man and his societies is the account of such change, usually slow and frequently imperceptible to all but later historians who have the advantage of perspectives not available to the persons involved; occasionally a series of rapid changes that to the men and institutions affected appear to be, and are, shattering and cataclysmic, but for subsequent men were but incidents in the history of mankind; rarely, but most importantly, a dynamic change that at the instance of its occurrence is recognized as being of unusual consequence even by those who do not fully understand what it is and how it came to be.

Oppenheimer was speaking and thinking in terms of the atomic age whose emergence he had helped to bring about. He understood clearly that something dynamic, seminal in the history of mankind, had happened, and that men and their societies would never be the same again. The face of the earth had been changed, and because of that inescapable fact man would

have to be changed, and society would need restructuring. Past conditions would never be exactly the same in the future, if they ever were, and future conditions would inevitably emerge in a context unlike what it would have been if the dynamic—atomic—event had not occurred.

We are aware, of course, that the atomic age is the inevitable product of a larger, more significant age or time, namely that of science. Science of a type has produced various "ages" in the past (copper, bronze, iron), and now modern science has even brought forth a new dimension which excites, frightens, and challenges our imaginations. So now we have the Space Age, but still the Golden Age of which so many cultures and societies have dreamed continues to elude us. And, as a result of the science which offers us so much, we are becoming aware that there is no such thing, at least on earth, as a Golden Age. Science is teaching us what in our rational moments we know, but in our hopes and dreams continue to deny; there is and will be no Golden Age. It is the lesson of science, elementary but all important, that there can only be successive ages, sometimes better and sometimes worse, occasionally little different from each other, but never perfect. Science itself is a series of ages, a succession of generations or eras each marked by its own contributions and problems, none known to have contributed fully what its enthusiasts confidently expected and predicted from it.

It requires very little study and reflection to understand in general terms the nature and scope of the contemporary problem, or problems, suggested by the title of this seminar: "Man, Science and Society". I rather imagine that when we are frightened and baffled by the subject as we often are, it is because we do see the problem fairly clearly, but not the answer to it. Because of the nature of the problem we know that the necessary solutions must be dynamic in their ability to change men, to change society and, perhaps, to change or rechannel science itself.

The many books, essays, articles and speeches that have been produced in the past few decades on the subject of Science and Society, all, in one fashion or another, dwell at length on the need for education in science to train scientists, of course, but even more eloquently plead for the obvious necessity that the general members of the society be educated about science, if not in it. They remind us of the need for well planned government support of such training—both that of science in depth and science in general as the central factor in the contemporary and emerging society and its culture. Such writers and speakers refer to the changing requirements this new science and its resulting technology place upon the educational system of a society, even in the areas of humane studies and the so-called social or "soft-sciences". And, not infrequently the writer or speaker seeks

to reiterate in some new or distinct manner the plea that traditional cultural values should not be forgotten while science is eagerly being pursued.

As one who is not a scientist, but who does conceive of himself as pursuing what the Germans in their precision of language term *wissenschaft*, there is little, or more correctly, nothing new that I can suggest to scientists themselves about their method and their problems within their respective scientific disciplines. However, as a student of human culture, especially as cultures have articulated their structures, meanings, and aspirations through religion and philosophy there are some things—not new, but I hope pertinent—that I wish to bring to the attention of our collective thinking.

My first point is a debatable but I think correct one. It is that the great religious traditions of human history are capable of being aids to the better incorporation of science into the structures of society and the thinking of men. As soon as this is said our minds immediately recall the abundant historical evidence that without question challenges the statement. True enough, history certainly demonstrates that that which has been designated as a culture's or a society's religion has frequently, if not almost always, been a fervent defender of the *status quo*, an obstacle to progress and a declared enemy of the new and different.

Among the leading contemporary religions, Christianity was the first to confront intimately and dramatically the rise and impact of modern science and its resulting technology. There is neither time nor need to repeat the story of that confrontation and the charges and counter-charges that emerged from rival protagonists. From our contemporary perspective the statements of Christian theologians particularly during the nineteenth century, while perhaps understandable given their presuppositions of faith, are ludicrous in the extreme. They were fighting a losing battle and within a few generations they came to recognize that fact. With the accumulation of evidence supporting the growing scientific knowledge in the physical and biological areas of existence, Christian theology was forced to come to terms with the new world of thought being produced by scientific methodologies, and the new modes of living resulting from applied science and rapidly expanding technologies.

However, I think we miss a lesson of history here because, for example, we remember Galileo in his struggle with the official Church, and forget Galileo the devout Catholic Christian who was aware of no fundamental conflict between his scientific methods and assumptions and his Christian beliefs. Or, we remember Copernicus and the long period in which his theory or discovery was denied and suppressed. I am not recommending that we should forget such all-important events of history, but I do suggest that we need to look closely at religion in order that we may better under-

stand its function within a culture and its potential, though admittedly not always actual, contribution to social change, social adaptability, and social cohesion.

My suggestion was not that the great contemporary religions have been or are aids in regard to the problem we are discussing, though in some instances they may have been, and may now be. Rather, I said that they are *capable* of being, and it is this potential that the present-day student of human affairs must consider carefully. All too often the non-religious scholar or educated citizen, and even the nominally religious intellectual assumes that religion in whatever form is by inherent nature and accumulated tradition inevitably the enemy of science and the foe of modernization. As a result, he frequently dismisses it as a significant contributing element in the emerging world of tomorrow and mistakenly ignores its central role in human life and social structure.

In his essays on *Science and the Modern World*, Alfred North Whitehead noted that "When we consider what religion is for mankind, and then what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them."² He went on to point out that a careful study of human history indicates two important facts. First, that there has always been conflict between the two, religion and science, and, secondly, that both of them have always been in a state of continual development.³

It is this second factor which I would emphasize; not that aspect of it which points to the obvious developmental character of science, which is so readily recognized, but the developmental nature of religion that is so easily and frequently unnoticed or ignored. In the case of the religion to which we have already alluded, Christianity, its genius and its role in western history and society is largely undiscovered if we only note its conservatism, its rallying to the defense of its significant "myths" as they were confronted by scientific, empirical "fact" that apparently destroyed the myths and the spiritual values accruing from them. These things did happen, true enough. But something else was also happening, and it is the genius of those religions which have endured through long periods of history as significant participants in an ongoing culture, and as meaningful elements in personal and collective human lives, that this ability to participate in a "happening", that is, in a development, a change, is one of their greatest but often unnoticed resources.

We misread the history of religion if we do not discern carefully the adaptability of the enduring religions. In fact, though their most devout adherents may well argue that they have endured because the truth they possess is eternal and indestructible, the student of religion also notes that it is only those religions possessing the aptitude of accommodation that

have continued over long periods of changing circumstances to have relevance to personal human life and collective human society.

And, further, it needs to be emphasized that such adaptability, accommodation, change, is not, as sometimes thought, compromise in which the essential themes of the religion are abandoned simply in order that the religion may survive. When the essential themes of the religion are abandoned or compromised to the degree that they cease to possess their fundamental morphological integrity, then the religion as a vital contributing force in human life and society ceases to be. The religions that have existed through long periods of history with the result that we refer to them as the "leading" or "great" religions, may in specific instances or circumstances have compromised their essentials, but from an historical perspective such lapses have been only momentary and that which was lost was again recovered.

Positively, the point is that vital religion possesses the necessary sensitivity to be sufficiently aware of the changing needs of men's minds, men's social conditions, and men's spiritual requirements. Since such religion is in a constant state of development and flux, though not necessarily of radical change, it remains relevant to men and societies that are also in similar process.

I began my discussion of this point by reference to Christianity because that religion has been most closely related geographically and perhaps intellectually to the development of modern science during the past few centuries. One could point to the role and relationship of Islam to the place of science in the Golden Age of Islamic culture, to the degree to which the various great religions because of their individual structures and predominant themes have possessed or lacked in specific instances the ability to adapt, and have appeared to be either avenues or obstacles to the development of what in broad terms we would hold to be the scientific ethos and mind of the developing past and the enigmatic present.

But we in this seminar are basically concerned with "Man, Science and Society" in the Indian and, therefore, primarily Hindu context. We know that Hinduism, broadly defined or understood, considered in its widest historical sense, in its variety and complexity shares in many of the debilities and potentialities possessed by its fellow major religions in the present scientific age. I trust that each of us in our own religious adherence and tradition, or lack of it, will not allow ourselves to be blind to the debilities of any religion, or so overcome by them that we too quickly allow them to obscure possible potentialities.

A primary task facing us is to establish what, if anything, within the total entity of a particular religion can be legitimately separated from the core of the religion. This core, or what I find it helpful to designate as

the "essential themes" of a religion, is that which if subtracted from the religion would cause it to cease to be what it has been in the minds of its adherents, as well as bringing about a fundamental collapse or change of the culture with which it has been traditionally associated. This is not an easy task, but if such a separation for purposes of analysis is theoretically possible, then a way is opened for the discussion of what is essential and, therefore, from the perspective of the religion must be enduring, and what is ultimately peripheral—though not always inconsequential—to the religious tradition and its cultural expressions.

When such a separation is attempted by those properly equipped to do so, one of the most noticeable results is the placing of the cultic at a level or role less significant than that usually accorded to it by the majority of the adherents of the religion itself. Such a judgment about the cultic is not a conclusion that it, in itself, is inconsequential, nor that it has not played an important role in the historical continuation of the religion. Quite the contrary. But it is an affirmation that in the development of religion, particularly today in the age of modern science and men and societies living in the midst of such science and its technology, cult is not of primary significance to the religion as it seeks and continues to have relevance to man and his society. Cult will resist change, it will continue, but by the very nature of circumstance it will not hold the center of the religious platform as the human intellect seeks to articulate its religious concerns in this world—no, today I must say universe—whose face is being continually changed by science.

Again, let me make it clear that I am not defending religion in general, or any religion in particular, by erroneously claiming that it has always and in every way been sympathetic to the science or technology surrounding it. But I am suggesting that when the essentials of the historically significant religions are considered, we discover at our disposal resources which can be used for the adjustment of the human mind to each new age and its problems and enriching potentialities.

In India from the time of the R̥g Veda, if not before, the nature of empirical creation has fascinated man in his religious dimension as well as his social concerns. Thus the Hymn of Creation begins:

Non-being then existed not nor being:
 There was no air, nor sky that is beyond it.
 What was concealed? Wherein? In whose protection?
 And was there deep unfathomable water?

And ends by declaring:

Who knows for certain? Who shall declare it?
 Whence was it born, and whence came this creation?
 The gods were born after this world's creation:

Then who can know from whence it has arisen?
None knoweth whence creation has arisen ;
And whether he has nor has not produced it:
He who surveys it in the highest heaven,
He only knows, or haply he may know not.⁴

And the Hymn to Dāna or charity praises the liberal man by reminding men of their corporate social nature and responsibilities.⁵

Sources such as these can be quoted by the apologists for any great religious tradition, and they can be dismissed by those who fail to discern value for any man, let alone modern man, in religion. But either extreme of absolute uncritical acceptance or rejection does little to aid contemporary man in his search for meaning in this scientific age. A judicious ascertainment of the essentials of the religion and its values, however, reminds the inheritor of the religious culture of the resources which belong to his society and himself, and equips him with a basis upon which to build his own understanding and adjustment to his environment and its unfolding.

Thus Professor Sudhakar Chattopadhyaya without, I think, being oblivious to the ways in which Hindu culture like most cultures has not generally been scientific in the present meaning of the word, can write:

The complex of values that emerged to guide the ancient Indians in the field of scientific investigations included the following concepts and goals:

1. That the mystery of the universe should be solved for attaining a true knowledge of the ultimate Reality
2. That science should be cultured in the background of *dharma* or natural justice and it must have a humanitarian end in view.

And he could point to the fact that the Ministry of Scientific Research and Cultural Affairs has before it concepts and goals in accordance with those same ancient Indian values.⁶

Such values are the products of the intermingling and cross-fertilization of religion, philosophy, social experience, personal aspiration, and human sensitivity. Together these create a religious culture, and it is this religious culture which serves as the norm, the value base, for social action. Science influences such social action; it may in fact at certain periods be primary in determining the course of the action. However, modern science is not in itself the producer of ultimate values. It is not in a final sense beauty, nor art, nor philosophy, nor political ideology, though it may or may not contribute to or be an expression in some instances of any one of these.

As J. W. N. Sullivan in discussing physics puts it:

The statements of science are true within the limited region it claims for itself—the region of mathematical structure.

No scientific principles are sacrosanct: no scientific theory is held with

religious conviction . . . Science is still an adventure, and all its "truths" are provisional.⁷

In the continuing adventure of science as it evolves in the Indian social structure, if it is to be productive and not destructive its succession of provisional "truths" will be made meaningful and valuable to the Indian people and their society within the context of a Hinduism that is itself undergoing development and articulating religious values possessing contemporary relevancy. When either science or religion ignore or oppose one another, the resources that each can contribute to the other and to human society do not achieve their full potential and man and society are impoverished.

The structural anthropology of Claude Lévi-Strauss contends that communication is the indispensable element of society, be it the so-called primitive or the most modern and scientific. When this conception is coupled with his thesis that "moving cultures"—our modern civilization—are receptive to change and seek to bring it about, then it seems to me to be demonstrable that communication between changing or developing science and developing religion is indispensable to present societies as they move into the scientific future. The scientific mind and its technological results are a fact of modern society; the religious heritage and aspirations of man remain also as a reality of modern society. If religion does not enter into and maintain communication with science, or if science ignores religion's role in society, both of these central components of contemporary life will be the less for it, and man and his society will be the losers. The dialogue within each can be enriched by a simultaneous dialogue between both wherein each recognizes the other's legitimate sphere and the rewarding contribution each can make to the other.

Ernst Cassirer, the great and learned advocate of the philosophy of symbolic forms contended that "Science is the last step in man's mental development and it may be regarded as the highest and most characteristic attainment of human culture".⁸ Cassirer considered science to be the most refined system of theoretical classification, a language of numbers giving man the ability to understand things and their relationships with a precision lacking in any other method of understanding. However, he did note, as many others have observed, that "all systems of classification are artificial".⁹

While science in its modern sense may be the latest step in man's development, I am not so certain that it is the last step and that there are no more to be made. It is part of the intriguing beauty and practical value of artificial things that they are always susceptible to change. Science as the expression of artificial but productive and valuable systems of classification has achieved much of its eminence in today's world because of this ability, but also necessity inherent to its nature, to change.

The revolution in scientific method in the present century is indicative

of this scientific propensity to change and the value that results from it. Classical physics and quantum physics are as different as it is possible to be, and because of that difference Oppenheimer could say, in fact had to say, "we have changed the face of the earth".

My second suggestion, put very briefly, is that society in the modern scientific world, like science itself, must not only be prepared to undergo change, but it must have as its sought after goal the constant prudent incorporation of the never-ending new into itself. This is not a novel suggestion, but to use Lévi-Strauss's term, the necessity for "moving cultures" or moving societies is a 'fact of life' that must be continually remembered by those who seek to understand contemporary "Man, Science and Society".

It is perhaps well illustrated in science by Werner Heisenberg's well-known Principle of Indeterminacy. If an electron is considered as a particle it is apparently impossible to determine both its position and velocity at the same time. It is Heisenberg's conclusion that the lesson to be learned from this principle is, philosophically at least, that there is a basic indeterminacy in reality itself despite the fact that predictability and probability exist in the mass of things.

Ancient societies and pre-modern ones of the recent past have generally not recognized the indeterminacy of their location and/or movement in history. They have most often considered themselves fixed at the centre of existence and usually have thought that if there was a velocity to their being it was a predetermined one beyond their control or change.

If society is to be anything more than loosely organized chaos in the contemporary age of science it must recognize that its position and its speed of movement, i.e. change, is by the very nature of things indeterminable. Its present is transient, its future unknown. Rigid insensitive social structures will not survive; they are not acceptable to men surrounded by science. Unchanging social values that are not adaptable and are thereby unservicable to men and their needs will not be retained for long.

A recent, admittedly American, commentator upon continental European problems in the sphere of political economy concluded that many of the problems were the result of a failure to grasp the implications of modern technology. "One reason they have not [grasped the implications] is the European educational system, which is training surprisingly few people to think in scientific and technological terms".¹⁰ Referring to the so-called 'brain-drain' and the economic and scientific competition between the Soviet Union, the United States, and the Common Market countries, he noted that generally "Europeans still regard a university education as something reserved for an elite minority," and quoted European sources to the effect that the Common Market countries with a comparable combined population to that of the United States produce just one-fifth the number of college graduates.

Also, less than two per cent of the college graduates trained in the Common Market countries specialize in science and technology, while about four per cent do so in the Soviet Union and the United States.¹¹

I do not make the foregoing reference with the intent of suggesting that from the perspective of cultural or personal values the end result of one system or philosophy of education is inevitably better. Nor do I wish to necessarily intimate that European or other societies should imitate two societies whose success in some areas has not assured them of a Golden Age in all others.

However, I do think the example illustrates the absolute necessity placed upon all societies today that they question their previously held views concerning themselves and their participating institutions and contributing structures. Every item must be questioned and subject to the possibility of change. This is not to advocate that all things be changed; rather, it is to insist that all components of a meaningful society must be alive to the demands and potentialities of the time. And, to be truly alive is to be in a process of development, the only other mode of living is one of decay wherein the inevitable result is death.

Discussing the "Requisites for Social Progress", Professor Whitehead noted that in the history of man and his societies a main element in any progress has been the power of wandering. It has been movement from one location, from one idea, from one commitment, from an apparently inherent habit to another that has differentiated man and his communities from other forms of life. And he emphatically declares, "Modern science has imposed on humanity the necessity for wandering".¹²

It is this wandering that modern social orders must be prepared to do. I have suggested that the great continuing religions of human history have the quality of being wanderers, and that because of this ability they have the potentiality to serve man and his society in the age of modern science. And, I further submit that the society that is not prepared to wander rather freely and widely (while retaining its own essential values perhaps or perhaps not in new forms), such a society will fail the men and women who are a part of it.

Great and continuing social orders, like the religions that have been associated with them, have been continuing, viable and, therefore, great because of their quality of wandering. The contemporary indeterminacy both as to their present situation in relation to the demands of modern science, and in regard to the movements they must make to meet future challenges which science will inevitably present—this indeterminacy can best be converted into a predictability and a probability acceptable to thinking men when a close working relationship is created between science, society and religion. For like Nils Bohr's Principle of Complementarity

which attempts to solve the apparent mystery of Heisenberg's principle by suggesting that the two experiments which exclude each other form a unity complementing one another—so the necessary interrelatedness of science and religion must be recognized. Then what is apparently contradictory will be correctly discovered to be complementary, and the future, though remaining enigmatic, can be contemplated with hopeful probability rather than dire predictability.

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U. E. CHOWDHURY

The Dilemma of our Times

BEFORE discussing the interaction of the subjects, it is worthwhile to note that religion, philosophy, and history are very closely connected to one another. Religion and philosophy have, in many cultures, been two parts of a single whole. History has, amongst other things, been a record of their effect on events.

Science, as opposed to religion and philosophy, has exercised an increasing influence on man's way of thinking and acting, particularly during the last hundred years. Man's mental equipment provided him with the means to observe nature and its forces and to harness them for his benefit. Thus came into being the plough, the wheel, and the sailing boat. But the manner in which man approached science in the past is a far cry from his approach to it today. The Greeks evolved the Archimedean spiral and enunciated the Euclidian theorems with which we are familiar from our school days; Leonardo da Vinci tried to build a flying machine with birds' feathers and nearer home the Indians produced the decimal system and discovered the zero. Though these and many other discoveries were milestones on the road of man's conquest of his environment, the manner and the social environment that produced them are very different to the precise, methodical approach followed by today's scientists. It is this scientific approach which has brought about a complete change between the present way of thinking and that of ancient times. It is difficult to imagine the Curies — or Alexander Fleming or Albert Einstein or Jagdish Bose — functioning in any century other than the twentieth, and equally impossible to conceive of a scientist today trying to change base metal into gold as

Leonardo did, or affirming as did Ptolemy that the sun goes round the earth. The goal still remains to convert nature's energies for the benefit of man, but the manner of working for it has altered startlingly in the West since the sixteenth century, starting with Copernicus, Newton through Darwin and Pasteur to the present time.

Religion and philosophy have formed an integral part of man's development from the earliest ages to very recent times. Religion, of whatever kind, and in whatever country, has endeavoured to establish dogmas and beliefs about events — real or mythical — with the object of enforcing certain precepts and canons of behaviour. Most of these precepts and canons were such as to ensure the healthy continuance of the society which fostered them. If a particular society did not have a strong religious bias, philosophy provided it with a moral and ethical base which could guide people in the conduct of their everyday life. To illustrate, some of the religious practices adopted by the Hebrews and Mahommedans such as not eating pork were meant more to safeguard health than for any purely religious reason, the pig being a dirty animal which, because of its eating habits, could transmit disease. Another Hebrew practice, the lighting of a candle every night, was aimed to bring about a sense of unity in a small community whose very existence was at stake, hemmed in and beseiged as it was by hostile neighbors. In India the cow was protected for economic reasons. Some of the religious (and social) taboos regarding contact with those whose duty it was to dispose of night soil were probably intended to isolate the majority from potential disease carriers as contagious illnesses were far commoner and exacted a much higher mortality rate than today, and it was either known or guessed that human excreta was a source of infection. Religious epics such as the Ramayana romanticised and idealised respect for property to such an extent that even a wife was treated as chattel and her unwilling abduction tainted her so much that her destruction was inevitable, in spite of a devoted husband. The Mahabharata enjoined fighting against evil as a sacred duty — though who was to judge which side was evil was (as it still is) dependent on the side you were on. It could have incited otherwise peace-loving people to take up arms.

These epics and the ideas they embodied became a part of the national unconscious and a yardstick for behavior in the centuries to come.

In philosophy, too, elaborate systems were erected. The philosophies of Socrates, Pythagoras and the Stoics, while paying only lip service to the gods, lay down fairly rigorous codes for the governance of human affairs. Socrates laid the foundations for Platonism and Aristotelian logic. Zeno's Stoicism concentrated on ethics and inculcated control of the passions and indifference to pleasure and pain. The philosophy of Buddha is a guide

on how to conduct one's life, the purely philosophical content being slight and the religious even slighter.

If either philosophy or religion needed reinforcing civil laws were introduced, for example, the laws of Hammurabi and the laws of Manu. Manu codified the caste system, propounded a complex structure of dos and don'ts to preserve the racial purity of the fair skinned Aryan invaders and sanctified their obvious inequalities in the name of religion.

The biblical injunctions not to steal or kill have a perfectly good social foundation as they preserve order and do not upset the even and steady working of human communities. But a gulf now exists between social morality and private morality. All the "thou shalt nots" of the Ten Commandments on which law in the West is founded, but which do not affect society such as worshipping only one god, not making idols, not blaspheming, observing the Sabbath, honoring parents, not committing adultery and not coveting others' property are now honored more in the breach than in the observance. A typical case is sexual morality which, as it does not affect the whole of society, is now increasingly considered a private matter between the individual and his predilections. The sins of yesteryear are as dead as a dodo. Homosexuality is accepted, premarital and extra-marital intercourse are prevalent and even unusual relationships such as between adults and children — witness *Lolita* — are no longer hushed up.

Previously society was tightly controlled not only by dire civil punishment for those who broke its laws, but also by the brimstone and hellfire of the religious concepts of an afterlife in which good conduct in this one was rewarded and bad punished. Whether it took the form of the Christian heaven or hell or the Hindu one of eventual liberation from the carnal frame or the Islamic one of a Bahishtian harem, the net result was to reinforce the codes of society. It proved extremely effective. The transgressors were subjected to chastisement by the law's custodians and had also to suffer the lashings of their own conscience. Modern science has struck at the roots of these beliefs. It has not said, "There is no supernatural force overseeing human destiny", nor stated "There is no life after death", but by its very silence it has produced a pervasive agnosticism.

Though conventional religions and philosophies continue to exist, they have lost their grip in the West and are losing it in the East. The recent *Time* magazine article "god is dead" is symptomatic of the change. There are of course minds who cannot live without some faith and when the old beliefs started to crumble, out of their need they turned to new ones such as theosophy.

The swing away from established religion began early this century. With the constriction of the world, the reduction from months into hours of distance, the leaps in technological knowledge, there was a weaning away

of those who are now nearing middle age. The period before the Second World War produced in some countries the desire to overthrow totalitarian regimes, in others to bring about the proletariat revolution, in others to fight for lebensraum and in the less developed countries such as India, to strive for independence. These consumed so much of the mental and physical energy of this group that most of those who survived the ensuing holocaust were too relieved to confront themselves with new dilemmas. War-scarred Europe licked her wounds and set about rebuilding her economy and her shattered cities. Nehru and his associates were fully occupied in the exciting task of building a new country after a hard-won independence. They did not seek, nor did they need, new faiths.

The quest for an ideal to replace the fallen gods has taken other forms besides the religiously esoteric or the philosophically abstruse. The need to do good has produced social organisation of various kinds and sizes such as the Peace Corps, Oxfam, and in India the Bharat Sevak Samaj; but these have necessarily been limited in their scope as social welfare has increasingly come to be regarded as the responsibility of governments and not of private or semi-private organisations.

The lack of a religious or philosophical compass is felt — albeit unconsciously — most keenly by the young. It takes many forms and manifests itself in a variety of ways. The flower children, the beatniks, the teenagers who howl for the Beatles, the psychedelic trip takers, the transcendental meditators, are not so much heading towards a positive goal as running away from a reality which is harsh and unpalatable — man's aloneness in the universe. It was easier to live when man believed, in spite of plague and pestilence, that he was created in God's image and was at the hub of the universe, the culmination of nature's efforts to produce the finest of living creations, for whom all other organisms were made. Science has made nonsense of this image. Civilised man is so intelligent that he can devise ways of blasting himself out of existence almost inadvertently. In contrast to his advances he is the only living creature who has successfully defied this planet with his scum, his slums and his debris of war. His voyages into outer space demonstrate his triumphs but also the infinitely small speck he is in the universe.

Twentieth century liberals cast in nineteenth century moulds can still come to terms with this brave new world. The Shavian philosophy of social justice and equity for its own sake (sans other worldly rewards) or Marxist social materialism or the simplified "the greatest good of the greatest number" continues to sustain them. But a new generation has grown up for whom this "life is real, life is earnest" theme has no meaning. Glutted with the refrigerators, cars and transistors of the affluent state they seem to turn their backs on the society which bred them. This attitude is neces-

sarily reflected in the arts. Beckett, John Osborne, even Camus, amongst the writers, the pop group of painters and sculptors, the cult of the anti-hero, black humour as in Edward Albee's works, all reject and go on rejecting with passion and vigor. Existentialism (whether Kierkegaard's or Sartre's), one of the few philosophies to emerge in this century, is not very positive, but, as its name implies, is a philosophy of acceptance, even of resignation.

With the introduction and widespread use of such pervasive and powerful forces of communication as the radio, the cinema and the press a large mass of people has been awakened, and this mass has to be fed with the kind of news and entertainment it will enjoy. Hence the escapist spy stories, glamorising James-Bond-type heroes, cowboy thrillers, and the lavish spectaculars of the films.

Does all this really matter? How does it affect us here? It makes much less difference in advanced societies where the structure is such that its mechanics must continue to function even if groups reject and become parasites or escapists. A C. P. Snow will come forward with the solution of a third culture of an enlightened elite combining the best of the worlds of science and the humanities. It matters far more in a less developed society such as ours. For one thing, time has not permitted a new social pattern to emerge so that the lack of belief and ideals coupled with the reflexes of rejection can take forms very destructive to society. It may appear facile to attribute students' and workers' strikes, looting, arson, rioting, *gheraos*, *satyagrahas*, fasts, and the other disorders which are eating into our vitals to the decline of time-honored beliefs such as respect for property and veneration for elders, but in fact a definite connection does exist. Modern science has come with a blessing in one hand and a hidden curse in the other. The colossus that threatened superstition, conquered disease, produced mechanical gadgets to replace human sweat, also brought with it economic, social and mental ills — unemployment, overproduction, neuroses, and maladjustments.

In India medicine eradicated malaria, reduced the toll of plague, typhoid, small pox and cholera. The average age went up and the population burgeoned and what appeared to be a blessing has turned into a demographer's nightmare. The educational facilities required to produce a large number of technologists, doctors, social workers and teachers were provided. Education, communication and transportation reached out in a spectacular fashion to embrace vast segments of the population, and before we knew it we had a surplus of educated people who were qualified to do jobs which did not exist. We have grown used to hearing that our problems arise from the "transitional phase" through which we are passing, but this is hardly a valid excuse when it has endured for well over twenty-one years. The historian may be tempted to say that our problems of over-population, the

language issue, food scarcity, political instability and mob violence are a part of the cycle of our history — disintegration and disorder followed by invasion, conquest and consolidation. Whether or not this is true, it does not divest us of the responsibility of facing the facts as they appear before us. It is not so much our young people who have abdicated responsibility, but their elders. To paraphrase the words of a contemporary writer, we may be mild sheep, belligerent bulls, cunning foxes, or praying vultures, but all these animals are better than an ostrich. Ignoring the facts in such a parlous case as ours reveals an idiotic urge towards self-destruction. We have discussed our problems, relentlessly, in the press and in speeches until our pens have run dry and our throats are hoarse, but somewhere we have missed the disease and seen only the symptoms.

In a world which has shrunk as much as ours it is useful to see and analyse what is happening elsewhere even if the situations are not analogous. As in the past, inevitably new trends in the developed countries will be imported into India and imitated or adapted. Ideas and patterns of behavior travel very fast. The teenagers provide a ready example of the high speed of communication which has made possible a universality in their language and aspirations. The standard paraphernalia of western society — its TV sets, tape recorders, laundromats etc. — come to us first as luxury goods and with the passage of time, like other consumer commodities become basic necessities for a much wider range of people. We too may wind up glued to a television screen or driving bumper to bumper to find a patch of countryside. But unlike some western countries we have not, in addition to the goodies produced by technological advances, a spectacular space program which can be a source of pride to the people. The country is still, and will be for some considerable time, too poor to think in terms of exploring interplanetary space. Under-developed countries whose traditional social structure has crumbled and who have plummeted into the scientific age with its fast cars, test tubes, aeroplanes, guns and bombs are now in a state of chaos. The tools produced by science have been turned towards their own destruction.

We in India are at the crossroads, but where do the roads lead? Eventually to the self-sufficient materialism of the advanced countries with its by-products of rootlessness, indifference and aloneness or to the turmoil and internal strife we see in countries where the new has not made its peace with the old.

It is easy, on the one hand, to predict optimistically that future generations will solve everything, that youth holds the answer and will create a new golden age out of its present restlessness. It is equally easy to say that the world in general, and our country in particular, is going rapidly downhill, the young are becoming wilder and more undisciplined and there is little hope left. Neither approach gets us anywhere. We are too close to our time

to see its phenomena in historical perspective. Not having the gift of prophecy we cannot foresee what changes the future will bring. But it is important to pose the problem clearly and accurately. Stating a problem thus is already going half the way towards solving it.

The erosion of belief in religious codes, the values of materialism, the comforts provided by the contrivances of technology, seem to have produced people who do not have and do not wish to have a sense of commitment. Idealism has become almost a dirty word. One's primary duty is to provide, as far as possible sumptuously, for oneself. If one's own country does not suffice greener pastures are sought elsewhere. Time, effort and money are spent on the training of engineers, architects, doctors, chemists, physicists, who have no sooner received their degrees than they emplane as immigrants to rich countries. Technologists who remain behind work hard at their individual specialisations. They hold frequent professional discussions at home and abroad, but there is a lack of horizontal communication within their profession as well as with other professionals. The result is that each specialist's view tends to be myopic, as if he were wearing psychological blinders. The overall objectives are blurred and a sense of purpose (other than specific purpose) is dim. Specialists — both in the sciences and the humanities — regard trips overseas not so much as opportunities to learn from others' achievements or profit from their errors and apply their observations to the Indian context but as jaunts — free pleasure trips with the P-form, board and lodging taken care of. Perhaps there is something lacking in our educational institutions which teach science, technology and the humanities. Universities have become little island factories for producing graduates.

Businessmen are so busy making a fast buck by means fair or foul that they do not hesitate to adulterate even life-saving medicines. That industry has grown and is flourishing in spite of these practices is to our credit. Administrators are caught in the web of departmental intrigues and politicians in the jockeying for power. Those who secure jobs become smug. Those who do not become rebels. Few, if any, care for the common weal. Nehru's vision of the adventure of building a new India in the 1950s has undergone a sea-change in the 1960s. Self and pelf are the unspoken goals. It is scarcely to be wondered at that there is widespread frustration which erupts in periodic violence.

Occasionally one hears the cry for inspiring leadership. Occasionally the old guard recalls with nostalgia a vanished world when there were causes to live and die for. Liberals from any country could go and fight in the Spanish Civil War or, like Schweitzer, try to heal the lepers, or become followers of Gandhi. A kind of world fraternity of liberals existed.

Perhaps today people everywhere, and in India in particular, are in need of such a fraternity — dedicated scientists, philosophers, writers and artists —

who can make living purposeful for their contemporaries and the coming generations. This cannot come about inadvertently, but has to be consciously sought after and created both in one's immediate environment as well as in a forum such as this.

Such a gift will give meaning to all the products and researches of science and all the learned treatises of scholars.

During the course of the seminar I have noticed certain phrases being used which I believe are misleading in the present day context as they are either outmoded or meaningless. The phrase "Marxist Morality" may have had a meaning 50 years ago. It has none today. "Scientific Morality" is a contradiction in terms. Science does not impose any morality or injunctions. Science has its own logic. As science introduces innovations whole patterns of social behaviour become outmoded. For example, the use of contraceptives is not a 'moral' imperative but a social and economic one. Science and technology are against simple abstract formulas.

India is at present on the threshold of the Industrial era. Most countries of Europe entered the Industrial era a considerable time ago. The U.S.A. and other advanced countries such as the U.S.S.R. and Sweden are entering another which is as different from the preceding one as it was from the agrarian. In fact, this new change is even more fundamental with the increasing use of automation. Electronics and computers will change working habits completely. Industrial progress will no longer determine social change, social structure and social values. Workers in industrial employment will make way for automation and cybernetics. The new society will be shaped by technology and electronics especially computers and communications. In the not too far distant future the average American, Russian or Swede will not have to work more than two or three days a week. He will have an enormous amount of leisure. The exhortations heard today to work harder and produce more which are essential to an agrarian and industrial society will become positively harmful and anachronistic. Work and leisure will come to have different meanings.

Changes will take place much faster. Those who control information will exercise power.

It is possible to visualise mind control, genetic interference in human beings and even the creation of robots who will perform the work of men.

The ideologically minded elite will be replaced by specialists who will relegate various activities. Audio visual data will be readily available in any house. This will affect educational technique. This may also bring about the Orwellian light more of total surveillance. The gap between the underdeveloped countries and the industrial ones will continue to widen, and a new gap will be created between the latter and the advanced societies. The

USA, USSR, and one or two other countries are entering a new historical age.

The underdeveloped countries are becoming relatively poorer. Their specialists will, through travel, the cinema, radio, TV, be a combat with these changes, will understand and so far as it is possible put them to use by introducing new techniques and procedures. The poorer sections however will become aware, through the new media of communication of the enormous gap and they are bound to feel a sense of frustration. It is difficult to conceive of the new societies producing ideologies as they did in the past, which could find an application in the poorer countries to offset this imbalance. In this may lie the seeds of envy and hatred and thence political instability and disorder.

The nuclear striking power plus the ability to nullify the possessed by the two super powers has already lessened the risks of a global conflict but it does not rule out the possibility of local wars.

How are we to avoid the harmful effects of this widening social and cultural gap inherent in the three major types of society today? A confrontation could bring chaos. In Kenneth Boulding's words: "The network of electronic communication is inevitably producing a world super culture, and the relations between this super culture and the more traditional and national regional cultures of the past remains the great question mark of the next fifty years".

There is a need more than ever before for discussion on a world-wide scale to find out what we wish to preserve and nurture beyond merely economic development. In our own country new techniques will be available. But they demand the capacity to frame the questions properly for today. For next year and for the next twenty years "Whither" and "How"? As has been said our development programmes are being constantly outstripped by the growth of our population so that we are in effect practically standing still.

The creation of an inter-disciplinary forum to meet regularly and frequently to exchange ideas, pose problems as they arise and suggest solutions taking into consideration both immediate and far-reaching effects, is one suggestion worth trying out.

G. D. JOGLEKAR

Science and Spirituality

THE subject of science and spirituality is interesting not only to the scientist and the philosopher, but is also of interest to enlightened people in various walks of life. Scientific developments are engulfing the activities of men. They have now experienced the advantages and disadvantages of scientific and technological developments and they naturally have formed their well-founded opinions on this subject; these opinions may be quite interesting and perhaps at variance with each other. In this article I have tried to put forth my views as a scientist as well as one interested in the spiritual values affecting our life.

A question that one would be tempted to ask is, "What do we understand by science and spirituality, and what is the connection between the two? Can they work together for the betterment of humanity? Nothing could be more important at the present time than getting an answer to the above questions. In the present paper an attempt is being made in this direction to emphasize the importance of the integration of the outer life with the inner life, i.e. Self of man.

I begin with a passage from the *Bhagavad Gītā*, wherein one comes across the words ज्ञान and विज्ञान together in two places. In the seventh chapter, Shri Bhagwan says:

ज्ञानं तेऽहं सविज्ञानमिदं वक्ष्याम्य शेषतः ।
यज्ज्ञात्वा नेह भयोऽन्यज्ज्ञातव्यमवशिष्यते ॥ (7-2)

I shall tell you ज्ञान along with विज्ञान without any reservation: know-
ing which there is nothing left to be known in this world.

Again in the ninth chapter, Shri Bhagwan says:

ज्ञानं विज्ञानं सहितं यज्ज्ञात्वा मोक्षयसेऽशुभात् (9-1)

Knowing ज्ञान along with विज्ञान you will be free from evils.

The word विज्ञान has been interpreted differently by different commentators ; but I prefer the interpretation given by Jnaneshwara and Tilak.

Jnaneshwara¹ tells us that ज्ञान is ब्रह्मज्ञान or आत्मज्ञान i.e., spiritual experience which lies beyond the scope of reason, and the rest is विज्ञान or प्रपंचज्ञान or worldly knowledge.

According to Tilak² by ज्ञान one understands that God is to be found in everything in this world, and by विज्ञान one understands how from Him all these perishable things in the world are created.

When we go back to the *Upaniṣads* we come to this distinction between the *para* and the *apara vidya*. No amount of mere intellectual equipment would enable one to apprehend the Reality. There is a distinction between *para* and *apara vidya*, between higher and lower knowledge. According to the *Mundaka Upaniṣad*³, the lower knowledge is the knowledge of the Vedas, of grammar, of etymology, of metre, of the science of heavens, while the higher knowledge is that by which alone the imperishable Being is reached. In the *Chhandogya Upaniṣad*⁴ Narada tells Sanat Kumara that he has studied all the *Vedas*, as well as all history and mythology ; he has studied the science of the Manes, mathematics, the science of portents, the science of time, logic, the science of the gods, the science of the Brahman, the science of the demons, the science of weapons, astronomy, as well as the science of charms, and fine arts. But he tells his master that grief fills him beyond the ocean of sorrow. . . . This passage brings into relief the distinction between the lower knowledge and the higher knowledge.

The *Isopaniṣad*⁵ tells us that the life of bare contemplation (ज्ञान) and the life of bare activity (विज्ञान) are alike, fraught with evil ; but that he alone may be said to attain the goal of life who knows how to harmonise the two different paths. ज्ञान and विज्ञान are necessary for living a full life, or, in other words, the life calls for an integration of the outer with the inner self. This is brought about beautifully in *Brihadaranyaka Upaniṣad* in the episode of Yajñavalkya. I could do no better than to quote Prof. Ranade⁶, "It was thus that even that idealistic philosopher Yajñavalkya when he went to the court of King Janaka and was asked as to whether he desired wealth and cattle, or victory and controversy, said he wanted both: he wanted the cows along with their golden coin, as well as victory in the argumentative battle with the other philosophers in Janaka's court. The apology which Yajñavalkya apparently offered for his conduct was that he was enjoined by his father not to take away any wealth without having imparted spiritual instruction. It is evident that Yajñavalkya desired both material as well as

spiritual good ; and in spite of his otherwise supremely idealistic teaching, he possibly wanted to set an example by showing that the consideration of external good cannot be entirely ignored, even by idealists as constituting a moment in the conception of the highest good." The two should be reconciled in a proper perspective. Science without moral backbone might only degenerate into something harmful. In fact, science and spirituality are inseparable in the interest of the full development of the man and the mankind. Yajñavalkya expressed his views three to four thousand years ago, but they have not changed even to the present time as seen from the following passages.

Hutchins⁷ has said, "The advancement of man in spiritual excellence and physical welfare is the common goal of mankind. Universal peace is the prerequisite for the pursuit of that goal. Justice in turn is the prerequisite of peace".

Thomas E. Murray,⁸ Atomic Energy Commissioner in the US, in his thesis 'Science and Religion must join if World is to survive H-Bomb' observes: "The physical discoveries which have shaken the spiritual faith of some men are also shaking the philosophic foundations of materialism. I have noted a new extremely encouraging disposition on the part of some leading non-religious scientists. They are beginning to acknowledge that the concept of divine creation should no longer be dogmatically excluded from rational speculation about the origin of the universe. To my mind there are today startling possibilities of a religious break-through into the secular mind. The time is ripening for a marriage of religion and science".

Einstein has also expressed similar ideas which will appear subsequently in this paper.

It would be seen from the above discussion that the two words, viz. ज्ञान and विज्ञान or परा and अपरा vidya are in the modern terminology: Spirituality and Science.

This integration of science and spirituality or even the thought of it was not to be met with in the early period of the scientific era, which began about 300 years ago. I prefer the word spirituality to religion, or, in other words, ethical religion to ceremonial or ritual religion. There was an unreconcilable conflict between science based on knowledge of how facts are related and conditioned by each other, and religion, i.e. religious practice, governed by superstition and tradition. Both science and religion have always been developing, though the achievements in the field of science have been spectacular. Science, the word used in the most general sense to indicate natural sciences, and technology are the two wheels of the vehicle of development ; they provide us material benefits but not cultural and higher values of life. Therefore, the achievement of the ultimate goal of living a full life cannot come without help from the other source, viz.

spirituality which emphasizes the moral and ethical values of life. We are men before we are scientists, and, except in the context of what the individual and humanity should be and should pursue, our science will be of little worth. In the laboratory, in his experimental work, the scientist seeks truth and is guided by reason; reason implying the ability of man to come to agreement and results by discussion and thought. But does the scientist behave the same way when he is facing a human problem? Not on many occasions, probably. If he again happens to be a person controlling the destiny of many men the result would not be happy. Einstein in his essay on Science and Religion says:

“Science without Religion is lame,
Religion without science is blind”.

What Einstein wanted to impress was the value of the humanizing influences of religion on science and the value of scientific training in the fields of religion, in order to appreciate the value of the noble principles therein.

When we talk of science, we should have a proper notion as to what is understood by science. A number of definitions have been given by well known authorities; for example, Einstein says⁹:

“It would be difficult to come to an agreement as to what we understand by science. Science is the century old endeavour to bring together by means of systematic thought the perceptible phenomena of this world into as thoroughgoing an association as possible. To put it boldly, it is the attempt at the posterior reconstruction of existence by the process of conceptualization”.

While talking about science, Jean Rostand¹⁰ in quoting Eugene Batallion, says: “Really we create nothing; we merely plagiarise nature, and our plagiarism has not the perfection of the original.... When we succeed, it is because, on some imperceptibly small point, our logic has turned out to be in conformity with a logic that goes prodigiously beyond us....” Man with his small success begins to regard himself to be the lord of all he surveys; he may try to compel nature to bend to his sovereign will; but events in life prove that these expectations are not realized. If we consider this, the scientist, after a moment of pride for his discoveries, should bend his head in humility.

The achievements of science may be termed discoveries, while invention is the utilization of the results of discovery, new or old, brought about by technology to change the existing environment.

Scientific and technological development dominates our present day lives, our intellects, our imaginations and the prosperity of millions of men depends upon it and it has, thus, become a powerful force controlling the activities of men and nations. Man has begun to give importance to observation and reason in preference to acceptance of superstition and tradition. Science in

its early days affected only a few scientists who took interest in it, but in recent times it has been transforming ordinary life with breath-taking velocity.

With our increasing scientific knowledge and technological developments, the standard of living is increasing and life is becoming more complex. Man wants to know the good and the bad effects of every new achievement. Since the development of the atom-bomb, man is having a feeling of insecurity. The scientific progress has made the world small, but with the immense destructive power which man now possesses, the civilized world stands in constant danger of extinction.

Scientific activity—measured by the number of scientists, scientific societies, scientific journals—has been doubling about every fifteen years. Any slackening of the research pace of pure science gets reflected quite rapidly in our advancing technology, and thereby in our economic state. Progress is measured in terms of a Gross National Product (GNP), standard-of-living charts, and such other indices. The normal expansion of science demands each year a larger place in our lives, a larger share of our resources. A stage may come where this cannot be satisfied.

In the days of Faraday and Davy the scientific experiments were carried on with only a few instruments. The whole laboratory could be carried, so to say, in a tray. With the development of science, things have changed considerably. Sophisticated instruments are now required which are beyond the normal resources of the institutes. Science has now to be supported by big grants from the governments, and naturally the political outlook occupies an important part of scientific work. A substantial part of the resources are now being diverted to military sciences. With this change in the outlook of the scientific work, the scientist does not enjoy the earlier freedom, and with the development of the automation he may perhaps become a human instrument for scientific research.

The foundations of modern science may be said to have been laid about 2000 years B.C., when all the ancient civilizations of the world developed in countries like China, Egypt, India and Mesopotamia. With the passage of time some of these civilizations have vanished. One of the reasons for this state may, perhaps, be that they did not become progressive enough with the passage of time. The progress should be natural, like the rivers flowing or progressing on their journey. If this progress is stopped by artificial impediments like the construction of dams, the water becomes stagnant. Due to such stagnancy these countries which were once highly developed, now become underdeveloped or what are now euphemistically called, developing countries.

Western Europe, a small part of the globe, essentially outstepped these countries from the beginning of the 18th century, i.e., from the time of the Industrial Revolution due to development of science and technology, which

gave it the power to use natural forces and raw materials, to obtain a higher standard of living for the people. With the passage of time, USA, USSR, Japan and some other countries joined Western Europe and in some respects have surpassed it. These countries now have affluent societies, and are, therefore, known as developed countries. What the developed countries possess and the developing countries lack is modern science and an economy helped by modern technology. There is a staggering disparity in the standard of living between the developed and developing countries, and this is a great danger to humanity. The problem before the latter is, therefore, the problem of establishing modern science and transforming their economy to one based on modern technology.

The present civilization may be termed as a scientific civilization. The great difference between the old and the present civilization is that through improved transport and communications, especially mass communication systems, the world has become a small world and now there is a great deal more interdependence of one part of the world on the other. The two world wars have shown already that the fate of the nations is closely interwoven. The policy of aloofness would harm humanity. A common language becomes a prerequisite for better communication. Any discovery or invention made even in the remotest part of the world becomes immediately known through the present day communication and transport media, and influences the mode of living and thinking of the people throughout the world. Swami Vivekananda¹¹ says:

“One atom in the universe cannot move without dragging the whole world along with it. There cannot be any progress without the whole world following in the wake, and it is becoming everyday clearer that the solution of any problem can never be attained on racial, or national, or narrow grounds. Every idea has to become broad till it covers the whole of this world, every aspiration must go on increasing till it has engulfed the whole of humanity, nay, the whole of life, within its scope.”

When one reads the lives of great scientists one finds that during the last three centuries science has been advanced by people who were dedicated wholeheartedly to the task of extending scientific knowledge. Science has now become truly international in character, and this has brought about an international fellowship amongst the scientists as seen from the various international scientific societies. Recently the rocket launching station at Thumba has been dedicated to the study of upper air atmospheres for use by other countries. The shift from independent working to interdependent or international working has become the order of the day.

One would be tempted to ask whether our present civilization based on science and technology would not meet the same fate as that of the older civilizations.

In some quarters it is believed that technology, by fulfilling man's material desires, would relax human tension and conflicts, for it was supposed that only poverty and hardship made man unhappy. But we find instead that modern developments also create temptations, that far from putting an end to all conflicts by fulfilling the wishes of all men, they intensify these conflicts.

The last two world wars and the present armed conflicts bordering on major wars in various parts of the world, carried on with the help of modern technology, have shattered many of our fond expectations of a happy and prosperous world. The third world war would bring along with it new moral degradation on a vast scale. One would be tempted to ask, what remains when everything that has been created by man collapses and proves inadequate. This kind of thing cannot go on, if men have to preserve their sanity. We want some effective method by which peace could be assured.

The failure, with the help of science and technology, to solve these conflicts, political, racial, economic, linguistic, etc., which endanger human life, compels one to turn one's attention to other factors influencing life, and for the solution of the problem one must look to spiritual values which would be respected universally.

Does the moral behaviour of a person get reflected in the moral behaviour of an institution or a nation of which the person is a member, and does this in turn tend to the betterment of humanity as a whole? Moral behaviour of a nation is as important as that of an individual, but in practice it is hardly the case. Carr¹² has stated, "... Dr. Reinhold Niebuhr published a book under the title, *Moral Man and Immoral Society*, in which he showed that whereas the behaviour of an individual member of society may reach a comparatively high standard of morality, the behaviour of societies and groups in general and notably of nations, falls far below that standard. And this is true not only of actual behaviour, but of ideals and aspirations. The collective group, and particularly the nation, does not profess to aim so high, morally speaking, as the individual and not normally expected to have such a high moral standard of conduct as the individual. This observation is indubitably correct, and has important consequences."

The conflicts mentioned earlier are the obstacles which will have to be faced for the betterment of the individual and the humanity. In this connection Hutchins¹³ states :

"The knowledge of our times may be summed up in the proposition that our knowledge now exceeds our capacity to use it for good. *The solution is not to reduce our knowledge or to halt the progress of science, but to make our moral stamina equal to it* (italics mine). We have now reached the point where the bad character or even the momentary carelessness of the human race may lead to its extermination by the tremendous discoveries

which the human intellect has achieved. The problem of preserving our civilization is a moral problem. Our difficulty is not to get more knowledge or more goods, but to the right thing *with when* we get them. Today we are confident that every scientific question will in time be answered. We know that every material deficiency of mankind can with goodwill be made good. The problem is obtaining the goodwill.”

The idea of progress mentioned earlier brings in a new concept of enlightened reason as a governing factor in human relations. This is necessary for the advancement of humanity. The progress should be in all fields affecting life, especially in the integration of science and spirituality. It should advance both the culture of man and the civilization of a nation. Culture is a moral condition for the individual. Civilization means an advanced state of arts and sciences of a nation. Progress in the “process of civilization” would not mean progress in the “process of culture” or vice versa. It is hardly possible for a state to make progress without accepting religious toleration as a maxim for government. One of the greatest things our Constitution has done is to treat India, i.e. Bharat, as a secular state. The idea of toleration has to go hand in hand with the idea of unity. Freedom of thought, speech and writing are necessary for the continuation of any intellectual progress: the basis for progress in other lines which make life worth living. One of the obstacles to progress can be bad government brought about by the despot who is armed with the immense power that modern science and technology has given him, and who wants to keep his enlightened subjects in chains. In democratic institutions and states, it is necessary to choose wise men governed by enlightened reason to run the institutions or states.

The culture of an individual depends upon the spiritual training he has: the virtues he practises and the vices he discards. Indian literature, right from the time of the Upanishads to the present time, is rich on this subject. The virtues and vices which were prevalent three thousand years ago, are prevalent even now if we see their catalogue as given in the spiritual texts.

The *Brihadaranyaka*¹⁴ mentions self-control, charity and compassion as the three cardinal virtues for people who are born respectively with the *Sattvika*, the *Rajasa* and the *Tamasa* elements predominating in them. The chief virtues of man according to the *Chhandogya Upaniṣad* are austerity, charity, straightforwardness, harmlessness, and truthfulness. The thief, the drunkard, the adulterer, the Brahmicide, and the man who associates with them are all regarded as worthy of capital punishment. The *Taittiriya Upaniṣad* mentions the opinions of the three moralists, each of whom insisted upon a special virtue. The sage Satyavachas Rathitara taught the virtue of Truth. The sage Taponitya Paurushishti insisted upon the virtue of penance. Finally the sage Naka Maudgalya said that there was no virtue higher than

the study and teaching of the Sacred Books, for that, he said, constituted penance. The same Upaniṣad also tells to respect Dharma; the Law, to perform those actions which might be regarded as faultless by the society, and to practise charity with Faith, Magnanimity, Modesty, Awe and Sympathy.

The *Bṛihadaranyakaupaniṣad* tells us that man is merely a conglomeration of desire, will and action: "as is his desire so is his will, so is the action that he performs; as is his action, so is the fruit that he procures for himself".

One comes across a beautiful cataloguing of the twenty-six virtues (दैवीसंपद्) to be practised and the vices (आमृरी संपद्) to be discarded in the sixteenth chapter of the *Bhagavad Gītā*. Bhagwan Krishna says:

दैवी सम्पदं विमोक्षाय निबन्धायासुरी मता (16-5)

The virtues make for freedom and the vices for bondage. Lust, Wrath and Greed (काम, क्रोध and लोभ) lead a man to perdition. These three should, therefore, be given up

त्रिविधं नरकस्येदं द्वारं नाशनमात्मनः ।

कामः क्रोधस्तथा लोभस्तस्मादेतत्त्रयं त्यजेत् (16-29)

We cannot help mentioning here the beautiful सांगरूपक or metaphor in Tulsidas¹⁵. In considering the chariot of spiritual victory, the charioteer is God-love, who leads the warrior to spiritual victory. Tulsidas mentions here the virtues of valour and courage: truth and goodness, vigour, discrimination, self-control and benevolence; forbearance, compassion and equanimity.... The warrior must have dispassion and contentment, generosity and intellect. If the warrior wants to exercise his bow and arrows, science would constitute his bow, a steady and motionless mind the quiver, and the *yamas* and *niyamas* the arrows.

Einstein in his essay, referred to earlier, states, "A person who is religiously enlightened appears to me to be the one who has, to the best of his ability, liberated himself from the fetters of his selfish desires and is preoccupied with thoughts, feelings, and aspirations to which he clings because of their super-personal value.... In this sense religion is the age-old endeavour of mankind to become clearly and completely conscious of these values and goals and constantly to strengthen and extend their effect. If one conceives of religion and science according to these definitions then a conflict between them appears impossible."

In the scientific and technological development, money and materials alone cannot deliver the goods. They are only adjuncts, and it is the human element behind them that does the job. The power given to man by science can be used to change the world for better or for worse, for progress or for destruction. If he does not lack the mental equipoise (*yama* and *niyama*)

and the virtues mentioned above, he would use the power for the welfare of mankind.

These virtues or vices practised by an individual may be termed as individual *karma*. Individual is an organic constituent (घटक) of his family, community, nation and the world. The individual may be compared to the limb and the family, society, etc., to the body, and the individual's *karma* goes to contribute what is good or bad to them, and it in turn reacts upon him. If virtues are practised not merely for personal gain, then man and man can work together for promoting the good of humanity. It is for international bodies like UNESCO to see how far the thoughts first propounded in the *Upaniṣads* 3000 years ago, can contribute to the betterment of humanity. The education of the masses in this direction would be of immense significance today.

The effect of the individual's actions would be proportionate to the intensity of the virtues or vices the individual practises. This is brought out by the vicious actions of the despots who have brought upon humanity untold miseries, while good is brought to the suffering millions by the actions of men of high spiritual stature.

It has been stated earlier that the world has become small. We are realising that it is not only the individual but the whole of humanity that gets affected. International activity is necessary not only in the scientific and technological fields but also in other fields. The establishment of the *Auroville* at Pondichery for international living is a step in the right direction, to reduce the tensions between different communities, nations, etc., and the cultivation of the conception of mankind as a whole. The conflicts now raging in the world could be diminished if man realises that he is a member of mankind rather than a member of his own community and race, and that the present civilization based on science and technology could continue, if progress is made in the direction of providing a sort of collective life. The necessity of this has been brought out very forcibly by the two world wars and the present armed conflicts between various nations.

As one enters the foyer of the National Physical Laboratory, Delhi, he sees two tablets there which are reproduced below :

“Take interest, I implore you, in the sacred dwellings of which one designates by the expressive term: LABORATORIES. Demand that they be multiplied and advanced. These are the temples of future — temples of well-being and happiness. There it is that humanity grows greater, stronger, better.”

— Louis Pasteur

सत्यमिति सप्यवचा राशीतरः । तपो इति
तपोनित्यः पौरुशिष्टिः । स्वाध्याय प्रवचने
ऐवेति नाकोभौद्गत्यः । तद्धि तपस्तद्धि तपः ।

Taittiriya Upaniṣad : I-IX

It would be seen that those responsible for putting these tablets at the time of the opening of the NPL Buildings, have shown great insight, by bringing out the importance of the integration of Science and Spirituality. Let Science and Spirituality cherish one another to attain the highest good of humanity ; or in the words of the *Bhagavad Gītā* :

परस्परं भावयन्तः श्रेयः परमवाप्स्यथ (3-11)

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JAMAL KHWAJA

Science and Religion

SCIENCE is systematic description and explanation of Reality at the level of human sense experience. The method of science is that of laws having progressively wider applicability. The function of a scientific law is to transform the brute data of experience into instances or exemplifications of intelligible patterns of event-sequences. Such an explanation not only satisfies the 'cognitive urge' of man, but is essential for controlling or manipulating his environment for the satisfaction of his aims and purposes. But mere descriptive knowledge and scientific explanation are not enough for man, who yearns for an existential interpretation (E. I.) of the human situation within the total cosmic context. This quest is a deeply ingrained human personality need. It is *sui generis*, and different, though allied, from the quest of scientific explanation. An E. I. of the universe should, therefore, never be deemed to be a pre-scientific or pseudo scientific explanation of events, nor is it just a poetic metaphor. To confuse the two is like confusing ethical and perceptual or ethical and aesthetic statements, etc. Similarly, it would be futile to apply the peculiar logic of a scientific explanation to existential interpretations, just as it would be futile to demand that a scientific proof in the realm of, say, physics or chemistry should be as tight or rigorous as a mathematical or logical proof.

This, however, does not imply that existential interpretations need have no test or criteria of validity, since, in this case, their acceptance or rejection would depend upon cultural conditioning or an arbitrary choice.

What precisely is meant by an existential interpretation of the man in the cosmos? It is far easier to give an ostensive rather than an analytical

definition. To interpret man as a drop in the ocean of Divinity, or man's conscience as the Divine spark or ray, etc., or even as the child of a Divine creator are instances of E. I. It will be seen that they are nearer poetic metaphors than scientific explanations. But while the primary function of a poetic metaphor is to please or delight the listener or reader, the function of an E. I. is to 'relate' oneself to the cosmos, or to adopt an existential 'attitude'. This master attitude, as it were, is meant to serve as a stable basis for the total ordering of the individual's responses and attitudes in the course of his life. An E. I. is thus, as said earlier, *sui generis*. Like morality the task or enterprise of existentially interpreting cosmic situation has been historically a function of man's religion. Religion is thus (a) an accepted pattern or type of existential interpretation. (b) a concrete value system, (c) a precept system, and (d) an institutional system. When the basic E. I. or world view of a religion is systematically formulated and developed by its intellectuals, it may serve as the thought system of that religion. If we reject the traditional thought system of a particular religion for some reason or other, we must fall back upon some other E. I. or thought system which better satisfied our criteria of validity or truth. We cannot live or function in an interpretative vacuum as it were, in the belief that morality and science jointly suffice for the satisfaction of all human needs. This was precisely the mistake committed by many western thinkers in the late 19th and early 20th centuries. The supposed self-sufficiency, of mere morality was an illusion born out of the western intellectuals' inability to accept the traditional Christian interpretation of man in the cosmos. This view was further reinforced by the gradual realization that no interpretation could be proved to be true either deductively or inductively. The western intellectuals' despair pushed them into a positivistic Humanism or pure 'Ethicism', in spite of Kant's view that basic religious concepts like God, life after death etc., were the postulates of morality.

The scientific outlook gradually veered to the view that morality was sufficient for man, and that religion was either a pre-scientific illusion, or at best a consolation for William James' tender folk. This implied that the process of science and technology and the eventual eradication of social evils like poverty, exploitation, etc. would ultimately deprive religion of its function, as well as of its present appeal in the presence of widespread insecurity and injustice, etc. But this belief in the all-sufficiency of science and morality is only a version of man's incurable romanticism.

The history of western Europe after the first world war shows the inadequacy or falsity of the belief in pure scientific morality without any interpretative support or base. The mono-dimensional fixation upon the peculiar methodology of the natural sciences, or in other words, viewing scientific explanations as the only model of valid interpretation generated a new

variety of scepticism after the first world war. This variety embraces not merely particular religious beliefs, but all values as such. This total and all embracing scepticism or nihilism saps the springs of all human endeavour, generating in man a total despair and a sense of the futility or absurdity of life. The logical terminus of this attitude is the quest of death, which is judged as the only means of release from the tyranny of being aware of absurdity, but being helpless to overcome it. In some cases, this basic despair seeks to disguise itself in a total hedonism. The quest of pleasure, no less than the quest of destruction, are desperate attempts to overcome the creeping crisis of the spirit, through numbing or killing the body. The phenomena of drug addiction, alcoholism, sexualism, and even such apparently disconnected 'ism' like extreme nationalism, religionism, 'scientism' and 'artism', etc., are symptoms of an inner spiritual imbalance or 'ontological deficiency'. They all betray an inauthentic human existence clinging either to escape mechanisms or fragmented loyalties instead of loyalty to an integrated value system. This inauthentic existence turns man into an insecure and anxious being. This breeds suspicion, aggression, intolerance, etc., and also an inner resistance to the promptings of man's creative conscience. This condition may aptly be termed as a hardening of man's spiritual arteries. Neither the reiteration of traditional creeds nor their intellectual defence cures this malady. Only a dispassionate self-confrontation, and more refined methods of philosophical analysis can liberate western man from his unfortunate nihilism.

Another basic mistake committed by some western science oriented thinkers was the tendency to reject the dimension of religious experience from their concept of the good life. This rejection of religious experience took place primarily due to ignoring the distinction between human experience and its conceptual interpretation. The advent of Darwinism, quickly followed by the sociological Darwinism of Marx, had exposed the difficulties of the traditional Christian or Islamic theistic interpretations. Many informed and self-consistent Christians were thus obliged to reject their traditional interpretation. But, unfortunately, they also rejected or were prone to reject the basic religious experience itself, which was part of the given data or the referents of their particular interpretations. This has led to a needless impoverishment of western man. Perhaps the swing towards or the fascination for 'transcendental meditation' etc. is a compensatory trend. It is very significant that even Russian Marxists have become interested in paranormal phenomena.

Religious experience is the feeling or sense of the 'holiness; of the oneness of the cosmos'. As man confronts or 'existentially interprets' the universe as a totality rather than as an object of perception or of scientific knowledge, he may be impressed or carried away by the immensity, complexity, regu-

larity, beauty, etc., of or in the universe, and experience an indescribable sense of 'nothingness', dependence, awe, etc., together with a deep yearning for 'melting' into the infinitude of the 'Holy Other'. These vague and half articulated feelings, images and responses are *sui generis*, and cannot be reduced either to moral, aesthetic, perceptual or logical experience. The 'state of mind and body' which we term 'religious experience', is a distinctive and unique organic whole of perceptual, aesthetic and moral 'experiential moments'. In other words, 'religious experience' has points of contact with the above described types or dimensions of experience, without being reducible to any one particular dimension. Religious experience has varying degrees of intensity, clarity, duration, etc. It may be accompanied by peculiar physical or bodily changes, like palpitation, sweating, an electric thrill running into the marrow of one's bones, spontaneous outburst of tears, strange visions or sense of 'the numinous' etc. Religious experience is, however, invariably cathartic and 'integrative', i. e., leads to an inner integration of the individual. This integration brings about clarity and a sense of direction and supreme purpose to the individual. His doubts and perplexities or hitherto fragmented loyalties are healed, and he becomes a 'whole' man, ready to 'melt' his 'individual wholeness' into the 'Cosmic Wholeness' of the 'Holy Other', of which he feels to be an integral part.

This sense of 'wholeness', however, is not a mere reflex or mechanical consequence of the religious experience. This integration is the fruit which grows upon the tree of an existential interpretation of religious experience.

The activity of interpretation is normally carried on in terms of the categories or concepts of the society of which the individual is a part. But an exceptionally creative individual may reject, modify or transform the received set of categories and concepts in order to achieve a more consistent and satisfactory interpretation of his authentic religious experience. Thus, the concepts of a Creator God, prophecy or revelation, incarnation etc., are the concepts or categories of Semitic or Aryan Society that were traditionally adopted for interpreting the authentic religious experience of the line of prophets and seers. The Creator God as such is never experienced or encountered by the individual. But the concept of a Creator God is adjudged as the most satisfying or 'true' existential interpretation of the prophet's religious experience. The popular conception of Islam as well as other religions misses the organic connection of the traditional interpretation with the socio-cultural conditions and the inherited conceptual framework of the society in which a particular religion grows. Theism is certainly one of the many possible existential interpretations. In its traditional Christian, Hindu or Islamic forms, however, it raises some serious difficulties for the self-consistent and critically oriented person, who has outgrown the stage of dogmatic religion, and is committed to the basic value of

spiritual autonomy or inner freedom in the Socratic, Buddhist or contemporary existentialist sense. However, many other interpretations are available, even within the wide connotative range of different major religions, e.g. Vedantism in Hinduism, and Sufism in Islam. Unfortunately, many science-oriented intellectuals who detect serious inadequacies in traditional theistic interpretations tend to equate the genus 'existential interpretation' with one of its species, namely, belief in a personal God. And when they reject the concept of a personal God, they are very apt to reject the concept of E. I. as such. Similarly, most people equate religion with belief in and submission to an external Creator God. Hence, when they reject this notion of God, they are apt to think that they must reject religion as such. But the word 'religion' remains a mere variable in the logico-mathematical sense, until it is given a concrete value. Consequently, if the word 'religion' be taken to mean exclusively 'submission to an external authority', the rejection of such an authoritarian approach *ipso facto* amounts to the rejection of religion. But then, why must the variable 'religion' be given this, or only this, and not some other value or concrete connotation? I would personally prefer to give some such value as 'authentic existential commitment' or 'the quest of cosmic integration' etc. to the variable 'religion'. Thus, whether one's response to religion is positive or negative would depend partly upon the value one chooses to attach to the word 'religion'.

After this clarification of the nature and function of science and religion, let us consider some further aspects of the relationship or interaction between science and religion.

Some hold that there is a complete discontinuity between the fields of religion and of science. But this conception is an over simplification of the nature of both science and religion. Science is viewed as purely factual, while religion as purely valuational. It is then held that there is no connection whatsoever between facts and values or between science and religion. Consequently, it is thought there is no need for a mutual dialogue between these two fields of human experience.

This approach completely ignores the complexity of both religion and science. It is highly misleading to say that religion has nothing to do with facts, which come under the domain of science, or that science has nothing to do with values which come under the domain of religion. On the one hand, every religion has its distinctive thought system or world-view, apart from a distinctive value system. Every religion thus has a connection with the realm of facts. On the other hand, science generates its own distinctive values, even though it is admittedly not concerned with values, and is an enquiry into the nature and explanation of facts. Consequently, science cannot be said to be without a valuational temper of its own. For example, the scientific method of observation and experiment or suspension of judg-

ment and formulation of verifiable hypotheses leads to a distaste for speculative metaphysics or a hairsplitting theology, both of which fail to possess any operational definitions or concepts. Similarly, a techno-centric society generates the new value of equality of the sexes or the value of speed, or the ethic of planning, etc. Moreover, science is not only relevant, but crucial for the purpose of the realization of basic values. In other words, science has a bearing on instrumental though not intrinsic values. Consequently, science is absolutely unavoidable in the determination of our means for the realization of ends. The inevitable conclusion, therefore, is that the slogan of a neat and clean demarcation between the domains of science and religion breaks down. It follows that we cannot combine a pre-scientific cosmogony or value system, or socio-economic structure with the scientific outlook or a techno-centric economy. This synthesis can of course be attempted, and may even last for a short period of time. But the inner tensions and strains would inevitably disintegrate and destroy such a synthesis.

Field tension means a tension or conflict between the 'directional functioning' or pull of two or more fields of human experience. Thus, if the thought-cum-value system of a particular religion pulls us towards a man-dominated society, while a techno-centric economy pulls us towards a more or less complete equality between the sexes, a tension is generated between the religious and the scientific fields of human experience. Similarly, tension may develop between the fields of art and science, or art and religion, science and morality, etc.

The concept of field integration implies an antecedent awareness of field tensions, and the value of an inwardly unified, organised and autonomous human being, who functions without inner stress or strain. Field integration means a conscious and systematic confrontation or dialogue between the different fields of human experience with a view to the overcoming of any patent or latent tensions between them. The process of integration involves the pruning or the extension of the conventional connotation of basic concepts, or, in current analytical idiom, the alteration or revision of the persuasive definitions or uses of the basic words in question, like God, creation, justice, beauty, etc.

The concrete reinterpretation of religious growth in our factual knowledge improved conceptual tools and our ever growing insight into the complexities of things. This reinterpretation involves an ever growing convergence or integration of the basic concepts of all the different natural, social, and humanistic sciences. This integration does not imply the creation of a super science or super philosophy sitting in judgment on the conclusions of the different sciences. All it means is that the basic well established concepts of the various fields of human knowledge cannot be viewed as irrelevant for the task of the concrete interpretation of the faith. For example, the

geological concept of time, i.e. an enormous time span with many long periods, or concepts of biology, like the many long periods, gradual emergence of life, ceaseless variations, mutations, evolutionary 'blind alleys', recapitulation, etc., or the concepts of sociology, like the impact of the means of production and modes of consumption on the total religious and moral beliefs of the society, the interaction between socio-political factors and moral and religious ideas, or the concepts of psychoanalysis, like man's fear of freedom, his sense of anxiety, his ontological loneliness and his flight into the arms of an external authority as a means of escape from the burdens of freedom, or the compensatory consolation and security generated by certain beliefs, or the concepts of Semantics, like types of meaning or use etc., all these basic concepts are relevant for determining or rather re-determining the concrete interpretation or understanding of one's faith.

The concept of field integration is supplemented by the concept of 'dimensional integration' of the individual i.e. integrated human growth. The dimensions of human experience are the basic coordinates or categories of man's response to his environment, namely, perceiving, feeling, interpreting, explaining, morally approving, artistically appreciating, and spiritually 'melting' or self-transcending. These are the basic capacities of the illustrative not exhaustive human essence. Every individual possesses all these capacities, but in infinitely varying proportions.

The ideal of dimensional integration is a much more inclusive and richer concept than of rationalism. Full integration includes the cultivation of reason but is not reducible to it. The hall-mark of 19th and early 20th centuries was rationalism, which was a legacy of the previous age of reason and enlightenment in Europe. But this mono-dimensional approach must develop into a multi-dimensional approach, changes in Russia, etc., which give due recognition to all the facets of human life.

A. A. KRISHNAN

Science, Philosophy and Religion

the three paths to equilibrium

MAN struggles today more confused than ever before to find his equilibrium in society and himself. His ceaseless search for material comfort, mental happiness and peace of spirit seems to be endless. And his feelings are split in an atmosphere of material, mental and spiritual confusion, standing as he does harassed, uncertain, wavering, double-minded, ineffective, easily discouraged, all too often tempted against any power to resist ; constantly diverted from one undertaking to another, finding it almost impossible to keep his resolutions or carry out his intentions. He believes in one thing and does another. What an astounding condition for an intelligent man! And even as he delves deeper into science through matter, into philosophy through the mind and into religion through the spirit, more confused he becomes, beset as he is with inherent built-in contradictions which he is unable to understand, appreciate, reconcile and realise.

So as it is, is there any hope indeed for his eventual understanding, appreciation and realisation of the attainment of a psychodynamic equilibrium in the world of matter, mind and spirit?

'Man has been carried along through the tide of history inexorably 'forward' along an amazingly fascinating route, a route that can be traced with some certainty for over four thousand million years.' The changes that have occurred during this long span of years may be termed 'progress' or 'is it?' or even called 'evolution' or that natural, fundamental and ceaseless 'drive' towards achieving comfort, happiness and peace, realising the truth and attaining the equilibrium.

The one approach has been in the physical plane, the understanding and

utilisation of matter and energy, through the path of science. Natural sciences are concerned with all research pursued to explain phenomena not created by man. It is truly the aim of human effort to comprehend and control such forces of nature. These are the foundations of the modern age, the cause of all the revolutionary changes we witness today all along the line from technology to medicine.

According to classical physics the world consists of 'things' in space and time, the 'things' consists of matter, and matter can produce and can be acted on by forces. And the human attitude changed from a contemplative one to the pragmatic one and man got more interested in not what the 'thing' is, but in what we can do with the thing ; in other words, natural science became technical science. But as enquiry into matter went deeper and deeper, modern physics evolved and this resulted in the dissolution of the old framework, connected with the fundamental concepts like matter, space, time and causality through the theory of relativity and atomic structure and the uncertainty principle. And the most important feature in this development and analysis of modern physics is the experience that the concepts of natural language was that which represented reality as was understood from the immediate contact with reality. 'But the scientific concepts are idealisation based on refined experimental tools and are precisely defined by axioms and definitions necessary to connect them to a mathematical scheme. And even here in mathematics, the most precise field of science, we cannot avoid using concepts involving contradictions. For instance, it is well known that the concept of infinity leads to contradictions that have been analysed, but it would be practically impossible to construct the main parts of mathematics without this concept!'

The impact of the scientific language also changed our attitude towards concepts like the mind, spirit, life and God which belong to the natural language. We have no satisfactory definitions of these in the scientific language, and we also encounter various contradictions when we apply them. This has given rise to increased scepticism, but it has at the same time turned it against over estimation of precise scientific concepts and against scepticism itself.

The world of technology is based on a true knowledge of nature as proved experimentally — by laws, orders and classifications. The world of matter perceived by the senses is found to be changeable and matter is now known to be a special case of energy, or energy is 'rarified matter', or matter is 'condensed energy'. But still we know not what is the origin of this energy, though we can manipulate and use it. 'So it has come to pass, that deeper as we go, our terms become elastic and appear more and more to become symbols and signs and stand for something certainly real but not yet comprehended, nay mysterious!' Such findings through the path of

science and technology have made man more bewildered and confused, and he is madly groping in this 'enlightened' darkness, as it were, to find his equilibrium and peace, driven, as it were, from a state of confusion more confounded!

Not long ago even science, particularly physics, went under the name of natural philosophy. As science of matter began to develop a stature, 'egotistic though', of its own, it disliked the word philosophy and began to define philosophy as that branch of enquiry speculating on unreal things, while it did on the real ones, those cognisable by the five senses. Then it came to be called as meta-physics 'strange the word physics is still linked on'! And as science grew wiser the very scientists who ridiculed the philosophers began to speculate on topics like 'causality' 'reality of the world' 'free will' and a 'supreme Being' 'God', 'ultimate cause', etc. How strangely the planes of enquiry met, the one of matter and the one of 'mind'.

In this journey through the philosophical path towards equilibrium, the 'mind' is the vehicle and the sixth sense, the faculty of reasoning, the charioteer. And philosophers made ontology the starting point for the exploration of the infinite and of the divine to understand the problems of 'being', of the essence of the ultimate 'equilibrium'. Although to clarify, understand and comprehended these, one had to accept not only those which can be known by the five senses materially, but also that which could not be known, but which, though not directly, was deductively known to exist, by the sixth sense, by intellectual reasoning.

Truly, we have seen that without such justifiable assumptions even the exact sciences can achieve little. This journey certainly involves the abandonment of strict scientific method, leaving the firm ground of matter and peering into the subtle 'being'. This has left man with one leg on the ground and one leg in the air, completely unbalanced, and he struggles with himself, the world and society, unable to understand in his eternal and natural longing and search for an enduring equilibrium.

The ontological thinking of the old time philosophers, naturally, led them towards religion, to the field of the 'spirit', where symbols and rituals were the basic elements. This journey through the religious path used 'belief' and faith as the charioteer driving the vehicle of symbols and rituals. Such an approach produced the confident assertions of theology linking the gross matters and the subtle mind and the subtler spirit. We talk in symbols when we talk of 'God', the *atma*, the *paramatma*, and the artist created material objects to symbolise the hallowed traditions. Mortals as we are we can only symbolise to describe things not of the material world, but belonging to the transcendental, the infinite, and the incomprehensible.

This symbolism, though found necessary, has its built-in dangers, and man today, more than ever before, is unable to escape from thinking some-

times in terms of the symbols only and substituting its concrete tangibility for the unknown and unattainable reality and making God of the idol, as it were. This has become a magnificent make-belief. Another danger, under which man labours, is to allow himself to be left unconvinced by such intangible and abstract symbols which do not appeal to the lower senses of perception and understanding, and thus rejects them. This erodes into the very vitals of this religious approach which are essentially 'faith' and 'belief', and consequently leaves man sapped of his zeal for life and the quest after the true, the good, the beautiful and the enduring equilibrium of life. This growing doubt in the symbolism and the built-in contradictions in this method of approach, have left man in a pall of poverty-stricken gloom and despair and into void and nihilism.

The rapid scientific and technical 'progress' that man is supposed to be making for himself by his very hand and mind slowly appears to be turning into a trap. The very comforts, the modern facilities, seem to be oppressing him and the movement of this avalanche has intensified his fears and scepticism, and material comfort is comfort no more.

Philosophy and metaphysics which exercise his being and mind is becoming more and more burdened with writings on the decline of civilization, of social ideals, of ethical and human values, and the aimlessness of existence.

Religion too appears to lose its hold and an atmosphere of spiritual confusion has also set in, as the religious tenets do not seem to be tenable when judged by the canons of the physical sciences, which use the inadequate five senses. Consequently, a new approach to our understanding and comprehension of the built-in apparent contradictions become poignant and paramount.

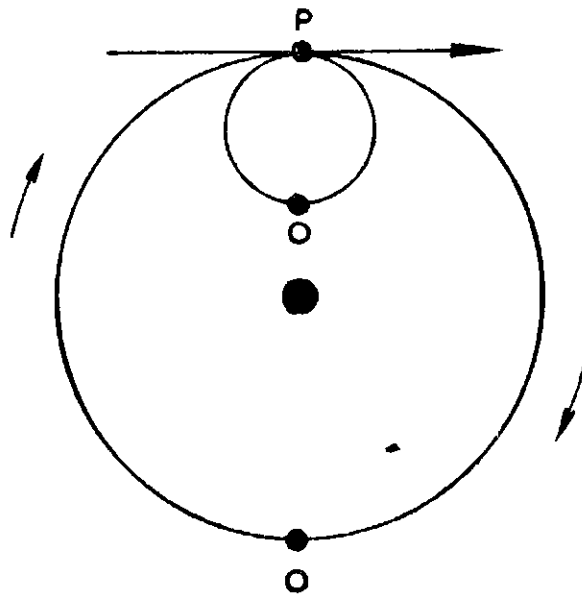
Man's evaluation and appreciation of any problem is based on his senses, and the capacity of the sense organs is governed by the range in the variations of the strength of the stimuli to which they can react. In the energy spectrum there are sound frequencies which are too low or too loud to be heard, and light vibrations are visible only over the range from violet to red, infra red and ultra violet light on either side of the visible range is invisible. And so it will not be wrong to conceive that the other instruments of sense like the touch, the smell, and the taste would also be operating only on a narrow intermediate range without any capacity to measure and evaluate below and above. This shows that man's built-in internal instruments (the senses) work and operate only in an intermediate range and this range is sought to be extended to some measure by external instruments. The sixth sense, the sense of reasoning, is a powerful tool, so powerful that it is self-creative, and under the same count, self-destructive. Despite this, the intellect heavily leans on the evidence of 'facts' known only by the five

senses, and rarely on the evidence of reasoning known only by the sixth sense, or on 'faith' which is known and experienced only by intuition, the transcendental sense.

The very many contradictions and paradoxes man comes across in his eternal quest for peace, truth and equilibrium, irrespective of the path he takes, be it science, philosophy or religion which may be likened to the approach *via* the matter, mind and spirit, have continued to baffle man more than ever before. In this magnificent evaluation and understanding the aids and tools used by science are computations of 'seeable' data, philosophy, its metaphysical connotations and logic and religion, its rituals and symbols based on faith, quite often contradict among themselves and more so when we apply the logic of metaphysics to the laws of science and the tenets and symbols of religion to the laws of science and the logic of metaphysics. So it becomes a problem of pregnant significance to evolve a new tool, a new vehicle or a new language to explain the apparent contradictions in order that we may understand and realise the commonality principle, the principle of unity in diversity, and find ourselves and our unison with the world of matter, mind and spirit in our eternal quest for the realisation of the ultimate, which is nothing but a state of equilibrium of matter, mind and spirit, i.e., the blissed state of psycho-dynamic equilibrium.

THE LANGUAGE OF THE CIRCLE

When we talk of a point, a straight line or a plane surface we talk of certain ideas in an intermediate range. At the very lowest end of this range, the plane surface as well as the straight line approach and take the dimen-

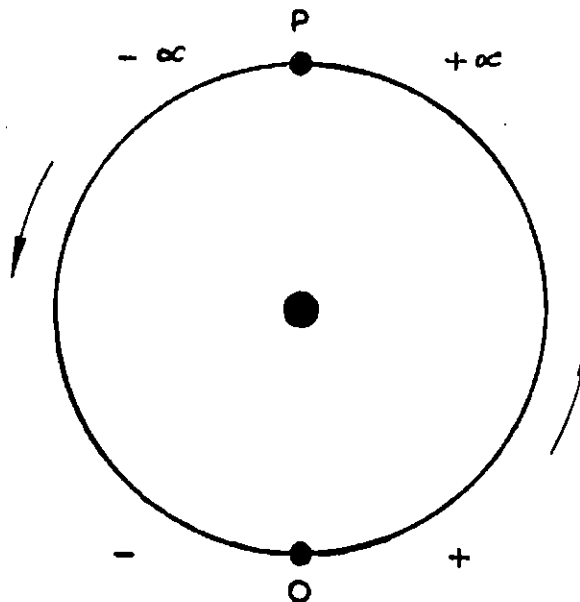


sions of a point. Looking now at the other end, the cosmic scale of space, the point would become an enormous sphere, the straight line a curve in space and the plane surface, the curved surface of a sphere, all thus connected and related to certain ideas and concepts in this cosmic spherical space.

Let us consider now this cosmological spherical space and introduce a new tool or a new language called 'the language of the circle' and try to explain, if we may, some of the magnificent contradictions and apparent paradoxes, we think we encounter both physically and metaphysically in the world of cosmic space, the world of matter, mind and spirit. The basic elements of this tool are a point, a circle and a sphere each self-generating or de-generating into the other.

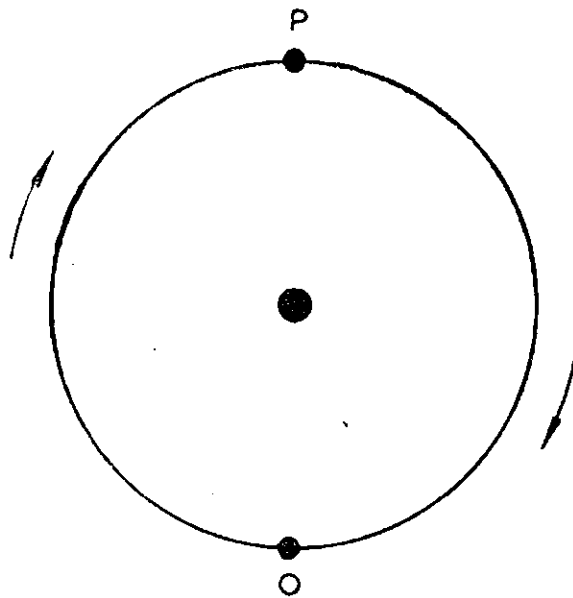
In this spherical space, if a point continuously moves forward, it will proceed farther and farther, come to a critical distance, depending on the 'drive' it has and then begin to come nearer and nearer till it comes to the very position from which it started as can be seen in the following diagram of a circle; if the point has a bigger 'drive' it will travel through the circumference of a circle with a large diameter having a larger critical distance. This critical distance may be called the distance at which the change occurs, vectorially or from the point of view of a condition, a state or dimension, depending upon what the entity of the point in motion is concerned with.

In other words, according to the language of the circle if we consider a point P on the cosmic circle, a negative infinite number, and travel along the circle getting increments in value we will come to the point, the critical distance, at which the value of the number will be zero whereafter, proceed-



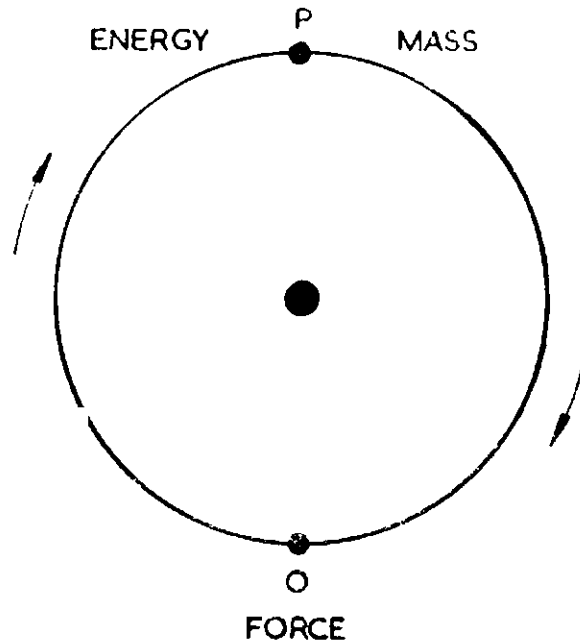
ing farther along the circle the numbers become positive with further increments, and finally reaches a value of plus infinity; strangely enough, at the very point where we started, the value was minus infinity. Certainly, nothing can run away from itself, for farther it runs, after a while, nearer it gets both physically and metaphysically!

Let us now consider a physical entity namely heat. At the starting point P let it have a positive infinite value and let it proceed along the circle losing heat and at the critical distance the value of heat would drop to O and with a further diminution of heat it will become more and more negative reaching

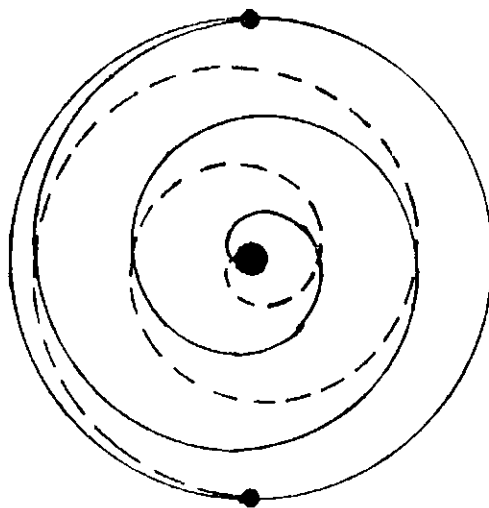


a negative infinite value and at the very starting point. Strangely, again, the infinite heat is the same as the infinite cold, and even in our intermediate scale we know that intense heat and intense cold are both unbearable to our body matter, and this is equally true when we talk of the mental plane where intense happiness and intense pain produce similar mental experience, nay, even the same physical experience, truly don't we shed tears of pain and tears of happiness!

Let us now consider another baffling concept called mass. Einstein has shown that mass and energy are inter-convertible or rather, in other words, we may say that mass is nothing but condensed energy. Let us look at this and try to explain by this new language, the 'language of the Circle'. If a mass moves with unit acceleration then the value of mass is equal to the value of force and force x distance it works. And work and energy have the same units, and, therefore, if mass is a function of energy or work which is the same, force would also be a function of mass or form or condition of mass in the mass-energy cycle, i.e., considering the law of the circle let



the point **P** where the mass is in the densest form and as it becomes less dense as it travels along the circle a reversal occurs and energy begins as it approaches the starting point, it is all energy, i.e., proving the inter convertibility of matter and energy in the physical sense. In the words of a distinguished scientist the special theory of relativity 'considered both matter and radiative forces as particular cases of the distribution of energy, to the point where the difference between matter and energy virtually disappeared'.

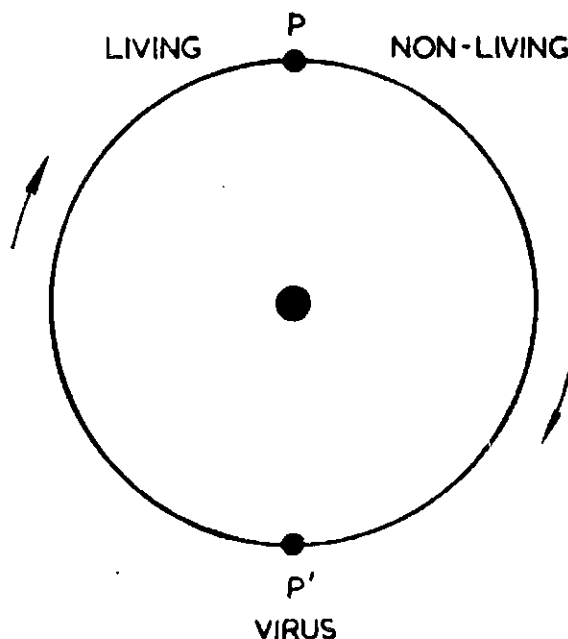


The compression and rarefaction process of the universe can be considered to have the essential properties of a Vortex ring (circles again!). Here the ring's energy is directly proportional to its diameter. But its axial velocity

is inversely proportional to its diameter. This shows that at a critical value of diameter the present expanding universe will have 'O' velocity and it is near such a condition that the reversal would take place to sustain this universe, and begin to compress and maintain its dynamism, and at the other end, i.e., at the centre of the ring or the axis, the energy is 'O' and the velocity maximum, which again becomes unsustainable and hence the reversal of this condition again, thus keeping the never ending process of compression and rarefaction of this mysterious universe.

Let us look again at the living non-living cycle and apply the rule of the circle. At the point P it is, say, non-living, and at a critical condition along the circle as we move, we come to the point P' where the change occurs, say, a 'virus' point, a living non-living entity and following farther up along the circle we come to a higher and higher form of life and at the point P the living and non-living merge and are indeed the same metaphysically. To quote the same authority again, 'an atom behaves like an 'entity' and has a 'structure'. If it loses one or more electrons following collisions with electrons or light quanta, it 'regenerates' itself at the first opportunity by taking up electrons and recovers its original structure, or basic pattern. It can, therefore, be asserted that the way in which an atom behaves bears a greater similarity to the behaviour of 'a living creature' than to that of a model functioning in accordance with the theories of classical physics.'

'It is no longer relevant to enquire what an atom, elementary particle or light-quantum really looks like. A compelling logic has accompanied the switch from demonstrable morphology to the pure forms which alone will guide the science of physics to full self-awareness. We may say, then, that



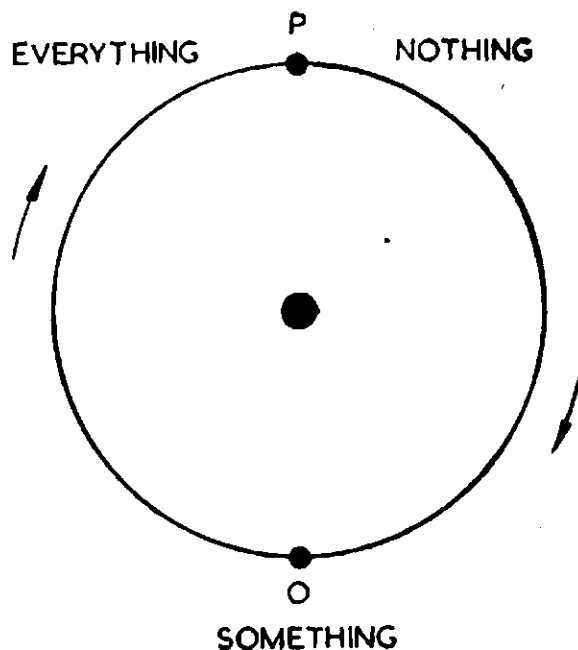
physics has reached a mature phase in its history, journeying along paths similar to those trodden by the arts down the ages, towards the elusive goals that lie in the future.'

Considering again the entities like matter, mind and spirit as different states or different dimensions, of the 'ultimate principle' we can say that matter is a gross or condensed form of the spirit and they are the same considering again the rule of the circle.

In the realm of the mind also the language of the circle is equally valid. Our reactions to pain and pleasure, the opposites, are very similar, for truly don't we shed tears of joy, just as we shed the tears of pain? Is it not true that he that never made a foe never made a friend? Truly intense love and intense hate seem to dwell together. And is he not the wisest man, he who knows that he knows not? Truly a metaphysical paradox, but certainly not so when we consider them in the language of the circle.

Then again in religion, the field of the spirit, where symbols and rituals form the basic elements, contradictions and paradoxes abound, but paradoxes no more when we look at them in the language of the circle. The 'god' of religion is described as a preserver and as a destroyer; as the all merciful and as a heartless punisher, bigger than the biggest, smaller than the smallest, nay at the same time good and bad, and 'is' and 'is not'.

Truly there is hope indeed, and it is near and within and not without. 'Nolum desiderium naturale inane' says an old Latin proverb, no natural longing is in vain. There is food for hunger, and drink for thirst, and sleep for the tired eyes. And this is for matter and so it is for the longings of the mind



and spirit. Every system will eventually find its equilibrium, but it is not static, it is a dynamic one and every successive step triggers off another and we choose one, only to forgo another. As one dissolves, another is created, only to dissolve and to create another again. What is this ceaseless strife?

Are we moving from something to another thing and end up in negation and nothing? Are we not after the thing which is both in something and everything, nay even in nothing, for truly nothing is nothing but 'nothing', where something plus nothing maketh everything? And truly, it is in the realisation of the amazing apparent contradiction that the nothing is the same as everything, by the language of the circle again that we can realise the common 'thing' and attain the 'psycho-dynamic equilibrium'. In other words, man must 'knowledgeably reconcile, but all the same, must struggle and carry on.

A. RAHMAN

Science and Religion in India

ANY fruitful and meaningful discussion of the subject should aim at defining science and religion, the spheres of their activity, their historical relationship, if any, and work out any possible relationship which could exist between the two in the context of modern social and intellectual development. Any attempt to discuss the topic, in order to be relevant to us, should also be in the context of the Indian tradition.

Such an endeavour, as outlined above, brings us face to face with two difficulties. Firstly, though both science and religion could be defined in a rather general way, a serious difficulty, however, arises when one tries to demarcate their respective spheres of activity. The matter is further complicated by the multiplicity of and wide differences in institutionalized religions and the variety of the so-called religious experiences. Secondly, though we know something of the scientific as well as the religious traditions in India, we hardly know anything of the interaction between the two. An effort, however, would be made to discuss some of these points in the light of the information available, and what could be inferred from the latter.

Science is a growing activity and it would be difficult to state precisely an expanding and growing activity in terms of a definition, which should be valid to cover all aspects of the activity and be meaningful for all times. In a general way science could be defined as a systematic approach to the study of phenomena. To begin with, such a study was limited to the investigation of the natural phenomena. The methods and techniques of study were few and limited. However, with the passage of time, methods for investigation improved, knowledge acquired became both intensive as well

as extensive and the fields covered became more numerous. The chief characteristic of science, therefore, is its continuous refinement and growth.

Science began as a revolt, as has been pointed out by Whitehead¹ against medieval ratiocination. It represented the assertion of 'brute facts', obtained through verifiable methods and systematic observation and experimentation. As scientific activity continued to develop ideas about its nature underwent a change. Francis Bacon (1561-1626), for instance, talked of science as a revolution against prejudice and superstition, on the one hand, and the surety and certainty of scientific knowledge on the other. This picture was later revised. According to Pierre Duhem (1861-1916), every achievement of science was capable of improvement but not of overthrow. However, by the beginning of this century, the picture changed radically. Karl Popper, summarizing the developments, advanced a theory of perpetual revolution. According to this, unless a scientific theory was overthrown by empirical evidence it was unscientific, and vice versa. The one conclusion which could be drawn from these changes in the concept of science is that the means, the knowledge acquired as well as the concepts developed, were subject to changes, and that the latter were evolutionary.

The term religion is rather loosely used to cover three different stages of its evolution, i.e. the two precursors of institutionalized religions, namely, the magico-religions and what is loosely termed as religious experiences, and the organized and institutionalized religions of the medieval period.

Magico-religions still survive, in some form or other, in tribal societies. The central figure of these religions is the magician, who through initiation, learns to perform certain *supernatural* acts to drive away evil spirits, cure diseases, and control natural phenomena. Nobody now takes these magico-religions seriously, other than as vestiges of human cultural evolution and for purposes of historical study of human cultures.

The so-called religious experiences are primarily a matter of individual psychology and behaviour. The religious experience may be spontaneous or acquired through apprenticeship. There are a number of schools and organized orders who believe in the primacy of personal experiences. Those who believe in these schools also believe in the mystical theory of knowledge. The latter suggests that perception of reality involves a process of illumination from god. The illumination can come to man in a state of ecstasy or otherwise. This is widely termed as Communion with spiritual forces, 'higher states', 'gods', 'reality' or 'ultimate truth'. There had been a lot of aura about these psychophysical states till recently. It is only now, with the use of both natural and synthetic drugs, that we are able to reproduce these states, and have begun to understand them in the light of chemical knowledge and knowledge of the human nervous system.

The institutionalized religions could be defined as a faith around a set of

dogma. On the periphery of each, we have series of rituals, which through practice, have become part of religion. The characteristic feature of religious beliefs, is that they are valid only for those who share it, and meaningless for those who do not.

Institutionalized religion cannot be considered as a body of knowledge, nor a means of acquiring it. It is, at best, a means for organizing human society into a community of men around common beliefs and objectives. Religious knowledge, if one could use the word knowledge for a set of beliefs, is based on individual experience based on revelation. It is passed, on from one generation to another by virtue of having been born into a family following a particular religion. It is not subject to scrutiny or growth. One could start a new religion on the basis of a new experience but could not modify the existing one. There is no growth or innovation in religion ; any attempt in this direction, as would be evident from the history of any religion, leads to the creation of a new sect within a religion or a new religion itself. And when that takes place the effort of the older religions is to suppress the newer trends and persecute its followers.

A significant feature of the religious attitudes is to promote outlooks which suggest that with the passage of time the early purity is lost, men degenerate and society decays. Consequently, the effort of the religious institutions is to return to the earlier, purer and more glorious days. The religious outlooks, therefore, generate the backward looking philosophies rather than those which look to the future.

There has been a tendency amongst some enlightened people, of late, to cut across the compartmentalisation of institutionalized religions and define religion in broad and general terms, such as the 'search for truth' or 'need for a faith', etc., etc. If such a definition was acceptable to the followers of various religions, could then one find a common or complementary ground between science and religion in terms of their definitions? In this context it may be worthwhile to quote the words of the late Dr. Sarton:

"Gandhi, or Gandhiji as our Hindu friends love to call him, was one of the noblest men of our time, and his main deed, the liberation of a continent without international war, is the greatest achievement in the political history of mankind. He deserves to be admired and revered not only by the people of India but by those of the whole world. In his autobiography he often spoke of truth (*satya*) as his ideal, and he associated the need of it with that of *ahimsa* (non-violence), *brahmaçarya* (self-restrained) and *aparigraha* (non-possession). That is all very well, but this idea of truth was at best that of a theologian or of an honest lawyer. It is clear that he did not understand truth as a man of science does. Perhaps he meant integrity or faithfulness ; when he spoke of fighting for the truth, he meant fighting for

the right (as against wrong); he was indeed vindicating the rights of his people and he did it exceedingly well. What is right or wrong in national or international politics is very different from what is true or untrue in the scientific sense."²

There is hardly any need to dilate any further upon the subject in the light of the above quoted remarks. It may, however, be interesting to contrast Sarton's remarks to those of Professor Seshadri on science and religion.³

It would be worthwhile to pick out a limited area for discussion to suggest the spheres of activity, the relationship and the interaction between science and religion. George Sarton had suggested the quest for goodness and justice as the sphere of activity of religion.⁴ Let us take justice and examine the prevalent ideas and the means available in different societies in the context of our problems.⁵

The concept of justice, it may be noticed, in the field of regulation of human relations has varied from time to time in different societies. Different religions, depending upon the area, and time of their origin, have given different meanings to it. In a society which permitted slavery, different religions accepted slavery as the basis of social organization. In the medieval period, for instance, while Christianity and Islam preached human brotherhood, they permitted slavery as an institution. In India, though slavery existed in ancient days,⁶ the regulation of human relations was mainly through the caste system. The basic assumption of the latter is the inequality of man.⁷

The societies which had accepted the basic concept of the inequality of man and had developed the necessary social organization could not but have a concept of justice which suited this basic sociological concept. The religions, which were part of these societies, included these concepts, and their implications, as a part of their tenets. Later, when this basic concept was challenged and movements developed around newer ideas, of equality of man, various religions considered them as an attack on religion and opposed them vigorously.

The modern concept of justice, whereby all men irrespective of their status, religion, caste or colour, are equal before law, is part of the newer movements which have been built around the basic idea of secularism. The latter idea and its practice have been possible through the ideas of science and through technology and its application.

The biological and psychological knowledge has contributed towards removing misconceptions, such as about the slaves or coloured people being inferior, untouchables having lower capacities, which were generally utilized to support the existing social orders. Equality in terms of capacities and

potentialities of man irrespective of his race, colour, caste or religion is, therefore, no longer a matter of compassion or belief but a scientific fact. Further, any disability in an individual, either genetical or environmental, is better understood and means, at least in some cases, are available to remove them. Consequently, efforts are made to do so wherever it is possible.

The invention of machines, which could do the menial work, has freed man from the stigma attached to him for doing certain type of work and its drudgery, and has made it possible for him to be equal with others. It is not a mere accident that those societies, which are technologically advanced and are able to use the newer gadgets are also those which have the possibility to give greater dignity and equality to man.

Science thus encroaches upon the sphere of religion when science through research brings forth new ideas and builds up a new intellectual framework. Through technology and its applications, it generates new social possibilities. The acceptance of the newer concepts demolishes the framework around which religious attitudes are built up, while realisation of the technological possibilities seriously erodes the social codes.

A study of such examples, like the one discussed in previous pages, would suggest that the relation between science and religion has not been complementary, as some would like to make out. It may also be noticed that the sphere of activity of science has been expanding continuously through encroachment on the domains of religion. Consequently, the historical relationship between science and religion has been one of conflict. It may, therefore, be worthwhile to examine these conflicts in three specific areas in some detail:

1. Belief in a god and the concept of supernatural power
2. Knowledge of nature
3. Social attitudes and practices.

(1) Personal belief in a god or a number of gods as creator, organizer, power behind the universe or as destroyer, is a central feature of most of the religions, if not all the religions of the world. It is further believed, at various levels of sophistication, that the god or deity is capable of influencing and does influence human, social, and natural phenomena. Consequently, it is assumed that god could be properly propitiated, through elaborate ritualism, whereby a person is either enlightened, communion established and the course of events modified or changed.

Science, on the contrary, has nothing to say for or against the existence of such a body. In fact, the postulate of a creator, which might have been possible in earlier phases of science, is unlikely to be true in the context of modern scientific knowledge. The concept of evolution in cosmological, geological, biological, and sociological phenomena, and the understanding

of organization and the processes of change in these spheres has rendered the chances of such a postulate to be true extremely remote. Further, the method of study of phenomena, followed in science, irrespective of the level — human, social or natural — rules out the possibility of a body controlling this phenomena at his will. The regularity of natural phenomena, and the discovery of laws governing it, goes against such a possibility. Hence, it positively asserts that if human, social or natural phenomena have to be controlled and directed, it could not be done through propitiation of a deity but through the understanding of the phenomena itself. The latter could be developed through a systematic study by methods and techniques developed in the process of acquiring knowledge itself. The validity of the contention is evident from the success and achievement of mankind in modern times.

If various aspects of the phenomena, at various levels — the individual, social and natural — are examined, it would be noticed that as knowledge has developed, the belief in the evidence of the interplay of a supernatural power to affect these has receded to the background. The supernatural explanations are not only not taken seriously any more, but the practices, based on such explanations, have also been given up.

At the individual level the belief in a god leads man to the desire of communion with him as a part of faith, or to have an insight into or a vision of ultimate reality or to acquire supernatural powers. The methods or techniques to establish the communion or to acquire supernatural powers were through ritualism. The latter was through rigorous physical recoditioning (meditation, etc.), or through other means such as music (e.g. Qawwali among Muslim Sufis, Bhajans) or dancing (dancing dervishes for instance) or through the use of drugs and narcotics. A mystique had been built around these rituals and practices. In modern times, quick results could be achieved by the use of natural and synthetic drugs. In view of our understanding of the chemical processes in man, the constitution and the mode of action of drugs and their effect on the nervous system, there is no mystique left any more. We now know that these are psycho-physical states, and have nothing to do with religion, ultimate reality or communion with god.

Social phenomena like war, the victory of one country over the other, or the success of one group over the other, is no longer considered to represent god's will and his punishment or reward. We know a little bit more than we did before about the possible causes of wars and the possible reasons of victory of one group over the other. Hence, men rely on scientific knowledge and technology to achieve their ends rather than on propitiation and prayers. What is true of social is also applicable to natural phenomena, for instance, it is no longer believed that floods, and the consequent devastation, represent the wrath of god on man for the latter's

sins. It is known how floods are caused and based on this knowledge, men are capable of taking successful measures to control them.

(2) The knowledge of nature, as incorporated in different religions and that as developed by science over the centuries, particularly since the renaissance, have often come in conflict. The reason for this conflict has been that knowledge of nature, as was available at the birth of a religion, for some peculiar reason became part of religion, and any modification or change in that knowledge through new observation, research etc. has been strongly resisted by religious fanatics.

a. *In Christianity and Islam* : Christianity and Islam accepted the scheme of universe as suggested by Aristotle, of course with some modifications to suit the needs of the respective faiths, as has been pointed out by Singer.⁸

“The scholastic’s universe, it must be remembered so far as it was material, was limited. The outer limit was the *primum mobile*, the outermost of the concentric spheres of which the Aristotelian world was composed. Of the structure and nature of all within the sphere of *primum mobile* Aristotle and Ptolemy had equipped him with a definite scheme. The self-appointed task of medieval science was to elaborate that scheme in connection with the moral world. This was specially undertaken by mystical writers, often working more or less consciously under the stimulus of Arabian learning. The schemes thus produced took into account the form of the world and of man as derived from Arabian sources, and read into each relationship a spiritual meaning. For such an attitude of mind there could be no ultimate distinction between physical events, moral truths, and spiritual experiences. . . .

“The medieval world thus knew nothing of that infinite sea of experience on which the men of science nowadays launches his bark in adventurous exploration. The task of these writers of scholastic ‘science’ was rather to give a general outline of knowledge, to set forth such a survey of the universe as would be in accordance with spiritual truth. The framework on which this encyclopaedic scheme was built was Aristotle, largely as conveyed by his Arabic commentators.”⁹

b. *In Indian Religions* : Religions of Indian origin, like Hinduism, Jainism, Buddhism and others derived from them, have their roots outside the Greek philosophical system. There is no single common philosophical system in the religions of Indian origin, loosely termed as Hinduism. The knowledge of nature and the theory of knowledge incorporated in them differs,¹⁰ so does the logical systems, attitude to metaphysics, etc., etc. The one thing common to orthodox systems is, as has been pointed out by two modern commentators:¹¹

“The spiritual experiences recorded in the Vedas are subjected to logical criticism. The question of the validity and means of knowledge form an

important chapter of each system. . . . Reason is subordinated to intuition. . . . The philosophy of India takes its stand on the spirit which is above mere logic, and holds that culture based on mere logic or science may be efficient, but cannot be inspiring."

It may, however, be pointed out here that the ideas and knowledge of nature and natural phenomena were never codified into scholastic schemes. Unlike medieval religions, in other parts of the world, a number of ideas, often contradictory, remained a part of a broadly held religious complex. Such a situation, it is suggested, had considerable impact on the relationship of science and religion in India.

AREAS OF CONFLICT

(a) *In Christian and Islamic tradition*

The major areas of conflict between knowledge incorporated as a part of religious beliefs and scientific knowledge in Europe and Arab world began with the geocentric and heliocentric theories, and later covered the theory of creation and the nature of life and evolution. The position as it stands today is that there is no competition between the scientific method and other approaches. Even though our knowledge may be inadequate about cosmic phenomena, yet there is neither any other means outside science of acquiring further knowledge nor any other method which could offer us a satisfactory explanation.

What is true in the field of cosmic phenomena is also true in the field of biological phenomena. Evolution is not only accepted as a valid theory, but our knowledge on the origin of life and functioning and inheritance of life has gone ahead. Consequently, the theory of creation of life as suggested by various religious systems, such as vitalism, is no longer accepted. Particularly now, in view of recent advances in medicine and surgery. In the field of nervous system science has not made any major break through, but in view of the researches underway, we know the areas of knowledge and information and the areas where we do not know much. It can, however, be safely stated that major break throughs would be made in the near future in the latter fields, and the ambiguities which exist in this field and are quoted to support religions would also disappear.

(b) *In Indian tradition*

We do not have sufficient information in India, as we have about the West and the Arab world, about such conflicts. There are, however, certain indications which suggest that commonly accepted beliefs exerted considerable influence by way of hindering the acquisition and development of new knowledge.

In astronomy, for instance, if we accept the statement of Alberuni, in *Kitab-al-Hind*, then we would notice that at least one contemporary astronomer believed in the heliocentric system, but could not express his belief publicly for fear of religious wrath, and hence openly supported the commonly accepted view. The example of Sewai Jai Singh II of Jaipur also throws interesting light on the problem. Sewai Jai Singh II of Jaipur, reveals himself as a truly scientific and original mind and was a remarkable astronomer by any standards. He worked in the second half of the 18th century and even though he made major contributions in developing novel astronomical instruments, yet he and his emissaries ignored totally the heliocentric system. In reconstructing the calendar and compiling *Zij-Mohammad Shahi* he talks about the inadequacy of instruments, and the need for collecting latest information about the contemporary developments in astronomy in different parts of the world. To meet the demands of instruments he devises masonic instrument and to know about recent developments, he collects a number of talented astronomers at his court and sends emissaries to collect information from Europe and other places. His emissaries, court astronomers as well as he himself, while mentioning and utilizing the works of European astronomers, are yet silent about Copernicus, Galileo and Newton and their contributions. This silence, to say the least, is most intriguing. One explanation for this silence could be that Jai Singh perhaps did not wish to start the controversy in India and preferred to keep silent for fear of consequences.

Such instances clearly indicate that religious views, which had incorporated scientific knowledge of a period, came in conflict with the newer ideas, views and concepts as and when they developed. However, this could not become a general phenomena in view of the special features of science in India. It may, therefore, be worthwhile to summarise the latter.

The separation between science and religion, as it happened in the West, never took place in India. The aim of knowledge, as it was acquired, continued to be in the context of the religion to which a scholar or a scientist belonged. Consequently, in spite of considerable information being available in diverse fields no laws of nature, to systematise knowledge in a conceptual and theoretical framework, could be developed.

Since the laws of nature were not clearly developed the question of conflict with religious views could not arise. The new information available, or a new interpretation of phenomena could, in the absence of a theory, coexist with the older information or earlier interpretations. People could pick and choose in terms of their individual preferences, or views they held, etc.

Hindu religious complex as it existed, as has been pointed out earlier, represented a wide spectrum of beliefs. In the absence of a codified religious view, while new views and theoretical outlooks could coexist with

earlier views and outlooks without causing serious controversies, the same could not be said of the social attitudes and practices. Consequently, serious challenge to science, and conflict with it, came not from the theories of nature but from social attitudes and practices.

Modern science was introduced by the British in the 19th century. Its association with the conqueror and the fact that it was introduced in a foreign language kept it isolated from reacting with the outlook and attitudes of the people in general. This isolation of and protection given to science resulted in making it a mere academic discipline. It could not, therefore, acquire the features of a social movement aiming at radical changes, and challenging the prevalent antiquated outlooks.

Since it did not go through the process of social interaction the Indian scientists developed an ambivalent attitude to science in its relation with philosophical and social values. The Indian scientists practised science only in the laboratory, whereas, outside the laboratory in everyday life, they remained entangled with antiquated ideas, a prey to prejudices and superstitions. It is not uncommon amongst Indian scientists to believe in astrology to carry out puja before performing an experiment, or to propitiate instruments and equipment! Such a social climate, where contradictory attitudes continue to coexist, could hardly lead to a commitment to science as a broad intellectual movement. The confrontation of scientific knowledge with views and attitudes associated with religion arises only with a commitment to science and its values. Despite the ambivalent attitudes of scientists and lack of commitment to science, the conflict did arise between science and social attitudes and practices, when an effort was made to modify the latter. This is evident from, for instance, the opposition to Sarda Act — aiming at the prevention of child marriage.

Joseph Needham¹² has suggested a very interesting explanation, as to how child marriage came to be a part of Hindu religion. According to Needham, biological knowledge of reproduction was limited in antiquity. Whereas the male's contribution was known, the ovum of human female was as yet undiscovered. Since the capacity of human female to conceive after menstruation was known, the menstrual blood was mistakenly taken as the female's contribution. The onset of the menstrual cycle in hot climates may begin by the age of 12, and in some exceptional cases even earlier. Consequently, in order not to waste the fertile period of the female, an early marriage was considered to be a safe thing. Particularly, in a society with a high death rate, the only safe course was to have as many children as possible and for that an early marriage, at the age of 10 or so, might have been considered desirable. The latter, through custom and practice over years, would have got successfully reduced. It should be clear from the above explanation, which is plausible, how biological knowledge

and social necessity combined to give shape to a tradition which became part of religion itself and how any attempt to change the custom, based on new knowledge and social requirements, was opposed by the orthodox people.

A similar type of conflict, in recent period, has developed over the issue of cow-slaughter. The cow, though a sacred animal in India since time immemorial, was sacrificed and the meat consumed.¹³ However, sometimes in medieval India, for reasons which are not clear, the sacrifice of cow was abolished and the consumption of beef tabooed. The latter practice came to be part of religious beliefs. Consequently, a serious movement developed against cow slaughter as soon as India achieved its independence and most of the states banned the slaughter. The movement for total ban developed recently. The question, as it stands now, has two aspects, one religious, and the other economic and scientific. Could the animal be used as a source of protein, for those who can use it such, or its uncontrolled progeny be allowed to become a pest and an economic burden? — is the vital question raised.

The scientists neither as a professional body nor as a community have taken any stand; many of course look at the problem purely from the point of view of current practice, and would support the existing practice. But if they were to take a clear cut stand and suggest measures based on scientific knowledge, a major conflict would develop.

One would have expected that after India achieved her independence there would be a radical change in the attitude of people to science, particularly in view of the policies adopted and followed by the government. This, however, has not happened. The policies adopted by the government, while it increased the number of institutions, scientists, and expenditure on science, did not generate a scientific movement. It is a curious irony that since independence the social pressures of medievalism have been promoted, under the pretext of nationalism and culture. In fact, a large number of leading scientists today have begun advocating a synthesis of science, religion, religious philosophies, and spiritualism. This would be evident from the numerous convocation addresses, and the presidential addresses delivered at the last two sessions of the Indian Science Congress Association.¹⁴ This could not but be regarded as a concession to medievalism, and is reminiscent of the attitudes of scientists in the early phases of development of science in Europe.

Further, it may also be noticed that on crucial issues where scientific knowledge is utilised for social decisions, the conflict with the prevalent social attitudes is generated, where scientists as a community are not able to take a professional stand, the question then naturally does not arise.

The conclusions which one could draw from the preceding discussion

are: lack of confrontation between scientific knowledge and religious views in India may not be on philosophical issues about theories of nature but on socio-religious attitudes. It would particularly be on issues where the scientific knowledge comes directly in conflict with socio-religious practices. The reason for that being the considerable advance in scientific knowledge, as against the earlier periods when the first confrontation between scientific knowledge and religious views took place, which has created a situation where one could hardly question the picture of the world given by science.

That this confrontation has not yet taken place in India is primarily because of the ambivalent attitude of the Indian scientists, and the concessions they have given to anti-scientific views by way of practising them in everyday life

There is, however, no doubt that with science increasingly becoming a part of the national tradition and culture the issues would come to a head. The conflict between the use of scientific knowledge in everyday life and the religious views and attitudes is bound to sharpen and the scientists would be forced to take a stand. When this happens Indian science would go through the same process of conflict with prevalent established socio-religious views as science in Europe had to go through in the early stages of its development. The issues would be different, but the problem would be the same. It is inescapable.

NOTES AND REFERENCES

1. A. N. Whitehead, *Science in Modern World*.
2. George Sarton, *Science, Religion and Society*, George Braziller, New York, 1955, p. 7.
3. For a discussion of the latter, see *Vijñan Karmee*, January 1968.
4. loc. cit.
5. The only danger in accepting Sarton's suggestion is that it may not be acceptable to the followers of most religions. They would like to give for their religion a wider and more comprehensive role, besides the latter being associated with a personal belief in god. This, however, should not detract us, as they would not exclude the specific area chosen by us for discussion.
6. Dev Raj Chanana, *Slavery in Ancient India*.
7. Some historians and writers have tried to suggest caste system as professional categories. Their contention, however, is not borne out by facts nor by the practice over the centuries. The treatment of *Sudras*, and of the untouchables and their suppression, to contain them to their lowly status, belie any such contention.
8. Charles Singer, "Historical Relations of Religion of Science" in *Science, Religion and Society*, pp. 89-152.
9. *ibid.*, pp. 121-22.

10. The Lokayatika developed a theory of knowledge, like that of the Greeks, and considered the four elements — earth, water, fire and air as the ultimate principle.
11. S. Radhakrishnan and C. A. More, *A Source book of Indian Philosophy*, Oxford University Press, London, 1957, pp. 353-54.
12. J. Needham, *History of Embryology*, Cambridge.
13. A. B. Shah, "Hindu Scriptures and Cow Slaughter", *Weekend Review*, March 23, 1968, pp. 16-8.
14. See for further discussion — Maharishi Mahesh Yogi and Professor T. R. Seshadri, *Vijñan Karmee*, January, 1968.

R. RAMANNA

Some Philosophical and Sociological Implications of the Discoveries of Modern Science

DURING the last 70 years we have witnessed a great revolution in the structure and formulation of mathematics and physics. These revolutions have been so deep and involved that it has shaken the very foundations of the laws of thought on the one hand and our ideas of the behaviour of nature on the other. It is, therefore, to be expected that such radical changes in thinking should have a lasting impact on our society and its future development. Let us review these fundamental changes that have taken place, without going into any technical details or making any arguments rigorous. They are sketched here merely to indicate the trends just enough to discuss some of the sociological implications.

Towards the end of the last century the great German mathematician, Cantor during the course of his "normal" mathematical investigations had to develop a new approach to mathematical problems known as set theory. This theory deals with quantities more general and primitive than the natural numbers used in arithmetic. One of the elementary human observations is to recognise groups or sets of objects, and Cantor's theory deals with the mathematics of such groupings. Set theory has grown to such proportions that it has now permeated into all branches of modern mathematics and in the course of its development it has changed the very nature of mathematics.

Using the powerful techniques of set theory which he had invented, one of the first things Cantor was able to do was to put an end to the mysteries surrounding the quantity 'infinity'. Further, he was also able to show that different kinds of infinities actually exist. For instance, there are many

sequences in mathematics which lead to the same infinity. Among these are a sequence of integers 1, 2, 3....., sequence of odd numbers, even numbers, square of integers, etc. All of them can be paired off to a sequence of integers (i.e. natural numbers) and thus shown to have the same infinity. Integers are discrete quantities and were discovered early in our civilisation following a need for the process of counting objects. Much later the need to measure distances began to arise and real numbers had to be invented. Real numbers increase continuously as opposed to integers which increase in jumps and thus the difference in the structure of integers and real numbers is one of difference of discreteness and continuity. It can be shown that in terms of the infinite, a continuum as represented by real numbers has a higher infinity than a discrete sequence as represented by a set of integers. Cantor was also able to show as a result of his theory of sets that not only do two types of infinities exist but a whole host of them. If now we work on these ideas in a logical manner we find that we can even order these infinities or 'transfinite numbers' as they are called. By ordering is meant that they can be put in a sequence according to their magnitudes. It is at this stage several paradoxes appear. These paradoxes are of such a deep nature that in trying to resolve them, the very consistency of the logic on which mathematics is based can be questioned. The various paradoxes and their consequences on the structure of mathematics are too involved for a detailed description here, but we mention one of the difficulties involved to indicate the type of the problem.

Let S be any set. Either S is an element of S or it is not. The latter is called a normal set. Consider Ω which contains as its elements only normal sets. It should contain Ω since Ω is normal, but if it does so it is no longer normal, which is a contradiction. In order to overcome this type of contradiction, which is not merely mathematical in character but can arise in problems of logic and philosophy, the whole theory had to be cast on an axiomatic basis. Such an axiomatic formulation has been developed, but the entire structure of the theory depends on one very important axiom known as the "axiom of choice". In the last 50 years it has been a debate among mathematicians whether this axiom of choice is (a) a consistent axiom with the rest of mathematics, or (b) whether it can be developed from the classic principles of logic. No clear answer seems to be possible and the situation still seems to be one of a stalemate. I mention this problem in mathematics because it tells you that even if you start from a consistent set of logical principles you can come across situations where no clear answer is possible.

However, these paradoxes of set theory have led to a very detailed study of the problem of language to make sure that problems of the type described above do not arise due to faulty language construction. In recent

years, the study of the structure of the language has been greatly encouraged by the coming of the electronic computers as these machines require instructions to be given in an accurate manner. We can only hope that the search for accurate language constructions will lead to a better and uniform understanding of problems of the world. Since the brain is essentially a computer (certainly of the most amazing kind), if fed with correct information, its response should be logically consistent.

The other great revolution that has taken place in science is the theory of relativity and the quantum theory. The theory of relativity has been considered to be one of the great creations of the human mind, developed almost single handedly by one person. In spite of various developments that have taken place in physics and various questions that have been asked concerning this theory, it continues to have the greatest impact on modern science. The theory is based on the fact that for two observers in relative motion, the laws of physics should be the same and that the velocity of any particle cannot become greater than that of light. The predictions of special theory of relativity has had ample verification that the postulates of special relativity can be taken to be universally valid. It is interesting to consider straightaway the implications of the second postulate, i.e., the velocity of any body cannot exceed the velocity of light. For instance, communication with far off places becomes difficult as it will take a very long time for our signal to reach these places and it becomes almost impossible to know whether other civilizations like our own exist in the universe. The theory further predicts that the clock of an observer moving at very high velocities is appreciably slowed down. This almost seems like a paradox but strange as it may seem, the clock has actually been observed e.g. the decay of the μ meson which Dr. Bhabha predicted many years ago. Perhaps the most important prediction of relativity which has the largest impact not only on pure science but on industry, economic development, and military power is the famous relation which connects energy and mass. A full exploitation of this formula can be discussed only in connection with the quantum theory and the structure of the nucleus, but without this prediction of the relation between mass and energy, atomic energy would have been impossible.

The impact of atomic energy on India has been very great due to the good organisation and early start given to it by the late Dr. Bhabha. In a few months' time, electricity produced from atomic power will be flowing through our grids and helping our industry. The fact that large sources of power can be generated with comparatively small quantities of fuel, and that they can be located in suitable places without much difficulty is going to transform the industrial structure of the country. Regions which have remained unexploited for want of power in several places can be fully ex-

ploited by way of developing the local mineral resources and agricultural potentialities.

Another way atomic energy is revolutionising our way of life is the use of isotopes in agriculture, medicine, and industry. Atomic energy has helped to produce various types of chemicals which can be labelled in such a way that these chemicals emit radiations with the help of which they can be located wherever they are. The penetrating nature of the radiations enables one to locate them in places where they cannot be seen. In this way it has become possible to trace the behaviour of chemical substances inside living matter and study the processes of life. They can also be used for detecting leaks in dams, the movement of silt in harbours and defects in weld joints in large industrial structures. Atomic energy has also helped in understanding the fundamental structure of matter, as the radiations that come out from isotopes and atomic reactors are exceedingly powerful in "illuminating" the inside of molecules and atoms. It has also provided a powerful tool in the study of genetics and in producing new mutants for exploitation in agriculture.

The fundamental structure of matter has always been one of continuous interest and speculation to the human mind. The way to analyse matter has always been to reduce it to its smallest constituent, e.g., the cell in the case of biology, the atom in the case of atomic physics, and the nucleus of the atom in the case of nuclear structure. The first problem is to identify the unit, the second is to determine the internal structure, and the third is to understand the laws of interaction between the various units.

In the case of the biological cell we know that it consists of large long chain molecules arranged in a very complex manner. As a unit these cells explain many things concerning the nature of biological systems. We have yet to understand the interaction of one cell with many others, and it is this that determines the behaviour of living matter. In normal living things, the cells usually all co-operate to sustain the body in an integrated way, but on occasions when something happens to the internal structure of the cell, it can turn out to be malignant as in the case of the cancer cell. Besides, it sometimes happens that the other healthy cells begin to co-operate with the malignant cell to destroy the living system instead of supporting it. The problems of modern biology is to understand the cell, its internal structure, and the co-operative behaviour with other cells.

In the case of solids, liquids and gases, the atom can be considered to be the unit constituent. To understand the structure and behaviour of atoms, it is necessary to introduce new laws of mechanics which are very different to those used in explaining observations that are common to us. The new mechanics is called quantum mechanics, and its principles have helped to understand atomic structure and behaviour in a fairly clear way.

The concepts of the new mechanics make an entire departure from the ones we are used to, so much so that it is difficult to picture their consequences. This can only be done by a proper mathematical formulation. For instance, we have to associate with each atom not only a particle-like behaviour, i.e., having momentum and mass, but also a wave-like behaviour like the waves of light. It is required that these two properties should co-exist, and though it looks almost paradoxical it has been possible to formulate a mathematical approach which allows for this dual behaviour. In this way, it has been possible to obtain a clear understanding of the structure of individual atoms. However, in the case of solids and liquids, where several atoms are involved, their co-operative behaviour can be very complicated. This very complication arising from the interaction of one atom with the other can give rise to some interesting properties. A familiar example of how the interaction between various atoms can give rise to new technological developments is the case of the transistor. This solid state device has revolutionised modern communication, and anybody who has seen a radio set containing valves and a radio set containing transistors will see the importance of this discovery.

The problem of understanding the nucleus of the atom and its co-operative behaviour is very much more complicated. Unlike in the case of the atom where the laws of interaction between two of them is fairly well known, the nature of forces which keep the various constituents of a nucleus together are still not understood. It has certainly been established that these forces are of an extremely complicated nature. While we have been able to use the energy that is stored inside the nucleus in the building of atomic reactors, we are far from the position of understanding how this energy comes to be stored inside a nucleus. The present picture seems to be that the various constituents of the nucleus are held together by an elusive particle, called the meson, which is exchanged between the two constituents of a nucleus, called the neutron and the proton. The meson itself is short-lived and does not exist freely in nature. Besides, as we go to smaller and smaller units, their wave like nature gets exaggerated, and it is an open question whether further study of matter by the process of sub-division is possible at all. The age old method of analysing a system by dividing it into constituent systems seems to have reached its limit, and an entirely new approach to the question of what matter is in its ultimate stages is required.

SATYA PRAKASH

Science as Religion of the Future Man

THE word 'religion' is of Latin origin ; it is derived from *relinquere*, to leave, or *re-eligere* to choose anew (i.e. to return to the deity). Another derivation is from *religare*, to bind, explained with reference to the restrictions imposed by religion, or the collection of duties incumbent upon man, or the bond with or dependence upon the Deity. Another derivation is from the word *relegere*, to gather together, reconsider with reference to the carefulness and attention to all that concerns the gods. . . . The term *relegio* itself has had an interesting history, and two senses can be distinguished : (i) a feeling of awe, anxiety, doubt, etc., one, however, so indefinite that 'religious' and 'superstitious' overlapped ; and (ii) the cult, worship, or system which arose in consequence of, and was founded upon, that feeling.

Religions have been classified in various ways. The criteria have been *dogmatic* : religions true and false, natural and revealed ; or natural and positive ; or *cultural* : the religions of savage and civilized races ; or of nomads, hunters, agriculturists etc. (of *vānaprasthins*, *gr̥hasthins*, *sanyāsins*, *brāhmanas*, *kṣattriyas*, *vaiśyas* etc.) or book religions (*Paurāṇikas*, *Biblical*, *Vedic*, *Mānava*, *Smārta* and so on) and those without sacred writings. Distinctions have been drawn also between national or race religions (as of Aryan, semetic etc.), and those founded by great individual teachers (as Buddhism, Christianity, Zoroastrianism), and those in which the idea of an individual saviour is wanting or germinal, and again between universal religions and those too closely bound up with social, national, or dogmatic restrictions to be universal.

Comparative mythology and history of religions leave no doubt that all

the religions of the Aryan, and Indo-German nations, viz. eastern Aryans (or Indians, Persians and Phrygians) and western Aryans (or Greeks, Romans, Germans, Norsemen, Letto-Slavs and Celts) are the common offspring of one primitive OLD-ARYAN religion, the earliest of which yet discovered is related to the *R̥gveda*. That the same name of the highest heaven god, Dyaus, Zeus, Ju (piter), Zio (Ty) is met with among Indians, Greeks, Italians, Germans, and Norsemen. Many more such illustrations can be cited to show a common origin.

In India, it is curious that religion also sprang in the midst of the scientific atmosphere. Atharvan or Atharvāṅgiras who laid the foundations of the *Atharvaveda* school was a discoverer of fire by attrition ; Viśvamitra, one of the Vedic Ṛṣis invented the first fire-producing convenient device, Dīrghatamas, another Vedic Ṛṣi, was the great astronomical observer and having observed the periodicity in the movement of the sun laid the foundations of the Vedic era. As I have said elsewhere,¹ it must have been an age of thrills when Dīrghatamas devoted himself for full forty to fifty years to the study of the movements of the Earth, the Moon and the Sun, and tried to find out the compass of the lunar month, solar year, and the relation between seasons and years, and it must have been a great discovery after an incessant devotion to observation that a simple year of 12 months, with thirty days in each, leaves a gap of 21 days in a period of one Yuga of four years. Dīrghatamas is the Ṛṣi of the *Asya Vāmasya Sūktam* of the *R̥gveda* which inspired the great sage to discover the Vedic era. Gārgya, another Ṛṣi of the *Atharvaveda* for the first time enumerated the constellations. *Medhātithi*, a Ṛṣi of the *Yajurveda* extended the numerals to billions. Through the rituals of the Vedic Yajñas were laid the foundations of geometry in connection of which the name of Baudhāyana is held supreme for his various geometric constructions and the Baudhāyana theorem, the precursor of the Pythagorean theorem. The numerals in the relationship $3^2+4^2=5^2$ were known in the Vedic times. Gotama strengthened the foundations of the Nyāya which was not only utilised for search of metaphysical truths but was also applied by Caraka for arriving at correct notions in the field of cure and ailments. The great Ṛṣi Kanāda not only discusses *dharma* as something which would give happiness in this world (*abhyudaya*) and also in the other world (*Nihśreyas*) ; he also laid the foundations of the law of causation (the relation between cause, the *Kāraṇa* and effect, the *Kārya*) and was the father of our atomic theory and chemical actions. It is said of Mahāvīra, the founder of Jainism that he had his thorough education in mathematics (*dhūli-karma* and *Pāṇiganita*) and that is why, the Jaina Ācāryas took great interest in *Ganita*, and they are the authors of several famous mathematical treatises. The extracts of medicinal plants were not only of significance in medicine ; the process of extraction was duly represented in

the Yajñas (in fact the *Somalatā* is a wider term which means medicinal creeper in general ; it is said that all medicines owe their curative potentiality on account of the presence of a fraction of Soma ; the Soma was a concept ; not a plant in particular). Fermentation processes were also discovered in the context of theological *Karmakāṇḍa*.

Thus we find that, in this country, the development of science was the main concern of theological persons ; science was held sacred and all the discoveries of science found some use in theological practices ; all the grains and cereals cultivated, all the domestic animals, all the metals and non-metals find some place in the Yajñas. When mercury was discovered, the chemist (or rather the alchemist) adored it in his temple: the Siva Liṅga was made of mercury amalgam and also of gold and other chemicals like *māḅṣika* (pyrites), *vimala*, *manaḅṣilā*, *capala*, *rasaka*, *śasyaka* *gandhaka* and *haritāla* found due place of reverence in the eight directions (*Rasārṇava*). When science in this country was dynamic, it found proper place in theology. In India, there was never a conflict between science and theology ; every scientific achievement or discovery was utilized in one or the other karma-kāṇḍa. The idea was to develop science, that is, to discover truth for the use of man.

Science is committed to one thing only ; not even to God, the scriptures or the Heaven ; it is committed to one thing alone, the Truth, its search and realization. So is the Indian theology : the only vow or resolution (*vrata*) which is held sacred is the vow of seeking and adopting truth. The *Śatapatha Brāhmaṇa* gives details in the form of a parable. Asuras were avowed to non-truth (*anṛta*), the Devas were the custodians of Truth. On each occasion of a Yajña or any *kr̥tya* held sacred, the yajamāna had to take a vow:

I will observe the vow, Lord of Vows, Agni! May
I have strength therefor. Success attend me.
Now into Truth from Untruth do I enter.

(*Yajuh. I. 5*)

On every sacred occasion, these lines were repeated. In the words of the *Śatapatha*, we have: Lead me from untruth to truth, from darkness to light, from death to immortality. In fact Truth was Light and Immortality: and its counterpart, Untruth, was synonymous with Darkness and Death. And hence the question of conflict between science and theology was unthinkable.

Today, science stands for progressiveness as opposed to dogmas and conservatism. When man was primitive and simple, the whole knowledge he possessed was sacred to him ; he was not opposed to knowledge ; he aligned himself with all that he could achieve as a seeker of truth. By and by, it so happened that the society could not continue to be dynamic. All that

the ancients possessed was taken as knowledge (the ancients themselves were, of course, progressive). When the society became static, one was only left to interpret what the Greek and Hebrew philosophers wrote. The great European Universities were based on the concepts of theology. By and by science revolted, the man was held more sacred than anything sacred then known. It was given to man to discover for himself the mysteries of the hidden. Creation is Creator's open book. God has revealed himself through this creation (*devam vahanti ketavaḥ* — every object in this creation is a flagmark of the divine nature of the Creator). This gives sacredness to the scientific tools of investigation. It is given to man alone to be a seeker and probably to no other species. Science is the religion of a dynamic man, of a dynamic society. The science of today is bound to be a dogma and superstition of tomorrow, since it is dynamic ; all dogmas and superstitions were based on something which was science-like once, but which has now passed into the past. They had some utility with the society of a distant past ; they were based on the then achieved knowledge. The use of candle in a church, the use of comphor and *dhūpa* in a Hindu temple with a *ghṛtadīpa* (the butter-lit-lamp) are even today sacred. In bygone days, they were used, because nothing else could have been used ; they are still continued today, though we might have something better than all that. No *Cūdākarma* ceremony would permit the use of a modern Bhārata or Panama blade, and no *Brahmacārin* would be dressed in shorts and shirts, howsoever, simple they be. Science and scientific achievements march ahead, but the conservatism of a static society clings to something old. The self-preserving factor takes shelter in conservatism ; and this happens more so in a static society.

Man resists in the beginning: the credulous amongst us cling to the old but after all the society by nature is progressive. The temples of South India are also now lit with modern electric lights. The priests also enjoy the blessings of the modern science. Bishops and heads of churches travel by air, and listen to broadcasts. They may not hold these things as sacred, but they welcome them. Perhaps no modern flower would ever be regarded as sacred to be offered to a god ; no sweet prepared in a modern bakery would be offered to a Hindu god, but the devotees would be enjoying all these articles without any reservation. No Indian temple would allow a piano to be played on a sacred occasion (though in churches it is common), but here too the influence of science and its day to day achievements is perceptible. Rāma, Kṛṣṇa and Sītā and Rādhā in the Uttarapradesha converse in the Braja and Avadhī, not in the language of Vālmīki and Vyāsa, and their dresses are now gradually adopting nylon and artificial silk and make-up materials of the modern times.

Science, philosophy and religion all adore truth. Science is based on one

concept: "The phenomenal changes are understandable, and coherent and can be reduced to simple concepts." In other words, law permeates through all changes. We may put the same thing in a different language: In the midst of chaos, there is something which brings out orderliness. It is natural that left to itself, the entropy of a system must increase. We might well say, it is *natural* to get into chaos; it is *divine* to get out of the chaos and establish orderliness. The Supreme Law, if any, which brings out orderliness out of chaos, is the Supreme Truth (call it god or give it any name you prefer). Opposed to it is *Nature*, which when operative increases the entropy.

Science discovers the laws which operate to bring out the orderliness. Once discovered, they become a blessing to the society. The discoveries of science can be harnessed for the benefit of mankind. Even a test tube experiment can be repeated in industrial dimensions.

Science revolts against frauds and superstitions; but if the society is prepared to succumb to frauds, fruits of science might be utilised to help it. During the early days of spiritualism, help was taken of the scientific achievements in fraudulently recording the messages of the astral brothers; frauds have helped in exhibiting the photographs of spirits of dead persons. The early twentieth century scientists of the calibre of Sir Oliver Lodge and Sir William Crookes honestly believed in the spirit photography, and they became victims of scientifically aided frauds. Clairvoyance was a faculty attributed to persons in an eternal abnormal state of seeing objects not present to the bodily senses, whereby the clairvoyant is enabled to describe events occurring at a distance. Happily, all this has now almost died out, for were it a truth, clairvoyance could have been utilized for the national use just as television and radio and radar.

Society is not absolutely free from credulity. This would be seen from a tablet which has been placed in temples like Birla Mandir of Delhi, constructed in the twentieth century. The tablet records the testimony of a so-called fact that such and such person successfully demonstrated the transmutation of a baser metal into gold in presence of infallible persons. If a spiritual Yogi, beyond all doubts of rigorous enquiry, could demonstrate such an achievement, why the knowledge he possesses should not be harnessed for the nation's use, specially during these hard hours of our national trial, when India needs so much of gold? Why should we not organise institutes of spiritual technology for the material benefit of the nation? A discovery of science accepts the challenge of its truthfulness and scrutiny, whereas the claims of spiritual achievements in the domain of mundane affairs rest only on credulity. They are still sustained by the inherent weakness of man.

It is a strange phenomenon that a rational person accepts the existence of

a Supreme Personal God, since he is a synonym of eternal truth, eternal good and eternal bliss. His creation does not betray laws of truth. The orderliness (law and order along with purposefulness) can be observed in every bit of the activity in Nature surcharged with the existence of the Supreme. Science reveals miracles. Is it not a miracle that from the seed of mango always grows a mango tree with all its previous history somewhere concealed in a tiny sperm of the seed? Godhead is a contradiction of such miracles. One is reckoned to belong to the category of the godhead (he would be raised to the status of a deity, prophet, incarnation, Yogin, a mystic) if he could bring out the flowers of a papaya plant on a mango tree, and from such flowers could produce fruit of, say, orange in a season when oranges are not available. Such achievements of a mystic thrive on the credulity of man; they are not subject to critical scrutiny, they cannot be harnessed on a national scale. Thus a prophet is one who challenges the truth and orderliness which pervades the creation of God, and establishes his authority as a rival of the Supreme. In this sense a scientist stands aloof from a person of spiritual attainments. His humility lies in surrendering to Nature and Nature's law, woos her with love and affection, and the beloved Nature reveals to him her tender secrets.

Science has considerably succeeded in objective studies. It is too much to expect from science that it would ever be able to reveal the secrets of the subjective world. But if science cannot succeed in the domain of the enquiry of the subjective, it also does not lie with any other field of investigation to achieve this success. Fundamental science has the potentiality of probing through any subtle problems of the real and the apparently real and also the unreal. Modern mathematics and its abstract algebra deal coherently with more abstract problems than can be comprehended by extraordinary students of philosophy. Still I would say, it has not been given to a human mind to explore the subjective regions. An enquiry is always objective, and is restricted to the faculties given to man in terms of his sense organs and the instruments, the records of which he could interpret through them. Religion and philosophy would like to thrive on this weakness of science, rather than on their own achievements. What can be known is science, and what is beyond what can be known, nobody knows.

The subjective is beyond investigation, but its existence cannot be denied. What Shakespeare or Kālidāsa wrote cannot be explained by mechanically accepted principles. Einstein was not a machine which could evolve out all he did in the time given to us. The theory of evolution is good, rational, and also reasonable. It rests on the principle of economy that we find in creation; it is a process which has its limitations. It is infinitely slow with a very small probability. The probability that the strokes from my pen would frame mechanically a sentence is very small, almost negligible. But

a subject as I am, I can go on dictating pages after pages without much effort. Of course, we know, we have now intelligent machines which would solve mathematical problems for us much quicker than any mathematician would do. This is an age of computers. But the agency which has brought out these computers (of course, by a concerted and co-operative effort) must be far supreme to the computers themselves. When compared to nature's automatic devices in the billions of tiny cells, these computers pale into insignificance. Science has tried to explain its problems by assuming mechanical models; that age is also now gone. The present concepts are even more abstract and are realisable in terms of mathematical expressions only. In many spheres of our behaviour we shall have to accept our ignorance regarding this. We are not wholly machines; we are something beyond that, even though we appear as machines in some aspects. We shall know very little regarding *asmad* and *yusmad*.

We, in our science and technology, are far ahead today than what we were a few centuries back. In the scientific achievements there is now a doubling phenomenon in about ten years. Science stands for speed and concerted co-operative team work. Science thus raises hopes for the future. But scientific achievements have produced new problems in society. It very much appears that man-in-society has grown on account of science, but *individual man* is heading towards a neglect. In early days, man evolved the system of society for *his* sake; today the individual man is being sacrificed at the altar of the society. It is difficult to say where it would lead to. If man as an individual disappears, if he has no destiny to look ahead to, if his individuality is doomed, what would happen to the society, for which he is supposed to become a martyr? These are some of the questions which one has to ponder. Science still raises hope for something better. This would be the third phase of science. The first phase was when science struggled against superstitions, dogmas, frauds and credulities; we are now passing through the second phase when science has posed fresh problems on account of the benefits accrued by the achievements of science on vast scales; and the third phase would begin when science would emerge out as the religion of the future man, and would raise fresh hopes against all odds that confront us today.

There is one thing which stands today against science. It, as a tool of knowledge with its methodology, neither accepts nor denies the existence of the future life of an individual. It, of course, promises a better future society, free from hunger, etc. In this respect, theology and religion would thrive even in a scientific age. Science respects moral values, which were discovered for man when civilization was in its cradle. *Satya, ahimsa, tapas, brahmaçarya, aparigraha*, etc. were held sacred in the early society also. But this is not all that a man aspires after. He is prepared to sacrifice his

present life for some life about which he is totally ignorant. Science does not deny the existence of such a life, but today, it holds out no promise in this regard.

PATRICIA UBEROI

Mr Science and Mr Democracy: Aspects of Chinese Modernization

"ON the New Democracy" (January 1940) is one of Mao Tse-tung's most important ideological pronouncements. It was made at a time when the ideological framework of Chinese Communism was being decided, and, in addition to its strictly political importance, it has remained a key statement of the orthodox Maoist conception of, and policy towards, culture right up to the contemporary Proletarian Cultural Revolution. In this document Mao demanded that the culture of Chinese Communism should have three essential qualities: it should be "national", "scientific", and "mass". It is this reference to science which concerns us here particularly:

"The culture of this New Democracy is scientific. It opposes all feudalist and superstitious thought. It advocates a realistic approach, objectivity, and the unity of theory and practice. On this point the scientific thought of the Chinese proletariat can unite with the comparatively progressive bourgeois materialism and natural science to oppose imperialism, feudalism and superstition. But it must not unite with any reactionary idealism."¹

This was not the first time that "science" was invoked to challenge the traditional forces of Chinese society (in Mao's terms, "feudalism", "superstition", and "reactionary idealism"); nor was it the first time that it had been suggested that true democracy could only result from a scientific attitude of mind. For "science" and "democracy", conceived in these terms, were the notions which underlay the New Cultural Movement of 1915-21, a momentous cultural revolution perhaps unparalleled in the history of man-

kind. With this revolution the whole foundation of the Chinese world-view was changed and Confucianism, the traditional and fundamental Chinese philosophical system, was discarded in favour of a new philosophy of life based on science.²

This transformation began in 1915 when Ch'en Tu-hsiu, a dedicated reformer who was subsequently a founder of the Chinese Communist Party, started a radical journal called *New Youth*, the aim of which was to awaken Chinese youth to the meaning and responsibilities of democracy. It speaks for the impact of this journal that within three years of its foundation the editors found themselves under attack from all the conservative upholders of Chinese tradition, accused of destroying Confucianism, Chinese culture and moral standards. Ch'en Tu-hsiu, brashly unrepentant, gleefully admitted the charges:

"We cannot deny these charges. But if you go into the matter, you will find us not guilty, for we have committed those dreadful crimes purely for the sake of those two gentlemen, Mr Democracy and Mr Science. For the sake of Mr Democracy we have opposed Confucianism, rituals, chastity, the old morality and the old politics. For the sake of Mr Science we have opposed the old arts and the old religions. And for the sake of both Mr Democracy and Mr Science we have opposed the theory of the "national quintessence", and the old literature. When you think over it calmly, have we committed any crimes other than those of protecting Mr Democracy and Mr Science? If the answer is in the negative, then I beg you not just to criticize our journal but to put all your efforts into criticizing Messrs Democracy and Science."³

At first glance it would seem that Ch'en Tu-hsiu regarded "science" and "democracy" as equivalent ideas, similar in their function of providing a basis for the reassessment of traditional civilization. Such was not the case. "Democracy" in the New Culture period represented the desired political and institutional end, while "science" represented the rationalistic attitude of mind or philosophy of life which alone could bring democracy into being. As Ch'en Tu-hsiu differentiated the functions of the two in the rhetoric of the slogan: "democracy in politics, and science in the realm of ideas".

In exploring the meaning, function and inter-relationship of these two ideas of "science" and "democracy" in the New Culture period, it is necessary to delve into the total question of China's response to the impact of the West, and of Western material power, of which the twentieth century growth of scientific philosophies represents one limited aspect. When nineteenth century European expansionism made it clear that China's very survival was dependent upon modernization and industrialization, the

Chinese response — the response of a great and hitherto self-sufficient culture — was to attempt modernization without compromising traditional values. It was felt that modernization should be strictly controlled, and should be limited to those fields where it would not impinge on the essential Chinese culture. Advocates of modernization reassured their contemporaries that “Chinese learning” was for “substance” or “essence” (*’i*), while “Western learning” was purely for “function” or “utility” (*yung*).

China’s humiliating defeat in the Sino-Japanese War of 1894-95 proved a severe shock to those who had held the opinion that modernization could be limited to purely technological innovation. It was apparent that a certain amount of education and institutional reform should accompany and underwrite technological changes. It was in this context that suggestions were made that China should adopt the forms of government prevalent among the great nations of the West, for it was felt that in these forms and institutions lay part of the secret of western power. Democratic government, in the form of constitutional monarchy or republicanism, began to receive the serious attention of all nationalist Chinese seeking a formula for “saving the nation”. Even under these compromising circumstances, Confucianism remained unchallenged as the essential Chinese philosophy, although the definition of what could be legitimately borrowed from the West in the name of “utility” was greatly enlarged. By this act, the danger of utilitarian reform impinging on, or even destroying, traditional Chinese culture became more real. Indeed, the attempt to forge a dichotomy between substance and function was probably doomed from its inception, for the very prestige of Confucianism traditionally rested on its practical utility as a code of government. In this sense, the ideology of Confucianism was intimately associated with the institutions of traditional Chinese government.

The Chinese Revolution of 1911 which overthrew the moribund Manchu dynasty came about so swiftly that the revolutionary parties found themselves without any definite policies as to the forms of government which they were to install. Though most were in agreement that the new state was to be a parliamentary democracy, the way to institutionalize this form under the conditions prevailing in China was not clear. The first decade of the Chinese Republic was marked by regionalism, autocratic presidential rule, factionalism, monarchical movements and warlordism. Democratic institutions, founded in the flush of idealism, were an empty mockery. It was at this juncture that the Chinese intelligentsia began to reconsider the implications of democracy. While the older generation turned again to contemplation of the virtues of traditional government through an autocratic monarchy, the younger generation began to analyse the meaning and nature of democracy in the West. Inheritors of the Confucianist example of the relationship between institution and thought, they came to the conclusion

that real democracy could only be implemented in China after a democratic revolution in Chinese thought.

The value system seized upon to effect this revolution was the value system of science, or of scientific explanation, for the values of science, along with the institution of democracy (which was itself supposed to have been begotten by the scientific attitude), were widely regarded as the twin props of western power.

“Only after the Westerners had gone to such trouble and shed so much blood for the sake of protecting Mr Democracy and Mr Science did these two gentlemen gradually save them from darkness and lead them to an enlightened life. We now insist that only these two gentlemen can save China politically, morally, artistically and ideologically from darkness.”⁴

A science-based philosophy also held out other appeals to Chinese youth at this time. Firstly, a scientific attitude would greatly assist the much-needed technological modernization of China which many felt was being impeded by the elitist and impractical attitude of China's traditional ruling class. Secondly, a science-based philosophy was a salve to national pride for the findings of science may be regarded as belonging impartially to all mankind, regardless of race. Thirdly, and more importantly, it offered the tools for the criticism of Chinese traditional values which were felt to be impeding, even strangling, the development of democracy in China. Thus, the New Culture Movement was a movement to use the method of scientific explanation and the values and name of science to combat the traditional assumptions of Chinese culture and to build a new ideology suited to the needs of a democratic state.

The criticism, disparagement and destruction of Chinese tradition was the initial aim of the impatient and iconoclastic intellectuals of the New Culture generation; only secondarily and subsequently did they attempt to evolve a coherent new philosophy of action. Scientistic philosophies, that is, philosophies which postulate that the world is knowable only by scientific examination, and that nothing can be known which cannot be verified by the scientific method, played a major role in the critique of traditional culture. Tradition was subjected to examination by the scientific method, so hallowed by the dynamic success of western science, and was asked for proof of its assumptions and contentions.

Darwinism, biological, social and philosophical, had a profound effect on Chinese thought in the early twentieth century,⁵ just as it had had in Europe in the late nineteenth century. Empiricism, philosophical materialism, dialectical materialism — all the philosophies which were in vogue in China

in the New Culture period — were in debt to some extent to the Darwinian theses. For this reason I shall not attempt to describe these various philosophies as they were developed by individuals, but rather confine myself to describing how elements of a theory derived from the biological sciences were used by Chinese intellectuals to subvert tradition and build a new philosophical framework.

The doctrine of the “survival of the fittest” was applied in the interpretation of the international position of China, and used to justify a course of rapid westernization. If China did not adopt the methods, institutions and ideologies of the European powers, she would surely be eliminated in the struggle for survival. The danger of national extinction at the hands of stronger nations was immediate and relevant in these troubled years, and the alternatives appeared stark:

“Only two roads are open to us now: the bright road to republicanism, science and atheism, or the dark road to tyranny, superstition and theocracy. If we want to avoid another Boxer Incident and another humiliating memory like the Von Ketteler Monument, which road shall we choose?”⁶

Darwinism, by demonstrating the evolution of man from the primates, at once called into question those philosophies and religious systems which posit a divine Creator, or which justify ethical systems in terms of a supernatural authority. The anti-religious arguments of philosophical Darwinism were used by the intellectuals of the New Culture era to attack and disparage as superstitious and unscientific the three Chinese religious-philosophical systems of Taoism, Buddhism and Confucianism. Buddhism and Taoism were typified as dangerous in that they encouraged escapism and an irresponsible attitude to society, while Confucianism was characterized as essentially undemocratic, as nothing but a rationalization of the *status quo*. In particular, Darwinism was called upon to prove that traditional ethical systems — especially the three authoritarian virtues of Confucianism, loyalty of subjects to the ruler, filial piety, and chastity for women — were neither necessary nor indispensable.

Darwinism gave man a new role in nature. It suggested that man might be investigated scientifically, for man, too, was subject to the laws of nature. Darwinism also brought into being a new vision of time. The theory of the constant evolution of species when applied to the study of history, society and institutions, encouraged an interest in understanding development and evolution, and in seeking the historical roots of contemporary society. This method of criticizing tradition served the purpose of the reformers in bringing a critical sense and a sense of relativity into the

Chinese understanding of Chinese culture. With this method of argument from origins, Ch'en Tu-hsiu began his memorable attack on Confucianism:

"Confucius was born in a feudal age and the morality he advocated was the morality of a feudal age. The ceremonies he instituted, and the attitude to life he encouraged were ceremonies and attitudes of a feudal age. The government he wanted was feudal government. The morality, ceremonies, life and politics of the feudal age meant no more than the authority and honour of a minority of aristocrats, and had nothing to do with the happiness of the majority of the people."⁷

Likewise, Hu Shih used the idea of historical evolutionism to reinterpret the whole history of Chinese literature, and thus to prove his point that the natural forces of historical evolution demanded the eventual substitution of the vernacular literary style for the classical style. The criticism of Confucianism and the development of a new vernacular style were two of the major achievements of the New Culture Movement. Both, naturally, had important socio-political consequences.

The new view of historical evolution inspired by Darwinism resulted in a new vision of the Chinese future. This generation of intellectuals bent itself to dividing history into stages and eras, and to developing deterministic laws of societal development which could serve as guidelines for future action. Ch'en Tu-hsiu was an exponent of deterministic argument long before he became a Marxist. For instance, in his essay of November 1915 on contemporary trends in European literature, he outlined the stages of European literary development—from classicism to romanticism to realism to naturalism⁸—and drew the inference that Chinese literature, currently in a stage of classicism and romanticism, would soon be progressing to realism and naturalism.⁹ Likewise deterministic arguments were applied by intellectuals of the New Culture period to a wide variety of problems in the social, political, philosophical and cultural spheres.

So radical and immediate was the transformation in Chinese thought brought about in the name of science and the cause of democracy that traditionalists rallied to defend Chinese civilization and question the wisdom of making "science" the basis of the new Chinese philosophy of life. The traditionalist viewpoint was reinforced by the pronouncements of Liang Ch'i-ch'ao, a former leading reformer who after a post-war tour of Europe had come to the disillusioned conclusion that western material civilization was both corrupt and bankrupt. All the leading Chinese intellectuals, among them a number of scientists, contributed to this debate which raged in the columns of newspapers and journals for a full year. As the debate

died down, it was clear that the overwhelming majority of intellectuals, whether left or right in their politics were agreed in their acceptance of one or another scientific philosophies. Science had replaced Confucianism as the basis of the Chinese world-view.

I have outlined above the pragmatic reasons for the growth of scientific philosophies in China in the second decade of this century, and the way in which these philosophies were expected both to justify and to bring into being the institutions of a modern society. In other words, Chinese intellectuals were seeking a philosophy, sanctified by the scientific method, which could serve as an instrument of political revolution. It should be noted in this context that Chinese intellectuals were prepared to accept deterministic theories only in so far as such theories offered a formula for effecting immediate revolution.

Marxism had a peculiar attraction for the Chinese intellectual in this period, for it neatly fitted the ideological vacuum left by the displacement of Confucianism. Confucianism was a system of ethics for both the individual and the state; a philosophy of government and of being governed. Marxism, likewise, was an individual philosophy and a state philosophy, and in its Leninist form it suggested means for practical solutions to China's political problems. At the time when it was introduced into China the Chinese mind was already highly susceptible to the appeal of a theory of society based on scientific explanation. The October Revolution provided an inspiring example of a theory of society which could serve a political purpose and which could provide a blueprint for revolution. To the impatient and activist generation of the New Culture, Marxism offered a perfect symbiosis of theory and practice.

In this paper I have given, as an historian, a short account of the dynamics of the Chinese New Culture Movement which represented a search for a new ideological framework to replace the discredited Confucianist world-view. "Science", the evocative symbol of western material power, was seized upon to effect this revolution, mainly through the application of Darwinian theories to the interpretation of Chinese culture. The Chinese invocation of "science" for modernization was a peculiarly nationalistic response, for, unlike the competing western philosophies it did not carry the hint of Chinese inferiority or western intellectual superiority. In the early part of the New Culture Movement, science was used to justify liberal democracy, and to bring about the change in thought which would be a practical precondition for the realization of democracy. Subsequently science was called upon to guide the formation of deterministic laws of

societal development which could underwrite political revolution. "Science", then, was the ideological link between liberalism and communism.

The triumph of scientific philosophies in the period of the New Culture Movement was in no sense a total revolution in Chinese thought. It was confined to the intelligentsia. But once a science-based philosophy became the basis of state communism, once a science-based philosophy was institutionalized in a defined area, however small, the scientific ideology of a minority became an ideology of state. It may well be said that the continual and unrelenting cultural revolution in China since 1949 has been the result of a conscious effort to make the acceptance of a science-based ideology total in all sections and levels of society.

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Science and Human Values

RUKMINI DEVI ARUNDALE

Science and Human Values

IN this age of changing values when the entire world is dominated by a materialistic approach to life, it is of utmost importance for scientists, philosophers, artists, and others to think together and see how our contribution to the modern world can help bring greater happiness and peace to all living beings. We may classify human beings as being scientists, artists, technologists, and so on. But whatever our mode of approach may be and in whatever field of human endeavour we may be active, the fact remains that we are human beings, human beings first unto the end of our lives. To me, science, art, and religion are all ultimately one and the same, and ultimately lead us to the one goal, the goal of self-realisation which is the acceptance of the fact that the Self means not merely you or I or any individual, but the life that pervades all manifested and unmanifested creation. Sri Krishna talks of many paths and says to Arjuna that they all lead to Him alone. We may think of His teachings as applying to all types of temperaments and religions, but His words can also mean that all forms of knowledge and experience also lead to an ultimate unity.

For intellectuals, the most dominant topic of interest for the present age is science with all its branches of knowledge. Science has almost conquered the world by its spectacular and almost miraculous advance and achievements. As the desire for scientific studies and knowledge increases in the world, the more imperative it becomes to emphasise the human values, for, without it, the human intellect can become a formidable and dangerous force. The people of the world are afraid of the hydrogen bomb, nuclear weapons and many other such deadly devices which have been invented.

We can only imagine, but imagine with a great deal of accuracy, what will yet be invented. In fact, actually, one should be more afraid of the human intellect that is able to produce all these things than of the weapons themselves. How much further will the human mind go, and what more miracles of knowledge are we going to witness? Although one admires all this development, we can always ask the question "what happiness is going to be derived by humanity from it." Of course, intellectuals always say we are going to achieve the incredible. We shall travel many times faster than sound; we shall visit other planets; we shall live much longer; be more comfortable and enjoy ourselves. While science can make all these things possible, the scientist, at least the great scientist, must surely find happiness in something beyond all the achievements which is the experience he has of discovering new potentials of life. It is as if he is penetrating veil after veil of the mystery of life and discovering the same indwelling, omnipresent, existence everywhere. So, what science does to the scientist is different from what science does to the world. To the scientist there is the discovery of life itself, in every form, in every manifestation; the discovery of a world of unlimited grandeur. He can beautify this world in which there is truth, but a truth that grows and changes so that no one can say "I have discovered it in its ultimate essence." To the scientist, today's truth is no more than a reality of tomorrow. By this discovery, he finds the unlimited nature of life. He may be said to have discovered God and realised himself as part of the creation and the Creator.

To me, the discovery is the very essence of life's purpose and is the goal of existence. It is the same goal that *yogis* aim at and discover in another way. It is the purpose for which religion exists and which in reality religion teaches. To the scientist, knowledge is the end and the continued effort to know more or the search for knowledge is an end in itself. While this may be true and while he may not be conscious of any other factor, we have to acknowledge that knowledge can never be obtained without its effect upon himself as a man, without its effect on his emotions, his attitude to life, on his outlook upon humanity, and on his relationship to all. In fact, no one lives alone even if he has to live in two worlds. Ultimately, this is a spiritual experience which comes as a result of contact with nature. This spiritual experience should make one realise that we all belong to a unitary consciousness, whether man, animal, plant or mineral. If we experience all this as a part of a greater consciousness, this experience would be called religion.

This is the human and individual experience of a scientist, the *yogi*, a sage, and also, ultimately, that of the artist. The social approaches are different. While the means are different, the experience is the same. Without this aim, there can be no happiness in life and, surely, all knowledge must

elevate humanity. Science or knowledge is a force and a power. Can such a force and power bring happiness to humanity unless human values are understood? What is knowledge for and how can it be an end in itself? It cannot and should not, according to my opinion, for, if it is an end in itself, divorced from life and human values it can become the destroyer of humanity and an evil force, ultimately, in its turn, to be destroyed by the greater force of human understanding and love. While science is an instrument for understanding cosmic principles, the result of scientific investigation and research can ultimately do the opposite, i.e., instead of unifying, it can end by destroying and disrupting human relationship. Ultimately, there is no greater experience than the relationship between man and man; that between man and all nature which includes the animal and plant kingdoms. All religions, saints, and philosophers have preached that to be human does not merely imply the development of the mind but the development of the heart as well. For a human being to be a complete individual, the mind, heart and the soul must live in harmony with each other so that the hidden god within finds expression in the unity with all life. When man does not pay attention to all these factors, science becomes desecrated by the cold mind that merely distracts truth and becomes cruel. Mind alone is a destroyer. It has been said by great teachers that the mind is the slayer of the real. We have seen wars, great wars like the last world war, and have seen, in Hiroshima, the effect of the instruments of destruction produced by science and used by heartless and ambitious humans. So, unless human values and their teachings have an important place in our lives, science and its progress are actually a danger to humanity. This is why the great teachers of humanity in India stressed the importance of another aspect of science — the science of the Self.

Modern scientists, with rare exceptions, generally think of science as an end in itself. The every day human being thinks of all the benefits to humanity. What are these benefits worth to us human beings except to make us more and more selfish and power conscious! It has been said "man cannot live by bread alone". We may add that man cannot live by the advantages of a materialistic age alone, and that we are in danger of becoming more and more materialistic. With all the discoveries that make travel and communication easier, our world is more torn by strife and misunderstanding than ever before. Though the World War II came to an end, wars have not ceased and since 1945 we live still in fear of another world war. We give a sigh of relief when one crisis is over only to be faced with another, similar, crisis.

All these discoveries and advances in technology have done one thing which did not exist before and that is to make us world conscious. Every trouble, every difference of opinion, political and otherwise, has now world-

wide repercussions. When Kennedy was assassinated, it became an event of world importance. When Martin Luther King was shot, once again the fear of world opinion and of world conflagrations came into existence. In fact, today, we all are far more conscious of evil than of the good, and a powerful evil man attracts world attention more than the great man of compassion, unless he be of the calibre of the Lord Buddha, Lord Krishna or the Christ. Rarely indeed do such beings come into the world. Even then we pay heed to them for a short while, perhaps for a few hundred years after which we follow our own selfish ways. If to this selfishness and the lack of vision of the small man great knowledge is given with the power to make use of it for selfish purposes, destruction of man by man will be the only result.

The Lord Buddha has said that the root cause of all evil is selfishness. Today we want to give scientific knowledge to every child. I agree it is wonderful to know the laws of nature. They can teach us to be humble, for we human beings are as nothing before the grandeur of nature. Nature is more powerful than the scientist though he tries to conquer nature. Nature is more beautiful than what man can create through art or even imitate. However wonderful a painting is of a sunset, it will still be only a means of reminding us of the creative beauty of nature. It is good for us to feel this and understand our place. We can try to conquer space, reach other planets. What man can do is incomprehensively great and is a miracle in itself, but yet, when man does not understand himself or other men, all this capacity is of no use to the world. Has all this knowledge brought more unity to the world? Do we know each other better? What has been the result of the League of Nations, the United Nations, the UNESCO, and other organisations? Wars are still going on in the world, sometimes wars even more cruel than were ever fought before, thanks to the scientific discoveries. Even the desire for one language in the world, though good in itself, can never achieve brotherhood. On the other hand, there will be a common medium of communication for greater quarrels.

As for India itself, we had far greater cultural unity even when we had only the bullock cart as transport, no radios, cinemas and other forms of mass communication. Valmiki's Ramayana, the Puranas, the Upanishads, the Songs of the Saints, the poetry of Jayadeva and Kalidasa were known all over India, while today, they are being popularised by spending large sums of money on mass media. All this shows that every bit of energy spent on all these is a waste unless scientific education goes hand in hand with the education of every child, man and woman, along the right paths of living and spiritual aspiration.

It is said that in ancient days scientific knowledge existed in all fields of thought including astrology, astronomy, medicine like Ayurveda and

Sidha systems. Much of this knowledge influenced western thought and western civilisation. But India emphasised that all knowledge was subservient to human values. In ancient India and particularly in the Hindu religion, there was no law laid down as to what you may believe. Religion meant knowledge and action. Knowledge meant all knowledge, everything that affects man, and man can comprehend as well as all that affects man and his relationship to life. So, knowledge as expressed through unselfish action to make this relationship a happy and beautiful one, is called Dharma which is a far better word than the English word 'religion'. It is because the search for knowledge combined with unselfishness was of such importance that truth became the most important theme in the Ramayana, Mahabharata and other epics. Not "THE TRUTH", because this is impossible to discover but truth which according to our level of understanding may be different under different circumstances. To act according to this truth with the purest motive was and is the Dharma of the individual.

The most wonderful sentence in Sanskrit is "there is no religion higher than truth". Truth is unlimited and, therefore, the freedom of mind to discover it was allowed, but while doing this the place of the individual in society was not forgotten. For this the disciplining of ourselves, the knowledge of the self and right action formed part of our Dharma or religion. This was the teaching of the *yogis* who penetrated into the realms of the higher mind and who by self-discipline were able to understand and control nature. They achieved the purpose of *yoga* which is to discover the unity of life. The modern scientist says 'understand everything around you', but in the East the ancient scientist said 'Understand everything within you, your emotions, your mind and your consciousness. Then only will happiness come to you and to all around you'. This is the essence of religion, the perfect blending of heart and mind. While in the highest region the scientist of the status of Einstein touches the cosmic emotion of unity and harmony through the mind, the artist who works through his feelings, touches the minds through his highest emotions. Religion teaches the blending of the two. Right relationship in life can only be achieved through the qualities of the heart and mind, education must be combined with the education of the heart. If human values are important as we know they are, urgent revolution must take place in the educational system.

Morality must be the foundation of all aspects of living and knowledge. It is strange how often one hears that a 'scientist does not need religion'. A person who thinks so, according to me, does not understand either religion or science. The most important thing in religion is not a set of beliefs, dogmas or doctrines, but the teaching of living, particularly living in harmony with all that lives. Investigation into right living, knowing how to live under every circumstance, is in itself a science of life. Religion, in

its highest sense, teaches us not merely to change our circumstances but to change ourselves. Surely this is practical, because all of us who live and have our problems and difficulties cry out that life is difficult and wish it could be changed, but do not realise that if we changed our mental attitude, all that forms our make-up can be different. To achieve what we want is difficult, but, yet every man wants to achieve happiness. This is why every individual tries to find happiness at any price.

True religion teaches us that there is no good end without the right means, that happiness is the end of our achievement as well as the right way of obtaining it. So, in the same way, knowledge as an end without the right path or means being used to achieve it, can never give the true fruits of knowledge to the world. There are many fields of science and technology, including the science of medicine, in which there have been spectacular developments. Great strides have been made and in the medical world, we find men doing almost the work of the creator, though, so far, man cannot save life for all time nor can he control death as he is attempting to control birth. We may think we are bringing much peace and happiness to the world by saving life. Man is an irrational being. We destroy millions through war and try to save millions by medicine! Yet, I believe war will continue to exist as long as we try to save through wrong means. It is unfortunate that many in the world think that we can save people only through sacrificing millions of creatures and torturing them in the medical colleges, laboratories and pharmaceutical institutions.

To me, the basic philosophy is wrong when we think that, just because helpless creatures which should find love and protection from human beings are available for our use and exploitation, they should be tortured to discover a fancied relief for man. If a child is dumb or deaf, does the child cease to have feelings? Just because the animals cannot speak, do animals have no sense of pain or suffering? Yet, we think it is right to use them, experiment on them most cruelly, often even without anaesthesia, send them up in rockets and so on. Now one reads of these heart transplantations and how a baboon's heart is to be removed so that it can become a repository of a human heart, once again to be operated on for transplanting it on to a human being in case of need. If we have no sense of the sacredness of life, nor compassion for a living creature, no human life will ever be respected or protected. The proof of this has been common human experience from early history to today. We think nothing, not only of killing but of torturing an enemy. We have seen such things in the unforgettable World War II. I know that scientists in the modern medical field generally think all is right if done for the sake of knowledge. Nothing can be scientifically or in any other way correct if it is morally wrong, and I am sure with the powers and the intelligence that man possesses it is possible for

scientists to achieve the same results or even better results in medicine if they have their basic philosophy right. We must not take for granted that sensitive creatures with obvious emotion and feeling may be cruelly exploited. We must protect them as we wish to protect our brother man.

This I know is a controversial subject and there is much to say which cannot be said now. Differences of opinion are bound to exist but whatever the differences, it is imperative that there should be serious thinking on the part of those who are concerned with the healing science, as millions of living creatures are daily being used cruelly for the purpose of medical science. Cruel means cannot be used for ultimate good and can surely harm humanity by making them heartless. What good is there in saving the body at the cost of minds and feelings hardened? This basic attitude to life is the foundation of life and has been so from time immemorial. It has been emphasised by the great teachers of humanity who have consistently said that life is dear to all creatures, and that he whose life is filled with compassion is indeed the noblest of all beings. We are today celebrating Gandhiji's centenary. Let us not forget what he said: "we should be able to refuse to live if the price of living be the torture of sentient beings." Let us remember the saying of the Buddha, "pity makes the world soft to the weak and noble for the strong." The greatest gift of the human being is to be truly humane, and this is the basis of human values applicable to scientists, artists, politicians and all others. For this the education of the heart is important.

The greatest factor for educating the emotions is art. In our education we have not realised the importance of art and what it does to human beings. Every human being in the world is dominated by emotions and it is the energy of the emotions which results in action. Right action is dependent on right emotions and right emotion is directed by the harmonised and controlled individual. Art is in reality an expression of beauty. What the creator has done in nature is what a true artist does in different art forms. A true work of art is an inspiration and a joy for all time. It has no fashions, no time limit, nor is it static. Creative expression is endless. What a musician can do with the twelve notes is unlimited. Music, from time immemorial, has played a great part in the lives of people and has inspired, elevated, and changed them. It has healed them, soothed and given them courage in times of need. Forms of music have changed but the essential character of true music cannot change, and if music of the right kind can form an integral part of education it can help build character.

Unfortunately, people think that art is meant for our spare time or for entertainment. Actually it is for life and is life itself. The science of the emotions is a great science, understood only by those gifted with true perception. What modern psychology does is elementary, for it merely stirs

up the emotions. Sometimes the emotions and thoughts that lie dormant are released to become serious problems to humans as when Pandora's box was opened. What art does is not merely to stir up the emotions but to sublimate them. Unless the creative aspect in each of us is moulded by the inspiration and teaching of art, complexes develop in our lives and destructive elements gradually begin to control us. I know much goes for art today, and ugliness masquerades as beauty as violence is held up as the means to achieve justice and harmony. Art reflects life and what evils we see in the name of art is only a reflection of the evil that is finding expression in life today. Morality at the highest level is as important in the field of art as in the field of science. While art without vulgarity and crudity is important, so must science be without cruelty and selfishness.

Education must be devoid of all these and it must be for living. When degrees are taken, jobs are found, wealth is accumulated and age creeps on us, the individual will need the firm foundation of character to deal with life and to set an example of true living.

The great and noble artists are messengers of beauty and point out to man the eternal beauty within each of us. It is the one universal language that does not need a tongue to speak with except itself. Its only medium is sensitiveness and feeling. In the realm of art there are no natural barriers. Art and science are the only two forces which create no barriers. Yet, this depends on how we use them and present them. Art is the one influence that can mellow and bind. While the mind has the tendency to separate, art unites, for its message is the message of beauty. For me, true art is an expression of beauty, for, even when human emotions like sorrow and anger are expressed through art, in reality, at the same time, it teaches us how they can be sublimated and elevated to higher emotions. The real importance of art in education is not only to teach appreciation of beauty and nature, but to influence the senses and to create sensitivity. Through the appreciation of beauty which the artists express and the appreciation of true works of art, each one of us unconsciously becomes sensitive to sound, form, colour, and touch. This sensitiveness develops also into a sensitiveness to surroundings, people, and everything else. Art is an expression of the soul which turns outwards in expression. By this, each one becomes creative in life. It is not necessary to be an artist in any particular form, but one should be an artist in living which is the ultimate aim of art. This sensitiveness develops an emotional response to all around us. This response is of vital importance to each one of us as this is the basis of understanding. To understand evil and good, to understand suffering and happiness, is the only way in which humanity can live in harmony with others.

To turn our attention outwards takes us away from ourselves and brings a selfless love for all. It is never possible to be happy alone as we are part

of this world. Ultimately, all knowledge must lead to this realisation. It is for this that education must be complete and not one-sided as it is today. The aesthetic sense which helps us in the fine points of life makes one civilised and contributes to the beauty of living both internally and externally. Where there is ugliness, cruelty and selfishness, there can be no civilisation. Culture is the essence of civilisation, but the essence of culture comes from a sensitive approach to life. Art can help create this atmosphere and invisibly help produce a sensitive individual to whom life is not merely material wealth but spiritual wealth as well.

This world, in spite of its many international and national organisations for better understanding, is surely more materialistic today than ever. This is because so little attention has been given to things affecting simple human values and to the individuality within each. This individuality with its aspirations, longings and needs, is divine in spite of human weaknesses. All knowledge and all education whether in the home or school, whether in the college or in life must embody the complete divinity of life and be given with the richness which we ourselves have inherited from the beauty of nature.

While I am glad to give my views on the different aspects of science and human values, I cannot express all that is in my mind in this short period. I also know that there is bound to be strong differences of opinion. I hope that these differences of views will stimulate our thinking and ultimately help to conclusions for the common good of humanity.

U. P. BASU

Science for Humanity

SCIENCE is the knowledge that men of all nations have accumulated in the search for truth about the universe. In doing so they have also worked out methods by which the people can live in peace and contentment. The outcome is evident in the vast expansion of modern cities with various amenities. Along with this the quiescent rural agriculture has also been given an impact for which more production from the same land has been possible by improved irrigation, modified cultivation, and enrichment of the soil with effective fertilizers. The largest part of scientific and technological efforts is, however, concerned directly or indirectly with man — his needs, his health and his pleasure.

Science looks at facts and does not depend on supernatural factors. This characteristic instills self-reliance in man and creates in him capacity and ability to do more work for a cause. Yet it does not induce any disbelief in the supernatural power or even in God as in any performance of science and technology one must have some faith in the spirit of things which are beyond conception, and are unknown to the physical world. Viewed from this angle a scientist is to believe in a force that is supreme and eternal, and which gives him inspiration and encouragement to work more. When he fails and/or wants to expand, he searches for further knowledge and seeks assistance or guidance from his fellow scientist or worker.

The above spirit induces in scientist a sense of tolerance, co-operative mind, and will to serve his profession and his society. In an attempt to reveal the mysteries of nature, his imagination goes beyond his reach. And he yields to the elusive power, forgets his egoism, works for integration of

knowledge which is unknown. In his movement, full of joy and sorrow, he learns, he teaches and he leaves behind legacies to be inherited by his successors. Thus he works for his own self as well as for others, and creates a society to do work for the betterment of the people.

The question is how science affects the people and the society. A change envisaged and translated in a developed country may not be applicable to a developing society, but the same may affect the economic conditions and social structure of a country as it happened in the North-East part of India with the advent of synthetic indigo from abroad. Who knew that the established textile industry and its associated agricultural development would take a new shape or pattern with the introduction of synthetic fibres by the chemical industry! Already the consumption of the cotton textile in the world has come down as a result of the use of synthetic fibre in textile industry during the last few years. A careful scrutiny would show how the fabric of social structure is gradually being altered by the introduction of many newer techniques and methods developed through the application of knowledge of science. Change of fashion or habit, alteration in the nature of trade, in the methods of transport, or, in the working system in an office, and many other modifications in our daily movement are affecting the behaviour of our people and the conditions of the society in multifarious ways. Even the non-ferrous metals, bronze, copper, brass, and nickel are being replaced. This new development tends to indicate that we may someday have our shoes from chemical factories. As such, any acquirement of knowledge of science and application of the same for the benefit of mankind would demand a sense of understanding of human psychology as well as a co-operative spirit to develop suitable alternative industry in order to make provision for ameliorating the sufferings of the less privileged people. Actual performance will depend on the Government policy and its power to develop new technology.

The whole world today is dreaming of a society where there will be no poverty in body or in mind. Science and technology have added a new dimension to human life by satisfying our physical and mental needs. Search for scientific truth pleases the mind, and the manifestation of science through technology gives material comforts. One is linked with the other just as the body is with the mind. The place of science in society should not be considered in the narrow set up of economic welfare of the people. Its contribution to the growth of reason and its desire to do good to mankind is no less significant. From time immemorial, the concept prevailed that the soul is eternal or immortal; but very little attention was paid to the improvement of the living conditions of the masses in general. This had led to a stagnation. It is in the study of science and technology that a developing society has found new tools of thought. And science has given

to man a new vitality and a new dynamism in orienting his culture. The benefit will be more felt when efficient steps would be taken to liquidate illiteracy, disease and hunger. "Scientific truths and discoveries should cease to be mere instruments of greed. The supreme consideration is man." These words of Mahatma Gandhi can only be translated into practice when both the material needs and spiritual aspiration of man be satisfied. This is more appropriate in our country where there is a belief that man being an emanation of God will look more after the values of life, in spite of the fact that man can achieve many things today in this material world through the scientific and technical achievements. The control over the earth, water, air, fire, and space have given immense power to mankind. This is, however, to be carefully managed so that no performance of a scientist may affect the whole fabric of the society, the welfare of mankind, or even the existence of a nation. Of course, it is beyond the power of those who have actually advanced our knowledge in this materialistic world to decide in which way their findings would be utilized, but still they by their individual and co-operative attitude may create an atmosphere where the feeling of working for humanity may pervade. Alfred Nobel discovered the destructive power of dynamite and dedicated his enormous wealth to urge scientists and others for human welfare and creative work. The World Federation of Scientific Workers are pleading for the humanitarian use of atomic power.

Whatever may be the thought on the mode of approach in our daily life, the question remains as to how far can man's aspirations in his own surroundings be realised, or how can man be inspired to use the resources at his disposal for the real benefit of mankind. Here a synthesis seems necessary between one's objective judgment and one's concept of fundamental values of life. This might be possible, if our education be imparted in a way so that man will acquire his knowledge and experiences not only for his own self but for dissemination of the same for the good of humanity. Scientists in general do a job for their satisfaction, but place the results of their performances for the good and comfort of humanity as a whole. This character of scientists virtually synchronises with the following lines of the poet, Rabindranath :

*'Ey jibane āmi gāhiyāchhi anek gān
peyechhi anek fal*

*Se āmi sabāre viswajanāre karechhi dān
bharechhi dharani tal.'*

[Many a song have I sung, and reaped many fruits ; I have donated all these to fill the earth as my gift to the people of the world.]

Success in establishment of a cordial relationship between science and humanity will lie in increasing the productivity in all spheres of life. Science

and arts can attain full bloom only if the individual and the society have the necessary freedom to work. For this the society will have to play a major role, and may even ask the individual to sacrifice personal pleasures and comforts that stand in the way of freedom of progress. In such conditions the individual may also demand a guarantee for the development of his abilities, his right to work, his education, his health and his free movement. How can the relation between the individual and the society be settled? These are issues that have puzzled man from eternity. A solution seems probable in modern industrial society if proper training be given in science. Here there is no concept of "mine", but the concept of "ours". The world has seen many warriors, many politicians, many statesmen, but they have not been able to bring about a reconciliation amongst themselves, nor have they induced cohesion amongst different groups of people. There is, however, universality of scientific laws amongst people of different race, colour, religion, and political opinion. China may differ with Russia, USA may have differences with the Arab world, but people of all these countries agree over the laws of gravitation, the properties of radium, the values of tetracycline, or, the potential force in a nuclear fission. Science has no bias ; any evil of science due to evil design of application of science is often beyond the control of its followers. It considers man primarily as a man, and at the same time works for the good of man. But whenever we talk about "creative individual", we seldom mention a scientist.

Ignorance of science means ignorance of one's self, body and mind. Love science and you will love the people. Creation of such an atmosphere for the benefit of mankind would need a change in the system of education from the early stages. A scientific attitude must pervade the whole educational process in schools, whether or not the pupils develop their career in the field of science, as science is playing a role in modelling our daily life from the early morning with the news from any part of the world to retirement at night with the melodious rhythmic sound of the National Song

"Jana — gana — mana — adhināyaka Jaya he
Bhārata — bhāgya — vidhāta"

heard over the radio, again a creation of science.

S. C. BISWAS

On Science and Human Values

A study in the analysis of values underlying science, philosophy and religion¹

At the outset I should like to preface my paper with a few brief remarks:

Firstly, although my paper is entitled 'On Science and Human Values' and has been included in the section bearing the same name, it might as well have been included in the preceding section called 'Science, Art, Religion, Philosophy, History', if we consider its content.

Secondly, I should like to make it quite clear that what I have intended to do in this paper is neither a criticism of science, nor of the particular methods adopted by it, nor again, do I intend to give my opinion as to the future of science and the mode of its advancement. All I have intended to offer here is a view of scientific experience from the standpoint of the totality which constitutes the whole range of what we call human experience, and to indicate, in the process, the type of relation that may be said to hold between it and certain other broad areas of experiences, which Philosophy and Religion typically seek to study.

Having indicated in the most general terms the different types of experiences with which each of these disciplines specifically deals, together with their respective objectives, I have sought to argue about a basic rationality that underlies them, all considered in their ideal manifestations.

Before entering into a discussion of the nature of religion in relation to science, I have made a plea for a clearer recognition of the profound difference which the presence of the human element brings about in a particular situation, so that there may be said to exist a real kind of a distinction between the physical and the human sciences necessitating an altogether different treatment for each, in so far as they deal with different types of

facts, or, looking at them more basically, with facts as such, at different levels of existence.

I have emphasised the important possibility of looking at facts from the standpoint of the reality of experiences as such. Varied and manifold are the experiences of a life. Religion stands for one phase of life's experience; science for another.

In his life of mere mechanical give and take, of needs and drives for self-preservation, when a man pauses to think, when reflectingly he turns to himself, he becomes a philosopher. The enormous prestige which science carries with the popular mind may be rightly pointed out, and it may also be argued with a certain amount of truth that its results have a certainty which for ever eludes the philosopher. Yet, for all this, the philosopher's quest may still be a worthy pursuit, in so far as it springs from the universal in the human breast. Every individual, whoever he is, has a world-view of his own, an attitude and an outlook on things in general—a set of beliefs, and a whole totality of them—a philosophy of life. It is, as it were, a fundamental urge with him, almost instinctive, something which a man lives by. "Men live in accordance with their philosophy of life, their conception of the world", says Aldous Huxley². "This is true even of the most thoughtless. It is impossible to live without a metaphysics. The choice that is given us is not between some kind of metaphysic and no metaphysic, it is always between a good metaphysic and a bad metaphysic."

If philosophy stands for a more complete and unified understanding of the world than it is in science, religion seeks a unity of a still more perfect order. The ideal religious catholicity does not consist in being merely a thought-unity (which philosophy is supposed to be); it is a felt *actual unity*—a sense of a practical oneness with the universe, of harmony between the individual and the wider world at large. This, according to some, is the last word of all true religious experiences. When we look at it psychologically, it turns out to be no more than a matter of adjustment—the inherent striving on the part of the individuum after a healthy concordance with the individua which it essentially presupposes and to which cumulatively it all the while reaches out. To be in tune with the universe³—to make the universe friendly—this has been taken as the grand object of the religious quest⁴.

It has somewhat truly been claimed that in science (in the true sense) the purpose is *pure theory*—knowledge for its own sake: knowledge ascertained through the employment of a certain methodology. (More commonly, however, for ordinary men, science represents knowledge arrived at by the

use of physical instruments and subordinated to practical economic ends.) Philosophy, to contradistinguish it with the former, takes its object to be love of wisdom through a comprehensiveness of knowledge and the consequent satisfaction of the mind. The fruit of religion is a quiet sense of possession, of harmony and adjustment—a peaceful poise in which all the tumult of the mind is laid. The whole, therefore, is just a progressive enrichment in greater and ever greater unity—this journey from science to religion. The bare factual analysis of science is seen through a more meaningful wholeness of interpretative synthesis. Science takes us to the purest variety of rational knowledge. Philosophy reaches us to that integrated comprehensiveness which is prized in wisdom. And religion, ideally, is the promised state of the perfect peace of the inward being—characterized uniquely by balance, poise, equanimity. To describe in terms of relative psycho-social attitudes: if science is man's ultimate cognitive awareness, philosophy certainly is his ultimate concern, whereas religion is nothing less than his ultimate commitment.

But this need not mean that religion is just a sentimental moonshine based entirely upon faith and imagination, having nothing to do with reason. It is faith, indeed, but faith in the essential rationality of the world-order and of that which we regard as the ultimate. It must be very carefully borne in mind that genuine religiousness, sooner or later, has got to be rational, if it ceases to be rational—if it excludes reason—it stands self-condemned. It is a significant lesson of the religious history of mankind that a truly religious life, a life of deep devotion, knowingly or unknowingly, is a life of profound thought. Knowledge or wisdom is always there whenever it is a case of deepening of the devotional life. For, in the last resort, true devotion can only be a commitment to truth. It is thus our instinct for truth that piety should really satisfy. The ultimate of religion, in this sense, is only the ultimate of truth-seeking in one of its aspects. Thus, in one sense God can be viewed as the nature of truth so that all sincere and devoted thinking is itself divine. Yet, reason without religion also fails in its total objective; for, if philosophy as a rational world-view can find no place for religion, how can it claim to have explained the total man? Such a philosophy must necessarily falsify itself. We are, of course, not talking about what has been called a closed religion or a closed philosophy. Philosophy, William James somewhere says, like life, must keep the doors and the windows open. It is this religion of open-mindedness that we are thinking about, and not the self-closed imperviousness of a windowless theology. The philosophy of religion, it must not be forgotten, is a part of general philosophy. The philosopher sets before himself the goal of interpreting the whole of experience, and, as such, he cannot absolve himself of the responsibility of

giving some account of that particular aspect of man's experience which we call religious.

The problem of the nature of religion has been considered from various points of view. The psychological, anthropological, and sociological approaches are some of the more important standpoints that have been taken in regard to it in recent years. It is sometimes thought that this would suffice as an answer to the question as to what religion, in its fullness, truly is. But this, we are afraid, is not the case—this easy assessment of the inherent religiousness of man considered from these positions which are so exclusively isolated from one another. Not certainly in the separateness of these narrow specialisations, but rather in their mutuality, in the reciprocity of their implications, are we to look for the essential meaning of our problem. In other words, we should need to coordinate and combine the findings of these sciences and evaluate them judiciously before we could hope to make any appreciable progress towards the solution of our problem.

Yet, in spite of the many multi-disciplinary approaches in recent years, we can no more be said to have advanced satisfactorily towards our journey's end than we did in the years past. And there is certainly nothing of what may be called a serious psychological defeatism in it which should deter the modern student from acknowledging this patent fact. For, plainly, the story of the intensest feeling of the human heart, of the unfathomable depths from which the God-idea wells up in the mind of man, just because it is *human*, cannot be expected to end in that rounded fullness of a completed story which is finished according to its author's desire. It is idle to expect all its threads neatly together in a perfected and unimpeachably precise unity as a science would like it to be. Man, in whatever relations we might take him, is not just a straight-forward and simple mathematical sum to be solved by the easy application of any particular well-accepted method or procedure. Man—the indomitable human spirit—simply refuses to be fully captured within this or that formula, however neatly it might be worked out. In so far, therefore, as it is essentially a human experience—rooted deeply in the nature of man—the question of the nature of religion no separate science with limited compartmentalised outlook can answer fully. Philosophy,^{4a} in the sense we have been using it, is, perhaps, alone competent to undertake such a task by providing us with a fuller understanding of the points at issue, in its normal *human* way, contradistinguished from the unerring precision of the computer's way as provided by the modern technological advances in control engineering and the highly ingenious servo-systems.

Science, for all we know, is not necessarily technology and the two can hardly be indentified, so that to dismiss or minimise any such modestly *human* account as being 'unscientific' and, on that account, to regard them

as condemned forever to uncertainties and imprecisions of all sorts, is only to indulge in an act of passing a judgment which, in itself, is not only far from being scientific but is also wholly unwarranted being contrary as much to fact as to logic. Such a summary judgment doubtlessly smacks of a certain baseless yet deep-seated bias at the back of it, for any such charge, we are afraid, simply does not stand to reason—the same reason by which science itself goes. It is an important fact of our actual living that whenever we are dealing with the ‘human’ factor—in any case where the element of the ‘person’ is involved, that is to say—we have got to consider the large multiplicity of forces to which it is perpetually open and which are to a very great extent responsible for moulding what we call human behaviour. And so far as any of these forces could be studied in isolation, considering only one at a time, the results arrived at are certainly quite as definite and precise as any that the most perfect of the physical sciences can boast of.

What actually happens, however, in the cases of every human study is that quite a large number of these forces come to act and interact simultaneously without allowing the students to have even the faintest of knowledge as to which particular one of these multitude of forces, or even which few of them, is going to dominate in a particular human situation. But to conclude from this that uncertainty, as such, is the peculiar drawback of the human studies alone would, we think, be entirely mistaken. Even the most seasoned of the physical scientists, we are sure, will hardly do anything better, if faced with a situation half as complicated and stubbornly unanalysable as that of the social scientist’s. May I crave your indulgence to be permitted to illustrate concretely what we are driving at? Suppose that our Director announces that exactly at the last stroke of twelve of the clock at noon on the 25th day of May, 1968, a tiny feather will be set floating in the air from a helicopter flying due north over the lightning conductor attached to the dome of the Rashtrapati Nivas, Simla, at 15,000 ft. and at 150 miles per hour. I have very grave doubt if any one from amongst the august group of scientists assembled here, or, for that matter, any scientist worth his name, would risk his reputation attempting to predict the *exact* spot *where*, and the point of time *when*, this released feather would land.

What is of utmost importance to note here, as any mature physicist would perhaps readily acknowledge, is the fact that the whole spectacular record of faultless predictions with which the physical sciences are rightly credited is due, to a very great extent, to the more basic facts of this discipline’s having rigorously confined itself more particularly to ‘the relatively simple phenomena where accurate predictability is feasible’, while scrupulously ignoring such complexity of situations as would allow for only a compara-

tively low predictive accuracy, on the ground that the latter are for engineering to go into and not for science. The 'proof' of a genuine science (as distinguished from the pseudo-sciences) does not certainly depend on the conclusions arrived at by it or on its particular findings. Such a proof, on the contrary, squarely rests on the type of the method employed in the inquiry of the problem concerned—on the manner of approach and procedure followed. The 'scientific', more basically, represents a certain general attitude of mind: a stern conviction in the efficacy of a purely objective analysis and assessment of facts (usually regarded as numerical particulars fully expressible in exact quantitative terms), an inalienable faith in the essential rationality of man wedded to a ruggedly honest determination not to accept anything as true till after it has withstood the test of the severest of rational criticisms, a firm belief that the universe which is basically 'self-existent, self-explanatory, self-operating and self-directing', does not necessarily require a supernatural cause. This general attitude, however, has to be adequately qualified to suit the nature of the subject-matters with which each of the separate sciences are respectively concerned.

In this sense, the special manoeuvrings and techniques that are employed in what are called the physical sciences are obviously not quite the same as those employed in social sciences—although the objective of both these classes of sciences is identical: namely, the adequate application of categories for an adequate explanation of facts. Methodologically speaking, this distance—if distance it could be called—between say, physics and psychology has got to be reckoned with within the fold of science itself. And whenever this great lesson of human experience has not been properly heeded to, and the dogmatists among the scientists refusing to accept the differences where differences really *are* and are also *real*, have obstinately clung to the now-exploded theory of the universal sameness of being, they have only succeeded in demonstrating, what for the want of a better name we may call, a kind of intellectual ostrichism in the manner of those orthodox theologians at whose behaviour Galileo did not quite know whether to laugh or weep when they refused to put their eye to his telescope, lest they might see an additional planet which had no scriptural authority to exist. Such an attitude, as has been amply demonstrated in the writings of many naturalists of the recent past, inevitably leads to a drastic narrowing down of the sphere of the real by entailing a series of sweeping negations eliminating such of those real, but certainly somewhat embarrassing, facts as do not quite fit into the limits of an exclusively quantitative objectivism. Thus, we hear the orthodox men of science tell us: that the world-process does not point to some benign purpose or deeper meaning; that it is clearly purposeless, deterministic and only incidentally productive of man; that amid such a world—the cherished desire of a teleological and anthropocen-

tric world-order presided over by a God-creator having been given up—our ideal must find its home ; that man is the product of causes having no prevision of the end ; that his origin and growth, his hopes and fears and loves, are but the outcome of accidental collocations of energy particles. As such, no fire or heroism or intensity of thought and feeling can preserve an individual life beyond the grave. All the labours and aspirations of ages, the whole temple of human achievements, we are told, must inevitably be buried beneath the debris of a universe in ruins.⁵

Yet, for all we know, this may not be the inevitable picture of man and his place in nature that one has to take ; for, the uniqueness of the person, the infinite richness of the qualified world of individualities can hardly be thus explained by an exclusively quantitative interpretation. In other words, individuality, which is essentially primordial, cannot with any sound logic be thus reduced to an ephemeral consequence of blind junctions of quantitative universal, and, in the process, made derivative. The crying need of the moment, therefore, is a broad-based outlook on the reality of experiences as such. And this will be best served by the clear recognition that some of the sciences have to deal with situations which are subject to one or a few dominant forces lending themselves to better understanding with accurate predictability, while others are set against a multitude of such forces none of which are dominant, each, however, being a significant contributory factor to the total situation in its own way ; that while concepts in one set of situations are more accurately definable and measurable, and experiments in regard to them are not only repeatable at will but are also subject to stricter control through comparatively easier ways of isolating the variables leaving the situation itself almost unaltered, none of these are true of the other set of situations we are referring to.

At some future date perhaps, let us hope, it will be possible to conveniently sum up *all* scientific knowledge—irrespective of whether they deal with carbon or chromosome or consciousness—by means of a few simple principles. This, at least, has been the basic faith of the scientist—worshipped overtly by his unqualified acceptance of the law of parsimony and enshrined somewhat ceremoniously in that great motto of his which proclaims: *entia non sunt multiplicanda praeter necessitatem*. But till that stage is reached, it will, perhaps, be much more meaningful for the scientists pursuing diverse disciplines to realise that in the realities of life and its actual experiences they have, between themselves, many more things in common and much more to be profitably learnt from each other than they had previously suspected. And to the trite objection that science advances through specialisation—that it has progressed through the centuries only by knowing more and more about less and less—and, as such, the grand generality of an overview is not quite compatible with its genius, we would

reply by saying that, as a matter of actual fact, in the sphere of knowing and of reflective thinking, there is no inherent contradiction between the piecemeal and the grandiose, that specialisation here can go on very well within an ideal of interrelated comprehensiveness, and that the ever-increasing volume of special informations collected by the different sciences might all be integrated into a more meaningful whole of knowledge. As in the case of cosmogenesis, so also in the development of human thought, differentiation has always been, as it should always be, side by side with integration. In the language of Morton White, "the hedgehog may lie down with the fox, and the result need not be grotesque".

The various philosophical theories of the nature of religion, which one comes across in the vast literature on the subject, have been conveniently classified under three broad heads: the Intellectualistic theories, the Moralistic theories and the Romantic theories, according to their most fundamental elements, namely, according to the emphasis in them on the element of thought, will, or feeling.⁶ It is of general acceptance, today, that in religion all sides of the personality are represented. Feeling, will, and intellect participate as necessary and inseparable constituents of religion. Yet, it is very difficult to capture the precise connotation of this amazingly complex concept within the frail frame-work of a logical definition.

The sweep of religion in the individual sphere is unthinkable large. It is most significantly co-extensive with life—touching every aspect of it. It embraces the social as well as the individual, the higher and the lower, the rational, the emotional, and the practical in one immeasurable manifold which is unique. It is not without reason, therefore, that academicians and the social scientists, taking religion as one of the expressions of the psychosocial gestalt of creative man, are found in the end to conclude that it is in reality, not one thing but a many-in-one—a veritable *complexio oppositorum*. And even on the closer analytical study of the modern intellect being brought to bear upon it—which starts by drastically eliminating from it the undefined term 'God' together with the usual theological concepts of self-existence, infinity and eternity associated with this term—the highly simplified definition of the concept of religion that results is still sufficiently complex: a felt practical relationship with what is believed in as a superhuman being or beings.

It has been customary to contrast the religious attitude with what has been called the scientific temper. Science claims to base itself entirely on reason, and nothing but reason. Denouncing religion as dealing with articles of faith, and as accepting things on trust, science has its own church built on the rock of man's inherent ratiocinateness. This is the new article of faith for the scientist. The very spirit is eloquent with an anti-authoritarianism and anti-dogmatism which is fundamental. A science,

says Whitehead, while accounting for the barrenness of the traditional logic, a science which hesitates to forget its founder is lost. The statement typifies most significantly the modern scientific outlook. Taking its stand on an open-minded rationalism the true worshipper of science begins with the empirical method. Things are what they are experienced as. Experimental verification is probably the best instrument one would think of in this regard. From the scientific point of view, stated in general terms, all judgments are only provisional. Nothing is of any worth if it fails to stand the final test of rational analysis. There is always the undeniable scope there for revision, re-thinking, and re-valuation in the light of fresh knowledge. Not the rigidity and closedness bearing on a narrowly circumscribed outlook of a doctrinaire, but the universality and the width of a latitudinarian, not the sedate inerrancy of a scripture-monger, nor the literal infallibility of the fundamentalist, but a broad-based catholicity of reason truly claiming all knowledge to be its province—is what is to be prized.

Yet, the opposition between religion and reason, contrary to what might be supposed, is not altogether a new story.⁷ This seems to be the perpetual burthen of all varieties of naturalistic thinking—the one theme to which all such thinkers are bound to recur. Russell, while stating the true import of philosophy by comparing it to a perilous no-man's land, strikingly brings home this typical attitude of the modern mind:

“Philosophy”, he says, “is something intermediate between theology and science. Like theology, it consists of speculations on matters as to which definite knowledge has, so far, been unascertainable; but like science, it appeals to human reason rather than to authority, whether that of tradition or that of revelation. All definite knowledge—so I should contend—belongs to science; all *dogma* as to what surpasses definite knowledge belongs to theology. But between theology and science there is a No-Man's Land exposed to attack from both sides; this No-Man's Land is philosophy.”⁸

Theology and science are thus rigidly separated through the intermediary of a philosophy which is neither the one nor the other in its entirety.

But this, we feel, is essentially a false view of the matter. It suffers from the serious drawback of being a static analysis in cold compartmentalization. We ought to remember that more recently not merely the antagonism and animosity of the old, as had existed between the two, has passed away, but that the period of rigid isolation is also manifestly passing; the need today is not so much for mechanistic advances in exclusive isolationism as for a fuller understanding of life and personality as a whole—of behaviour and community, in the wider perspective of existing moral codes and of religion. And science today, if it means to fulfil its proper service to

mankind, must claim the *totum scibile* for its province⁹. It is, indeed, difficult to draw a hard line between these apparently conflicting states. For, as we have already suggested, these are not the separate types of existents at all, but only moments in one whole of experience. Experience is a process enduringly finding itself both expanding in sweep and enriching in depth. The history of man's pilgrimage in knowledge is an everlasting search for truth. At one stage of this journey he finds it at one level, and it is caught up in his experience in one light; he masters it and looks for more of it. This is the tale of the growth and enlargement of human experiences. Through successive break-downs and dawn-breaks man is continually approaching the unity of philosophic experience.¹⁰

The purely empirical, the ontological, the axiological-spiritual are thus only different modes of man's experience in ever-increasing meaningfulness. The truth that we encounter on the purely empirical level—the so-called scientific certitudes—becomes much more significant and of deeper implications on the spiritual plane. The pleasure of a sensualist, the thrill and satisfaction of the scientist, the rapturous joy of the artist, the benevolent calm and wisdom of the philosopher, and supreme bliss of a beatific vision that the saint and seer have, are all strains and stresses within man's experience. Our concept of values—whether religious or ethical or aesthetic—are as much rooted in experience as the concept of Nature. For the attainment of truth the various types of experiences that we have are to be interpreted; and the method of interpretation is rational. Thus, it cannot possibly be that anything which is true for religion is false for reason.¹¹

Philosophy, speaking generally, is an objective and rational interpretation of experience, and it is an interpretation from the stand-point of the whole—the synoptic stand-point. But in the present day context, to keep pace with the rapid advances in the sciences, it is fast becoming, more specifically, a veritable emergent out of a conspectus of the scientific theories by way of a synoptic reflection upon them. The empirical foundation of contemporary philosophy, thus, is to be found in the natural sciences themselves. From the practical side, again, it has been urged that philosophy deepens and broadens life itself, as much as religion elevates and edifies it. It is thus a chastening approximation towards an experienceable ideal which is the systematic wholeness of being. Like the philosophic, religious thought too is perpetually wedded to experience; and like the former it is an attempt at a further reinterpretation of experience as a whole. The various problems of religious life are essentially and primarily problems of human experiences.

Varied and manifold are the experiences of a life. The purely empirical and sensory experiences, the biogenetic and the vital, the psycho-sociological and the axiological are but different kinds of experiences we meet on the

walks of life. The so-called scientific theories represent one phase of experience and relate to one type of facts. The philosophic and the religious doctrines relate to other types of facts and issue in experiences of different sorts.¹² There is, therefore, a whole hierarchy of values in human experience. This requires different categories of interpretation according as we encounter these experiences on different planes of existence. There need be no conflict between the different aspects of the *real* when we look at it from the point of view of the whole. In its uniqueness and qualified enrichment, the whole is always larger than the sum total of its parts and is essentially much more meaningful.

It must have been quite evident that in holding to such a view we are at once emphatically dissociating ourselves from the exclusively mechanistic views held in this regard and registering our fullest sympathies with what has been called the holistic and organic ways of thinking. But, unfortunately our scientific, philosophical and religious views are still too much conditioned by analytical concepts and materialistic imagery to be fully appreciative of the fact that science, philosophy, and religion are but the organically related, if different, phases in mind's pilgrimage towards the ultimate.¹³ Through these varieties of experiences man comes closer to the variegated nature of the real—he comes to know the infinite richness and diversity of being. These various aspects, internally related and interpenetrating each other, set up the whole of experience. Yet, in so far as the stress given on and importance attached to the different aspects is apt to differ in different persons, it is not quite illegitimate to say that the different individuals approach the real from different sides. The perfect life is an enjoyment of the integrated whole of experience. This is the stage of *vijnana* or science in the true sense of the term, in realizing of the fuller meaning of which religion is but a living engagement.

NOTES AND REFERENCES

1. Revised notes from a talk given in one of the meetings of University Study Circle, Allahabad.
2. Aldous Huxley, *Ends and Means*, p. 291.
3. R. N. Trine has a book the title of which is strikingly suggestive of this: *In Tune with the Infinite*. The views of Leuba and Edward Caird are interesting in this connection. Some, of course, condemn this as negative religion.
4. Yet, how few of the religious leaders have reached this ideal and what a mighty deviation from this ideal is actually witnessed in the divergences of our petty religious bickerings. In such cases of religious controversies which abound in mere meaningless quibblings certain other considerations than this grand ideal come to the forefront which end in altogether different results. Instead of the

envisaged universal fraternity what one gets is a constant strife and dissension leading sometimes into bitter, if holy, wars. This, however, may be said to show one thing: viz., the mighty power which lies at the back of religious sentiments as their undeniable and universal basis. History bears witness to the fact as to how empires have been overthrown and new ones built up in the name of this queer little word—religion.

- 4(a) A philosophy of religion, it should be remembered, is clearly distinct from theology in that it recognizes the priority of reason over faith, subjecting it to a logical analysis.
5. This is what a scientific thinker of the eminence of Russell would tell us. See, Bertrand Russell, "A Free Man's Worship" in *Mysticism and Logic*, Pelican, pp. 50-59.
6. This is too well-known an analysis of the problem to be considered in any further details. We can only refer to Prof. Leuba's classic attempt in this regard in his *Psychological Study of Religion* where he gives us a whole list of forty-eight definitions of 'religion' from various writers which he subsequently undertakes to analyse.
7. On this classical antagonism between theology and rational inquiry please refer to the present writer's paper, "Religion as an Integral Experience" in the *Allahabad University Studies*, 1955.
8. Bertrand Russell, *History of Western Philosophy*, p. 10. Of, also the rigid though self-imposed limitation between these as described by C. E. Raven: "Science was concerned with the ponderable, religion with the imponderable; science with general, history with the particular; science with fact, every thing else with fancy, such antitheses were proclaimed as axiomatic. They are indeed still widely accepted", *Natural Religion and Christian Theology*, 1953.
9. Cf. Charles E. Raven, *The Creator Spirit*, pp. 112-15.
10. See the book by the same name, *The Unity of Philosophic Experience*, Etienne Gilson (Sheed and Ward) where the successive rise and fall of the systems of thought have been carefully analysed throughout vindicating what has been called man's metaphysical urge.
11. It is quite common to take reason in an entirely narrow sense. The rigid empiricism of reason is certainly not the only way. The role of reason in the different phases of human life is much wider. And if the barrenness and sterility of reason has often been witnessed, it is only due to its improper employment in some of the crude naturalisms of the past. Even so from the purely scientific standpoint this fact is now being more and more fully realised. Physics, for example, the most developing of the contemporary sciences and the most formative of our times, does not deny reason, but simply calls for a more agile and more flexible reason. After all, this is again a question of what we have called an open-minded rationality against the oddities of a closed reason narrowly moving through its fixed grooves to a kind of myopic precision.
12. Since these notes were prepared a number of significant studies have been published. In *The Foreseeable Future* by Sir George Thomson (C. U. Press) the extra-ordinarily rapid advancement of science and technology has been fully acknowledged; yet it is held that this could not be regarded, by itself, to be an adequate guide for mankind and, as such, stood badly in need of supplementation by philosophy and religion. Again whether in *Science and the Modern Life* by Sir E. John Russell (Epworth Press) or in *Mysteries of Science* by John Rowland (Warner Lawrie)—from all sides the conclusion that is forced is that

science which is wonderfully suited within the limits of the material world, is, as yet, insufficient, by itself, for an explanation of the entire world of values.

13. This view that science, philosophy, and religion represent varying degrees of perfection in one single process of the self-enrichment of the mind is not anything entirely new. It is only a reaffirmation of fundamental truth reached on several occasions in the intellectual history of mankind. From the Greek period down to our own time we witness this position variously emphasised in Aristotle, Spinoza, Leibniz, Hegel, Alexander and Whitehead. In their successive systems it is the same truth that is struggling for self-expression: Mind defines and develops itself in a series of natural, psychological, moral and religio-spiritual categories. This point has been very ably brought out by E. E. Harris in his *Nature, Mind and Modern Science* (George Allen and Unwin, London, 1954), and further developed through an examination of the main theories of contemporary Physics, Biology, Neurophysiology and Psychology in his recent *The Foundations of Metaphysics in Science*, George Allen and Unwin, London, 1965.

V. V. JOHN

Socrates and the Scientists

A chapter from Plato's Indian Republic

“READING the newspapers that come from India”, said Agathon, “one gets the impression that Indians are great worshippers of science and technology. Did this come to your notice, Socrates, during your travels in India?”

“One could hardly miss it”, answered Socrates. “Some of the most impressive edifices we saw were dedicated to the pursuit of science. You are right, Agathon, in referring to it as worship. For the devotion was more akin to propitiating a deity for the sake of favours expected, than to the disinterested voyaging of the mind wherever reason leads it.”

“Did not one of their great leaders say, while visiting a large irrigation and hydro-electric project, that the dams and the power plants were the true temples of these days?” asked Crito.

“I see no harm in such figures of speech”, said Socrates. “The vulgar ostentations of technology should not blind us to the fact that in India’s desperate battle against ignorance, hunger and disease, science could be of great help. And whatever relieves the suffering of the poor should be reckoned holy.”

“But Socrates”, asked Lysis, “would you say that you noticed among Indians much genuine devotion to science, as distinguished from a mean-spirited longing for the more garish fruits of scientific discovery? I was with you on your journeys, and I remember you lamenting that while there was in the country a large presence of science and technology, there was little of the scientific spirit.”

“That is true”, said Socrates. “Their attitude to science is part of their

attitude to education. Science, like education, has a higher purpose and a lower. The higher purpose is the attainment of a quality of the mind. The lower is the acquisition of useful skills. One does not have to make a choice between the two, for one can have both, and ideally, one *should* have both. But in India, I noticed, learning was neither the pursuit of a quality of the mind, nor the search for employable skills: it was largely a search for advantage, mostly undue advantage over others. And if they could have the advantage without the learning, they would welcome the arrangement. Many clever men have managed this, and risen to high positions. They are greatly admired. This has resulted in a blurring of the distinction between the pursuit of knowledge and self-seeking."

"Even those who pursued learning did not seem terribly keen on overtaking her", said Lysis. "For, you remember how in the seats of learning we visited, a young man would spend his days and nights on scientific research, but the moment he received the title of doctor of philosophy, he would give up the research and look for a position of power and advantage. They have a goddess of learning, *Saraswati*, whom their forefathers worshipped. Today she has only temporary devotees. The artists pictured her as playing the *veena*, the notes of which linger in the mind and could become a permanent intoxication. But considering the continuous defections among her devotees, some one suggested that the *veena* should now be replaced by a penny whistle."

"The goddess of learning is a jealous goddess", said Socrates. "She exacts continuing devotion. Learning, particularly in the form of science and technology, becomes quickly obsolete, and yesterday's scholar becomes today's ignoramus."

"Unless he sets up as a resourceful charlatan", added Lysis. "Then he would set up business in one of their imposing institutes of learning, and make a career of obstructing devoted neophytes. He fancies it to be in his interests to ensure that his juniors get no smarter than himself. Or may be, he makes a practice of taking the credit for the work of younger people."

"Would this explain the exodus of young scientists to foreign lands, or what their newspapers call the brain drain?" asked Agathon.

"One wishes they had a more seemly phrase to describe the emigration of scientists", said Socrates. "I was told that this emigration had at least two causes, one respectable and the other not so respectable. Some stayed abroad because laboratories abroad provided facilities for scientific inquiry, that were not available at home. Others stayed abroad because that way they could make more money. The latter are not a great loss to the country."

"I remember reading somewhere", said Crito, "that the Americans who

give millions away to poorer countries, save millions by attracting to their shores thousands of doctors, engineers and other technologists, and thus sparing themselves the expense of training them at home."

"The traffic goes both ways", said Lysis. "But I heard the complaint that America tempts to her shores good technologists from India and in return sends out to India obsolete technology and third-rate experts, in the name of aid."

"Continuous dependence is not a soil that encourages the healthy flowering of gratitude", said Socrates. "Some of the technology that has come to India by way of assistance and some of the experts that came with such assistance, may have been of poor quality. Donors cannot always avoid an attitude of condescension. It was up to the receiving nation to have exercised due discrimination."

"Indians perhaps have learnt from the British proverb that they should not look a gift horse in the mouth", said Crito.

"There is another proverb that should warn them that beggars cannot be choosers", added Agathon.

"Both are humiliating precepts", said Socrates. "Anyway, if a gift horse has to be examined, the right moment is at the time of the gift and not several months or years after. The warning about beggars not being choosers perhaps indicates what is really wrong. The real evil in technical or economic assistance is not that it is of poor quality, but that it defers the stage of self-reliance. Self-reliance is inseparable from the idea of freedom. When Indians won independence from the British, they were surely not wanting merely to replace political dependence on Britain by economic dependence on everyone in the world. Whether we define freedom in the Indian sense of deliverance from what oppresses man, or in the Greek sense of being in charge of oneself, freedom is not a reality so long as one has to depend on assistance from others on a basis other than mutual. In India, this dependence will seemingly continue so long as her science and technology continue to be imitative, and unable to build up a true scientific spirit."

"With so much science education in her institutions of learning, and with richly endowed institutes of scientific research, how can you say that there is any deficiency of the scientific spirit?" asked Crito.

"Valuable research is being done by some of their scientists", said Socrates. "But if you travelled in India, Crito, you will learn how science could be pursued in an unscientific spirit. In many places we saw students of science abstaining from attending to their work in order to force the authorities to reduce curricular requirements or give them promotions beyond their deserts. Is it scientific to expect results beyond what the effort justifies?"

"We met other young people who had been trained for engineering jobs, though there were no jobs for them to do", added Lysis. "It did not seem scientific to train people for jobs that weren't there."

"And yet, one should have thought that in a poor country like India", said Agathon, "there is so much to be done to improve conditions of living, and there should be multitudes of jobs that engineers could do to improve those conditions."

"But there is no co-relation between the work that needed to be done and the salaried positions that their government created", said Lysis.

"Another instance of the unscientific attitude", observed Socrates.

"Work that clamoured to be done could be seen wherever we went", said Lysis. "In their institutes of research, they would import scientific equipment from abroad, but if anything went wrong, it would be put away for want of skilled men to repair it. If a census were taken of scientific and technical equipment that stayed unused all over the country, because India's technologists did not know how to repair them, I guess the tally would be large. This is an immediate challenge their technologists could take up, but no one seemed to be in a hurry to take it up."

"A phrase much used while we were there was 'know-how'", said Socrates. "They seem to have borrowed it from the Americans. And their habitual addiction to phrases prevents them from realising that knowing how should not take precedence over knowing why. Technology should not take the place of wisdom. Else you will have the situation, now more or less universal, of having excellent means of communication and hardly anything to communicate."

"I understand that their 'know-how' now extends to making the nuclear bomb", said Agathon.

"That is so", said Lysis. "While we were in India, some cynic even suggested that India should celebrate the centenary of the birth of Gandhi, the apostle of non-violence, by manufacturing the nuclear bomb."

"I understand that a great debate now rages in the country over this question", said Crito. "Their leader Nehru had once declared that India would on no account make the nuclear bomb."

"That was before their neighbour China made the bomb", said Agathon.

"Such a development could easily have been foreseen", said Lysis. "What are professions of peaceful intent worth if they are contingent on the absence of provocation to behave otherwise?"

"My understanding is that as of today, India has only refused to sign an agreement pledging not to make the bomb; she has not decided to make the bomb", said Crito. "The proposed agreement seeks to ensure that no one who does not have the bomb today will set about making it. Those who have it already make no promises about immobilizing their nuclear armoury."

“But have not the super powers promised what they call a nuclear umbrella for those nations that do not have the bomb?” asked Agathon.

“The promise, I understand, is ambiguous”, said Crito. “And even if it were not so, nations do not seem to have the same sense of honour over promises and pledges as private individuals have.”

“The situation seems to provide a rare opportunity”, said Lysis, “for certain of India’s scientists and economists to work up a high degree of patriotic fervour, and argue that India should make the bomb. Having failed to solve the problem of India’s indigence and bungled on many fronts of national development, they probably find it expedient to distract the people’s attention to an armament programme that has a large emotional appeal.”

“We cannot blame India for refusing to take a pledge that she would not make the nuclear bomb, if other and stronger nations do not do likewise” said Socrates. “This is clearly a question of national pride. But one would like to see this high pride expressed in other ways too, such as in refusing to live continuously on aid from other people. India’s Prime Minister declared that she would not sign a humiliating treaty regarding the bomb even if this meant the end of all economic aid to her country. If she could take this bold stand on one point of honour, could she not take the same bold stand on other points of honour involving dependence on other people? What such a decision would do to national pride may be greater than the making of the bomb, which anyway cannot be done without expending on it resources that are badly needed for relieving poverty.”

“The example that India would follow”, said Lysis, “is that of the powerful nations that are more keen on landing a man on the moon than on seeing that the poor in their own lands are adequately fed and clothed. And to the scientist, a piece of scientific bravado like the making of the nuclear bomb seems to be more attractive than devising ways of relieving the distress of the poor.”

“You are forgetting that the Chinese have the bomb and are therefore a potential menace to India”, said Crito.

“That may be true”, said Socrates. “You probably have in mind what the world’s statesmen call the policy of deterrence. The logic is that if you have the bomb, the enemy will not use his bomb. The logic is really not complete, for an enemy driven to desperation may use the bomb, when he finds that the alternative is even worse, namely, defeat and humiliation in conventional warfare. Short of such desperation, against which rational deterrence is unavailing, effective deterrence can be devised without the possession of the nuclear bomb. National unity and resolve, and the support of world opinion, could be as powerful deterrents as the bomb.”

“But the scientists, the economists and the politicians find the building up

of such deterrents too troublesome”, said Lysis. “So they pine for the bomb.”

“It would seem”, said Socrates, “that India’s scientists, instead of learning by the experience of their compeers in other lands, would want to create for themselves the same problems and go through the same errors. In America the first bombs were made by men who were thrilled at the thought of what they had accomplished. After 2,00,000 had perished in Hiroshima, their excitement was more restrained. One of them lamented how scientists had known sin, and how the world was not the same for them any longer. Must India’s scientists go through the same unthinking thrill and eventual remorse? Particularly when there is so much else for them to do?”

A. KRISHNAMURTHI

Science, Scientist and Human Values

EVERSINCE Alfred Nobel invented dynamite, the role of science and the scientist in evolving a better society has been the subject of much discussion and debate. The enormous capacity of science for destruction has focussed itself more sharply on the minds of people with the dropping of the atomic bomb over Hiroshima in 1945. In spite of the fact that scientific discoveries and inventions have benefited mankind in innumerable ways, in the wake of scientific discoveries and inventions, one after another, capable of more harm and destruction, people are wondering whether science is an unalloyed blessing. Informed individuals in many countries feel that scientists are responsible for the uses to which their discoveries and inventions are put and blame them for the difficulties in which the world finds itself today. It is not only for the creation of instruments of destruction that the scientist is blamed but also for his willingness to serve as an adviser when decisions are taken on the use of such discoveries and inventions for harmful purposes.

Every significant social, political and moral issue of our day is being dramatically influenced by the new powers made available through science and technology. It is also clear that science and technology have great potential for good as well as for evil, and the crucial issue is how the scientist can help in harnessing and channelizing his discoveries and inventions for the benefit of mankind and thus preserve the basic human values, such as sacredness of human life, non-violence, tolerance, self-respect, selflessness, fellow feeling, independence, freedom of speech and thought, etc., which go to make a better world to live in. What can the scientists do to bridge the widening gulf between the rich and the poor nations, the developed and the

underdeveloped countries, and the haves and have-nots, which is threatening to uproot all the human values held sacrosanct by man ?

To understand the negative role the scientist has been largely playing in world affairs today by not squarely facing up to the problems for society created by his work, it is necessary to examine briefly the process of science. In the early days, pursuit of science was not looked upon as a means of livelihood but as an avocation for a cultured person. Today science is a dominant factor in the struggle for a better livelihood and a better life. The scientist, by and large, is preoccupied with his work in the laboratory and his work is not motivated in any way with discovering something which will always benefit mankind. The scientist is governed by the rules and guidelines he has set himself in the conduct of his work—search for new facts. The society of scientists honours a set of values designed to reach the 'truth' about facts by open argument. The most important value is independence, without which there can be no progress towards truth, no argument is possible and no experimental test is convincing. Another value in science is originality. Both values are expressed in dissent, and it is therefore necessary that science should safeguard dissent by giving special value to all forms of freedom—free inquiry, free speech, and open publication. Thus one of the primary values of science is tolerance, not as a mark of indifference to the views of others, but as a mark of equal respect for them.

I am deliberately dwelling on these values of science, as they have an important bearing on the relation of science and scientist in public affairs. As to how these values are applied by the scientist in other situations will be referred to later. It seems rather strange, in this analysis of the modern concept of science and the scientific method, to come upon such underlying human values as tolerance, freedom and respect. They point to the basic fact that science is a human social activity and in a society where such human values do not exist, the scientist would have to generate them and put them into practice.

It is often argued that the scientists should put a moratorium on all discoveries and inventions which can lead to destructive and evil applications. Why is the scientist then reluctant to play such a role? The answer lies in the whole tradition of science and the values of science. In its essence science is democratic. It moves by open argument to free argument, and to break with this method is a breach of faith to the scientist. Free inquiry, free speech, and open publication have been the conditions for the success of science and it cannot grow without them. Scientists are afraid that any plan to suspend these essential prerequisites of science in order to meet some present threat, however grave it may seem, would damage the free tradition of science once for all. In spite of these avowed ideals of science and the scientist, scientific tradition today does not uphold some of the

values considered essential for the progress of science. For example, open publication is not the rule today.

Thus the scientist is more concerned with the methodology of science, and is blindly guided by the values he has set himself in the pursuit of science. The principles and basic values he finds so imperative for the progress of science are not applied to situations beyond the confines of the laboratory. The important question, therefore, poses itself: should the scientist get out of his ivory tower and set himself new responsibilities and new codes of action and concern himself more and more with the implications of his discoveries and inventions to human society? The answer is definitely 'yes'.

Scientific research is no longer a utopian occupation of the scientist-philosopher of the bygone days, whose sole aim was search for knowledge and unravelling of the mysteries of nature, oblivious of the impact and consequences of the results of his researches on society. Today science is a big industry and scientific research a profession, and the scientist should, therefore, be treated as a professional like a doctor or an engineer. The profession of the scientist, whether he is concerned with basic or applied research should be subjected to a code of conduct and professional ethics as in the case of the practitioners of medicine. The Hippocratic oath includes the following code of conduct: "I will prescribe regimen for the good of my patients and never do harm to anyone...To please no one will I prescribe a deadly drug nor give advice which may cause his death." Even in the present highly materialistic age, the oath of service and the ethical code of Hippocrates have established a standard of professional ideals which is still accepted and followed. Is it not possible to lay down a similar code for the practising scientist and technologist, so that his work is solely motivated towards and directed to the good and wellbeing of humanity and towards preserving the basic human values? It is no longer adequate for the scientist, at least at the decision making levels in public affairs, to be just an eminent expert in his narrow field of specialisation, if he is to play a positive role in guiding the destinies of human society. He should be a well rounded personality like the natural philosophers of the olden days — Plato, Aristotle and others — so that he can wisely influence and guide the authority at national and international levels to act in a manner conducive to universal good and betterment.

There are already signs that scientists are called upon to shoulder such responsibilities. The Society of Atomic Scientists, USA, which was set up after the atomic blasts over Japan, was organized to enable scientists to play their part in public affairs with the freedom to which they are wedded in their scientific pursuits. The great scientist-philosopher of our generation, Albert Einstein, a founder member of the Society of Atomic Scientists, has

said, "Concern for man himself and his fate must always form the chief interest of all technical endeavours...Never forget this in the midst of your diagrams and equations." He has shown by example and precept how scientists and technologists should act and what should be their ideals and goals. The scientist should guard his freedoms — free inquiry, free speech and open publication — jealously. If only open publication of all scientific discoveries and inventions were jealously adhered to by the scientist, the world would not be dissected into haves and have-nots, poor and rich nations, and developed and underdeveloped countries. There would be no technological gap and all the attendant misery over a large area of the globe. One wonders if the atomic blasts over Japan would have taken place if the scientists had jealously stuck to the freedom of open publication and if the details of nuclear fission experiments were published. Open publication goes a long way, but is not enough. The scientists must not only publish the results of their researches freely without any inhibition but also undertake a more important duty towards society. They must tell all those who will listen to them the social and political implications of their discoveries and inventions, and see that public opinion is brought to bear upon those in authority to use scientific discoveries and inventions for the benefit and not the destruction of mankind.

To conclude, the scientist must strive to attain a status and eminence in society so that others can look up to him for guidance in public affairs and in upholding human values. It is only the wise and pre-eminent who can influence and muster public opinion to the good and betterment of society. I am reminded of the eternal truth embodied in the *Bhagavad Gītā* which says :

यद्यदाचरति श्रेष्ठस्तत्तदेवेतरो जनः ।
स यत्प्रमाणं कुरुते लोकस्तदनुवर्तते ॥

(Chap. III, 21)

Whatever a great man does, the other men also do ;

Whatever he sets up as the standard, that the world (people) follows.

The scientist has all the equipment by the very nature of his training, to be a man of destiny and leader of men, and he should not shirk his duty towards society and his fellow human beings under the mistaken notion that he is not concerned with the applications — good as well as evil — to which his scientific endeavour is put.

R. C. MEHROTRA

Impact of Science on Moral Values

THE fear that 'science and its rapid progress' leads to immorality is not new. It has been argued, for example, from time to time that the countless automatic gadgets and energy slaves are affecting the morals of man in the same way as the practice of slavery exercised a corrupting influence on the free population in the later Roman period. Some others feel that the affluence brought about by science and technology might corrode the concept of 'self-denial' in our ancient philosophy, and still others opine that the easy cures and remedial measures provided by modern medicine may lead to a slackening of the fear of punishment and disease which come upon the offender for violating the laws of nature.

Amongst those who take a much more tolerant view of science, and this group often includes scientists themselves, there is a general belief that science may not be actively anti-moral but it is amoral or without any morality at all. The implication often is that science breeds in the minds of those who practise it an indifference to morality which gradually slackens their power of right judgment and urge to correct behaviour.

These types of charges are not levied only against science, but in fact almost all types of human activity have met with similar resistances at least in the initial stages. There has never been a great book or powerful creation of art which has not been thought of immoral or amoral by those with an older tradition. To quote only two instances: Shelley's poems were considered so immoral in the initial stages that selling them was considered a criminal offence, and one of Tolstoy's greatest works, *Anna Karenina*, was judged to have no moral value at all. With the passage of time, judgment

has been entirely reversed on these and other creations of art and literature: However, the concept that science has no moral values continues to linger as it is considered to be merely a collection of facts or data which can be merely proved or disproved by actual experiments.

There is no system of morality which does not set a high value on truth and knowledge and above all, conscious knowledge of itself. Judged from this angle alone, it appears really intriguing how science could be considered immoral or amoral, as even the greatest critics of science would at least agree that whatever else may be held against science, this cannot be denied that its final judgments depend upon the single criterion of being truthful.

During the last forty years, a number of important philosophers of science like Russell and Whitehead have tried to develop a philosophy of 'logical positivism' about the working of science. According to this, truth in science merely connotes 'verifiable in fact'. Although this concept may be true by and large, even it has its limitations as depicted so clearly by the 'principle of uncertainty' developed in the Nobel Prize winning work of Heisenberg. That our most delicate techniques of measurement themselves disturb the 'fact' sufficiently not to render it 'absolutely verifiable', has given to the scientific method an air of 'imperfection' which sounds like a human quality and has brought science nearer to the values which man has cherished for long. Reducing the limits of 'imperfection' would be in effect moving towards 'perfection', which is in itself unachievable, but the same is now accepted in the highest forms of scientific activity also.

The greatest moral value of science lies, in fact, in this feeling of 'imperfection', not only in its highly philosophical form as embodied in Heisenberg's principle of uncertainty, but even in the down-to-earth activity of every devotee of science. Urged by his curiosity, every true student of science soon realises, like the great Newton, the unfathomable depths of the ocean of knowledge at the shores of which he stands. Like the wise man in the Chinese saying "One who knows not and knows that he knows not", he continuously strives to know more, observe more accurately estimating every time the limits of the accuracies or inaccuracies of his measurements. In spite of the limitations of the technique adopted by him, he knows what he is doing. However, his true contribution to human knowledge does not lie in his individual observations or measurements, but in the 'correlation-ship', in the order or in the law which he continuously strives to discover amongst these apparently scattered data. He finally cherishes the truth of the laws, the realisation of which is often as difficult and as human as the sense of truth in a painting or the feeling of emotional truth in a dance or music pattern.

In his continuous search for truth, the student of science has to develop

another very human and desirable quality — respect for all his fore-runners, but at the same time not unquestioning submission to any of their dogma. In his ever-repeating fumbblings and failures, he soon develops a deep reverence for the mental calibre of earlier scientists who could discover so much in spite of much more meagre facilities available to them both in the tools and adjuncts to observation as well as in the growth of ideas which certainly were less advanced when they entered than when they left the field. At the same time, this very realisation of the limitations of the tools or the theory at the time of the earlier workers gives him the courage to improve the 'limits of accuracies' and often he soon discovers that the more accurate facts accumulated by him do not fit in the generally accepted theory or law propounded earlier. Convinced of his better understanding, he has no hesitation in suggesting improvements or even rejecting the earlier theory. Fortunately, even in this rejection the scientific worker does not lose any respect for the earlier worker whose ideas he has corrected or improved upon. The reputation of Newton did not suffer when Einstein exhibited the limitations of his laws of motion, nor are we beginning to think any lesser of Einstein when we tend not to accept his General Relativity concepts.

These trends of independence and originality of thought and dissent in belief are the greatest imprints of science and its methods on the moral values of society in general, and has led to what may be termed as the 'liberation of human personality'. The innumerable new trends in arts and literature and the unconventional experiments in all forms of human activities are valued and respected just for these very qualities of independence, originality, and therefore, dissent. Today, we find it just natural to recognise originality even in a child's drawings or an arrangement of such commonplace things as flowers.

As indicated above, the spirit of dissent in scientific enquiry is not an end in itself ; it is in fact the surface mark of the deeper human value of freedom. A society which cherishes progress has always given the freedom of dissent to individual thinkers, and has, in fact, placed a high premium on originality and independence of mind. The spirit of tolerance is characteristic of not only the present age of science, but had flourished even earlier, for example, in times when scientific thought was valued amongst the ancient Hindus or the Greeks. The absence of this freedom of tolerance has at various times led to notorious periods of dogmatism as that of inquisition in the medieval times.

Tolerance amongst scientists does not arise from indifference, but is really derived from mutual respect. In fact, the Society of Scientists is an active form of democracy which is a very happy blend of dissent and respect.

Science and its spirit of dissent have often been accused of leading to emotional conflicts between the old and the young, between the last and the next generations. It is, in fact, just the opposite. The development of the scientific attitude has given a rational understanding for this difference. Research as well as progress is a development; none of the gradual steps of the learning process is final; and the mistakes of one generation are rungs in the ladder, no less than their replacement or improvement by the next.

Values of science have thus emerged out to be essentially human values. There has never been a great scientist who did not make wild guesses at least sometimes. Scientists as men are fallibles, but as a society they are organised in a way as to be able to correct their errors without any feelings of hurt or unnecessary gloating. In fact, great teachers of science have always tried to train their students in the spirit of enquiry, questioning even the philosophies or theories which they were trying to present before them as developed upto that time. One of our prominent thinkers, Michael Polanyi, recently remarked that the professional standard of science must impose a frame-work of discipline and at the same time encourage rebellion against it. This dual function is but the logical outcome of the belief that the scientific truth is only one aspect of the reality as it is understood presently, but the orthodoxy of science should be taught as a guide that should enable the novice eventually to make his own contacts with this reality. The capacity to renew by evoking and assimilating opposition to itself appears to be logically inherent in the sources of the authority wielded by scientific orthodoxy. To train the young people in this dialectic between orthodoxy and dissent is the very difficult job confronting the science teacher of today.

Science has not only brought understanding and faith between the succeeding generations, but has proved as a strong binding force between fellow beings working at the same time. The international human outlook has repeatedly demonstrated itself without fear and with love. The institute founded by Napoleon offered its first prize to Humphray Davy in spite the Anglo-French war in 1807, and thus incurred the anger of its founder. The feeling of mutual affection and consideration exhibited itself during the Second World War when such a large number of scientists, assured of a warm welcome from the fellow-workers abroad, fled from Nazi-Germany.

The impact of growth of science is nowhere more explicitly evident than in the society of scientists themselves — which has gradually become more and more co-operative, uninhibited, free and communicative. Team spirit involving the qualities of give and take has become an essential part of the present day research work and fortunately, a number of new projects

like Geophysical year and Oceanography have been undertaken with the fullest possible international co-operation and understanding. The same spirit of co-operation appears to be growing in the field of nuclear energy and astronautics, fields which represent the highest form of scientific growth and could lead to unknown devastations, if misused.

There is yet another aspect of the impact of science on moral values which I can refer to only in passing. The dizzy advance in biochemical fields is reflected in the statement of Ralph W. Garard that "Behind every crooked thought lies a crooked molecule". The increasing effectiveness of tranquilisers demonstrates that the scientist has already set in his battery drugs which act differentially on higher centres of brain.

Fortunately for us, the possibility of tailoring the morals of a society by administration of specified drugs appears to be a distinct possibility just now. Let us hope that rational human values, growing steadfastly with the progress of scientific thought, would have been strengthened sufficiently to rule out the possibility of misuse by man of such far reaching powers bestowed on him by scientific advances themselves.

A. R. VASUDEVA MURTHY

A Scientific Approach to the Study of Ancient Indian History

Now it is more than a decade ago the Parliament and the Government of India resolved under the leadership of Pandit Jawaharlal Nehru to build a Socialist Society in India, which would take care of the welfare of the entire community. Its aim was to create a casteless and classless society in which every citizen will have equal opportunities and rights irrespective of his social background. They have observed that it is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community.

In spite of the efforts of the Government and the leaders of the community, caste barricades and class considerations lie deep in our daily life. Social reformers and political leaders have been repeatedly proclaiming from the platforms that caste system is a major stumbling block to our national integration, economic development, and normal regeneration of the country. The problem has been a formidable and challenging one.

It is generally agreed that the caste system by which we mean not merely the four-caste system of theory, but the endless and ramified caste system as we actually see it, is the outstanding feature of Indian society. But this is only a surface phenomenon. What is at the foundation? There must have been something in the mode of living of the people which made the caste system so deeply rooted, no attempts to reform it, no invasion to cripple it, no preaching of the Christian ideas by its priests has shaken its effects, until we come to the beginning of the 20th century. We might now ask ourselves, where is the caste system crumbling in practice? Where

is it that a man's caste has very little value in his material well being? The answer is obviously that in our biggest industrial cities caste is going out of fashion. It no longer stands in the way of a man becoming a banker, an industrialist, a merchant, a doctor, a teacher, a scientist or a writer if he has the other assets and qualifications specifically necessary for each one of these jobs. It follows, therefore, that caste is intimately related to the older forms of village life. What was this village life? How did these villages spring up and survive? What has changed the life of a village community? These are some of the questions which inevitably arise. In order to answer these questions satisfactorily and to understand our problem and find a solution, we have to go back to the history of our country and identify the contributing factors which gave rise to the society with castes.

The history of a country is made by its people. History should not be construed as merely an accidental succession of events like wars or changes in rulers, but the life of the people as a whole. It has become a fashion to glorify our ancient past, to ascribe to Vedic seers a knowledge of everything from atom to aeroplane, and to lament on the passing away of the glorious golden past. It is true that we have in our midst mystic philosophies, tolerant religions, voluminous amount of ancient literature, delicate and intricate sculpture, melodious music, and gigantic monuments, which we can certainly be proud of. At the same time, we should not forget that the same society has also built up intense poverty, acute hunger, social apathy, degrading untouchability, and endless superstitions. It is necessary to recognize that one is the result of the other and that one is the expression of the other. These two are the faces of the same coin. How did all these come about? Only a scientific approach to the understanding of this complex problem can help us seek a solution. Many may question whether there could be any such scientific approach to this problem of understanding of history. The answer is certainly 'yes'! The purpose of science is to understand the forces of nature, and with this knowledge it will be possible to control and regulate the natural forces. Similarly, it should be possible to understand the social forces and with this knowledge, to regulate them. With the help of modern science and technology, it is possible to give a new direction towards the historical development of a new society.

Scientific laws indicate the underlying interrelationships among the several phenomena revealed by nature in its development. It should be possible to recognize such laws of social forces in the development of a society. The evaluation of a social system and its movement in history with its background, will give a picture of the social life of the people. The study of the history of a society governed by its laws now comes under the realm of science. The formulation of the laws of development of a

society will help us to use them for practical purposes just as we make use of the laws of biology and statistics. One should not underrate the importance of obtaining a knowledge of significant events of history and arranging them in a chronological order, while the scientific method probes deeper. The scientific method attempts to study society in its growth and development, to differentiate this growth into well defined stages, to discover the laws that govern the development of one stage of history into the next, and to understand the basic factors which determine the structure of the society in each stage. It shows the events that are usually chronicled in history textbooks as merely superficial manifestations of these deeper social forces.

After men became differentiated from other animals and formed social groups, they could get better security and protection and the possibility of continuing the species. They were obliged to obtain the material necessities of life to preserve and continue it at the expense of their environment. In order to procure their food and later to produce it, it became necessary to invent the tools and design the instruments. The production experience and labour skill accumulated over long periods offered opportunities for improvements and changes. These productive forces created by the human society represent the relations of men to the objects and forces of nature which they made use of for the production of material necessities of life. It is easy to realise that the production is not carried out by a single individual but by a social group for its preservation. In the process of production of these material values, men had to enter into mutual relations of one kind or the other within the social group.

The productive forces of the society and the relationship of men to each other while making use of these forces are the two aspects of the mode of production. The means of production at the disposal of the society will determine both the quantity and the character of production. This in its turn will determine the productive relations. It is equally important to point out that the relations of production in their turn certainly react upon the development of the productive forces of society, sometimes accelerating them and sometimes retarding them. The productive forces can develop to their fullest extent only when the relations of production are in correspondence with them. Otherwise, there could be a setback in the social progress for a while until the relations of production conform to the new means of production.

The rise of new productive forces and the corresponding relations of production will not be simple and take place in isolation. Every new generation as it enters life is not free to choose its mode of production, as it already finds an existing mode of production within whose framework it is obliged to work. Invariably, a radical change in the means of production

is not made with full consciousness of its social effects, but merely as a method of lightening labour and getting some advantages to its owner. This is clearly visible even today. When a rice mill or a power loom or an oil expeller is installed in rural parts, hundreds of families will be thrown out of their jobs and their single professional skill becomes useless for any other job. The economy of the village is shattered, and we witness the pitiable scene of unemployment, hunger, squalor and greed.

Thus the means of production, the people who use the means of production to produce the material values, their accumulated experience and the relation of men to each other in the social group, or in other words, the 'mode of production' determines the manner of life of the social group. The manner of life which includes the social ideas, ideals and theories (however crude and primitive they could have been in the beginning), religious institutions and political views, are built up on this basis and form the superstructure of the society.

For our purpose, civilization or culture may be defined as the entire way of life of the society as determined by the basis (mode of production) and its superstructure. This does not mean that opposing ideas and opposing institutions cannot coexist side by side under the same mode of production. The very existence of such features indicate the presence of the seeds of change for the next epoch. A new epoch contains the remnants of the older epoch, and will also gradually make room within its womb for an embryo of the new age. As a result of constant improvement in the technique of production to meet the new needs of the growing society, the productive forces will become revolutionary and dynamic. Because of this they will be the agents to usher in a new society.

The scientific study of history shows that epochs in history can be determined and demarcated according to the modes of production, and not on the basis of changes of dynasty of kings or on the battles and wars fought or on the upheavals in the religious movements. These changes in the superstructure will often signalise critical and fundamental changes in the mode of production which is the basic social force guiding and compelling the historic development.

In order to understand the significance of any period in history the question to be asked will not be "who was the king at that time" or "what was the religion" or "was there a war", but "what was the mode of production" or "was there plough agriculture"—if at all there was a war, "what were their weapons?", and so on. Judged by this scientific and materialistic approach, India has a history in its truest sense. A knowledge of such a history is essential today both in the ideological struggle against various misconceptions which are being propagated widely on the basis of mysticism and romanticism, as well as in the correct understanding

of social forces guiding the current Indian history. The mastery of such a knowledge will help the people of India to create a new and hopeful history.

There exist three important sources of knowledge from which our ancient history can be created: (a) a prodigious amount of literary records both published and unpublished, (b) a living tradition of rituals and customs in our daily life and tribal pockets, and (c) inadequate but extremely useful archaeological finds.

Of all the source materials employed in the study of ancient history, it is archaeology that can supply the most reliable data for the study of extinct cultures, particularly those that had not yet reached the stage of development when they were capable of producing legible written records. It is completely a materialistic approach, for it tells, more than any other method as yet at our disposal, about the actual material remnants of prehistoric and certain historical periods of human civilization. From the remnants it is possible to find out the possible tools of production employed by the people of those ages. While wooden, leather and textile materials are often destroyed by natural causes, a good deal of stone and metallic articles exist today and they require digging in the right places to be seen, catalogued, and studied.

Though archaeological data in India is as yet meagre, a certain amount is available, notably that of the bronze age civilization of Mohenjodaro and Harappa in the Indus valley. Similar findings have been recently discovered in Lothal of Gujarat and several other places in India. Archaeology of the preliterate era enables us to know directly the method of production only. The relation of production and the probable ruling ideologies and institutions of the day will have to be reconstructed from the knowledge obtained by studying these means of production.

Archaeological evidence is dated by a study of the strata in each spot of enquiry. When a society lives in a particular spot, it leaves the debris of tools, pots, etc. scattered in that area. The succeeding society builds its habitation on top of these remnants. Thus in the course of history, artificial mounds are created primarily in alluvial soils. The technique of archaeology consists of digging of these mounds till virgin soil is met with. In the course of this digging, the archaeologist meets with the remains of the societies in layers or strata in the reverse order in which they actually lived. These layers are usually dated with reference to some known historical events such as the reign of a king, the destruction of a city by flood or battle, etc. Modern science provides more accurate methods for dating, such as carbon-fourteen (C^{14}) analysis, fluorine analysis, and dendrochronography. These modern methods have yet to be applied extensively in India. The major proof today we have for the antiquity of

the Indus Valley civilization is the importation of Indus products into contemporary Mesopotamia which is more accurately dated by modern scientific research. Study of ancient coins, inscriptions and engravings on stone, and metallic articles provide another valuable source material for the reconstruction of past history.

Anthropological studies provide evidence in determining the relations of production corresponding to the archaeologically obtained means of production. Anthropology tells us a great deal about the past of man. Field anthropology in particular will be very valuable. Observations of primitive societies' remnants, which exist extensively today in India, will offer valuable data in reconstruction of the studies of earlier societies. It is important to note that such a reconstruction has to be applied with great care and caution. The atrophied societies have been influenced in their rituals and customs by their surrounding higher social elements. It is possible that this abnormal stagnation in growth is due to the excessive dominance of superstition which discourages and retards any innovation in the means of production. Thus, these societies appear to be dead ends in social evolution.

As an example of remarkably successful use of archaeological finds in the light of anthropological studies, one may cite the connection between hand-made pottery and matriarchal cultures existing in various parts of the world. We find both wheel-made pottery and hand-made pottery in archaeological excavations, the former occurring in a later period in history than the latter. Modern anthropological studies, among the existing primitive cultures, have demonstrated that hand-made pottery is invariably associated with the fertility cult, worship of female goddesses, and in general with matriarchal cultures; on the other hand, wheel-made pottery is associated with men and worship of male gods, and predominantly with patriarchal cultures. When all these facts are collected, it is possible to infer that matriarchy preceded patriarchy.

In a new excavation if hand-made pottery is found, it can possibly be assigned to a stage of matriarchal society in the historical evolution of man. Pottery has been a very useful tool in the hands of competent archaeologists to reconstruct the history of extinct civilizations in various parts of the world. Limited archaeological and anthropological data available in India make it impracticable to give a comprehensive and precise knowledge applicable to the entire sub-continent. Even this limited information can be utilised for a reasonable interpretation of the facts which are known today. Querns that might have belonged to the stone age period are still used in our kitchens. Red pigments that are found on idols and stones on the roadside, symbolize blood sacrifice which went out of fashion centuries ago. The *vāhanas* that are employed to carry gods and

goddesses symbolize the fusion or submission of one tribe to the other. Many examples of interest from the Indian scene may be observed in the living customs and habits. Several of these modern customs, rituals and superstitions are merely fossilized remnants from ancient days, just as aboriginal tribes are the remnants of actual tribes whose mode of production was at one time historically useful and necessary.

Literary records are the third source of our knowledge of ancient Indian history. The oldest deciphered Indian literary tradition is that of the four *Vedas*. In order of sanctity and roughly of chronology, they comprise the *R̥g Veda*, the *Yajur Veda*, the *Sama Veda* and the *Atharva Veda*, the last attained the status of a *veda* very much later. These are liturgical books dealing mainly with rituals. They are amplified in associated works known as *Brahmanas* and *Aranyakas*. *Upanishads* are of somewhat later origin and deal with more of philosophic items and discussions. The two important epics *Rāmāyana* and *Mahābhārata* are well known in the country along with somewhat semihistorical works such as the *Puranas*. Buddhist and Jain works are also of importance to analyse the structure of contemporary society. *Arthasāstra* (Kautilya) and *Rājatarangini* (Kalhana) are two other works which give some account of statecraft and political strategy of the period.

It is needless to emphasise that great circumspection is necessary to make use of various documents for historical study. Additions and interpolations have made inroads into almost all ancient documents often till recent times. Such changes are not easy to trace, though their existence cannot be denied. As a result, it is rarely possible to date a document precisely much less to determine its locality. The passing of centuries have obliterated a good deal so that certain hymns and words convey no meaning even to the most optimistic commentator.

The existence of such an early literary tradition indicates the existence of a group of individuals who cultivated this faculty. This could have been developed only by such persons as were not tied down to the drudgery of earning their livelihood; such privileged persons were numerically small. The product of such a cross section of the society would invariably safeguard its interest. It is, therefore, reasonable to infer that every piece of literary activity had a conscious or unconscious class bias. Priests who cultivated the art of writing held it as their monopoly and passed them on to generation after generation within the closed priestly class. This is the reason why the most early literary records deal with rituals, theological controversies, philosophical discussions, and sometimes just fables. There are very few works written for or by craftsmen. Brahmins, who developed this priestly tradition in India, were in possession of these literary works until they were given to others by the printing press.

In order to obtain a correct picture of the evolution of Indian history in its early stages, it is necessary to extend our knowledge of all the sources of historical and prehistoric data, and collate scientifically the archaeological evidence with social traditions and the oldest records. An illustrious piece of work in this direction was contributed by J. Prinsep during the last century. He started with the inscriptions on Mauryan coins. The script and the language on one side of the coin was Greek and the script on the other side was not known to anyone then. By critical analysis and correlation with Pali records of the time he was able to decipher the entire alphabet of the then unknown language which was Brahmi. This made it possible to read the inscription on Asokan pillars which led to greater knowledge about the history of Asokan and Gupta periods.

The general classification of the stages of human society into palaeolithic, mesolithic, neolithic, chalcolithic, bronze, iron, and steel ages on the basis of tools employed by the people, has to be carefully applied to trace the development of the Indian society over the sub-continent. The first stage of human history which may be as old as 500,000 to 250,000 years was essentially a food gathering economy. Men ate what they could obtain from nature directly with or without the aid of tools. These food gathering nomadic people preceded the food producers (who formed settled communities later), and were also living in groups. We call now such groups as clans and tribes of several families although the concept of family or individual parenthood had not yet developed. Tribesmen had learnt all the techniques needed for food gathering from direct observation of plants, birds, and animals. The tribal relationships changed with the knowledge of food production. It is possible to show broadly that the entire course of early and later stages of Indian history corresponds to the fusion of these tribal elements into a general society that settled down in innumerable villages. Different methods have been adopted to absorb into it such a variety of tribal clusters. The change from the hunting or nomadic pastoralism to agriculture gave these tribes an improved and secured life. The technique employed in India for this process is found to utilise the services of the priestly community. This has avoided large-scale violence to keep down the settled groups. This also prevented chattel slavery which we find in the western societies.

The priests of the Indian community, notably the Brahmins, were able to evolve a calendar and to have a knowledge of plough agriculture. They became the pioneers and educated the tribal community. This helped the latter to settle down in villages. The history of hundred villages became different when the number of villages became a thousand and then tens of thousands. During the earliest stages, there were only two castes in the community, *Arya* and *Sudra*, which later evolved into the theoretical four

castes. This progressive step taken by the Indian society later became its fetters. A detailed knowledge of how it happened will help us to eradicate the evil. The theory to be adopted to work out these details has been broadly indicated in this paper. Further work is called for in this direction.

S. PRANANANDA

Impact of Science and Technology on Society

THE irresistible urge in man to live, to know, and to be happy has been the compelling force behind all his activities. This urge gave expression to itself in various ways in different parts of the world and at different periods of time. The story of this urge of the unquenchable spirit of man has come down to us as the history of mankind. Dr. Radhakrishnan says in his book *Religion and Society*: "The history of mankind is the life of the unconquerable spirit of man, with its endless variety of form and expression, all the different ways in which human nature seeks to express itself, its aspirations and adventures, its ambitions and achievements, its struggles and failures, through all of which the creative spirit of man is hoping, striving, failing but on the whole gaining ground, advancing, never giving way, pressing onward; this free spirit is at the heart of human history."

While this history of mankind has been a steady march now ascending and now descending in one direction and now in another, touching various aspects of human life both internal and external, its strides particularly during the last two centuries, specially in the West, has been extremely rapid, and their effects on humanity surprisingly significant. In its sweep it has engulfed the whole world and in its depth it has penetrated almost all levels of human life, and these strides are in the fields of science and technology, the two dominating forces behind modern civilization. Nothing can resist its march or escape its grip or remain outside its field. Modern man therefore has to reckon with these two forces, though they are his own creation.

Well, the nature of this impact is at different levels. (a) *Externally*, it

has brought about a tremendous change in the living conditions of man by providing him with varieties of comforts and facilities. The one example of a single power, electricity and the manifold and fantastic ways in which it has been exploited and made use of, is sufficient to give an idea of the extensiveness of its range. Perhaps, no other power except nature's gifts of space, air and water, touches physical human life so effectively directly or indirectly as electricity does. Whereas, this is just in one field of physics, chemistry, biology and the various other branches of science have their own significant contributions affecting human life physically in hitherto unimaginable ways.

(b) *Internally*, science and technology, with the use of precision instruments and complicated equipments, such as the microscope, telescope, computers and many other 'meters' and 'trones' and electronic devices, have considerably extended the frontiers of human knowledge. Here also it has not only explored new fields but also plumped deeper in old areas with the result that every branch has yielded unbelievably vast amount of facts and information. The inescapable consequence is the modern predicament where it is humanly impossible for any one to know everything of any branch of knowlege. Naturally, every branch is to be divided and further sub-divided into bits and studied, which process goes by the name of specialisation, commonly ridiculed as knowing more and more about less and less things ; all the same, this only establishes the growing vastness and the complexity of the fields of knowledge.

Internally, again, science exercises a significant influence on the pattern of human thinking and gullibility. The fundamental disciplines in science of reason, of observation, classification, verification and scrutiny, which constitute the scientific method, have imperceptibly influenced the pattern of human thinking at least at educated levels. There is a growing tendency for a scientific temper and rational attitude. Man is more and more inclined to enquire the what and why and how of events and concepts before he makes up his mind to accept or reject. This effect, though very subtle, has far reaching consequences in man's approach and adherence to age-old values of life. The saying is current that the way to modern man's heart lies through his head.

(c) *Collectively*, on the negative side, science and technology have placed in the hands of man tremendous powers, in the form of dangerous weapons capable of colossal destruction. Of course, it is obvious (as in every other case referring to science and technology), that man alone is responsible for the invention of these power potentials by his scientific researches, and he alone by their application has equipped man with these dreadful engines of destruction. The difference is merely that with one group lies the labour of discovery and the technique of application, and with the other

the right to possess and the authority to use. On the positive, or constructive side, science and technology have multiplied the scope and opportunities of human life and the richness and variety of its possibilities, by enabling man to reach wider and to know better. To enjoy music eastern or western or to see a play or to listen to a programme going on in any part of the world all sitting in one's own drawing room, to taste food Chinese or continental, to study at Princeton or Lhasa, to settle in Canada or Cambodia, to reach the Everest or the North Pole are all possible for man today.

(d) *Socially*, science and technology by providing worldwide network of communications and quick transport, have enabled communities from distant lands to know each other, to come closer, and to see and study different patterns of living, observing varieties of customs and traditions, and following different religions. The world is fusing into one community.

(e) *Nationally*, there is an increasing amount of inter-dependence of nations in the field of commerce and trade, economic planning and industrial development. The interaction that exists even in adopting political systems is also easily discernible.

The consequences of these impacts may be stated thus :

1. The successful performance of man in seeking scientific knowledge and its application and the consequent glamour, colour and comfort given to his living habits and facilities have made man feel his own importance. What is external and physical engages him more. He has begun to think he is a somebody and has the right for the pursuit of happiness or enjoyment. This sense of importance of the individual with his bloated ego, seeking his own enjoyment, renders him incapable of adjustment. The result is that he is mentally torn and domestically disintegrated, and inwardly maladjusted. Unhappy homes naturally breed psychologically shattered children, enhancing incidence of juvenile delinquency and leading to many other social problems.
2. Another ailment arising from the sense of right for the pursuit of happiness is the over-involvement of man in the material aspects of life, by working more than what he can take, with the greed to amass and control wealth or wealth producing agencies. These expose him to anxiety, hypertension, insomnia, nervous breakdown, etc. Dr. Alexis Carrel in his work, *Man the Unknown* significantly draws attention to this folly of man by saying: "Everybody is interested in things that increase wealth and comfort. But no one understands that the structural, functional and mental quality of each individual has to be improved. The health of the intelligence and the affective sense, moral discipline and spiritual development are just as necessary as the health of the body and the prevention of infectious diseases...What is the good of increasing the comfort, the luxury, the beauty, the size and

the complications of our Civilization if our weakness prevents us from guiding it to our best advantages?"

3. The scientific temper and rational attitude that modern man has inherited in themselves are very healthy and useful. But, unfortunately, these have not benefited him just because he is not true to them or serious about them. He applies them only to that extent it conveniently suits him. The immediate result of modern man's subscription to these is the dismissal of his age-old faith and sense of higher values of life. It is desirable, and thanks to the scientific temper and rational attitude, that all that is dogma and superstition in our culture and religion is getting exploded. There is no more scope for blind belief or dogmatic authority. But should rational attitude stop after dismissal of dogma and faith? Should it not proceed further in the pursuit of truth? It is here that modern man fails or blunders. What is not potent and gross does not interest him. What is latent and subtle and deep, he does not understand nor has he the patience to strive to understand. So, what he doesn't understand, he erroneously concludes as non-existent and thus throws away the grain thinking it is chaff. As Max Müller puts it, he throws away the baby with the bath water. So devoid of dogma and superstition and denied to faith and enlightenment he remains in a self-created vacuum unable to breathe the refreshing air of a liberating truth.

The real mistake lies in the fact that he wants to measure all experiences by the same standards of measurement, not realising that if the category of experience is different, its measuring standards and requirements are also to be different. The study of an object by the subject is not to be equated with the study of the subject by the subject; while the former ends with the fuller discovery of the object, the latter leads to the losing of the duality with which the study started and the discovery of the unity of the perceiver and the perceived, the spectator and the actor. It is heartening to listen to an echo of these very thoughts of the loftiest experience of the Indian tradition in the words of the famous physicist Niels Bohr, as quoted by Lincoln Barnett in his book *The Universe and Dr. Einstein*. His words are: "In the evolution of scientific thought one fact has become impressively clear: There is no mystery of the physical world which doesn't point to a mystery beyond itself. All high roads of the intellect, all by-ways of theory and conjecture, lead ultimately to an abyss human ingenuity can never span. For, man is enchained by the very condition of his being, his finiteness and involvement in nature. The farther he extends his horizon, the more vividly he recognises the fact that as the physicist Niels Bohr puts it 'we are both spectators and actors in the great drama of experience'.

"Man is thus his own greatest mystery. He does not understand the

vast veiled universe into which he has been cast, for the reason that he doesn't understand himself. He comprehends but little of his organic processes and even less of his unique capacity to perceive the world about him, to reason and to dream. Least of all does he understand his noblest and most 'mysterious faculty', the ability to transcend himself and perceive himself in the act of perception."

Is it not scientific and rational, therefore, that we necessarily have to follow different standards for apprehending experiences outside the known ken of subject-object relationship? Just as a scientist, for his own researches would require a background knowledge, should acquaint himself with the use of precision instruments, follow the rigid disciplines of scientific method, and apply his powers of keen observation under chosen controlled laboratory conditions and then should proceed with the experiments to obtain the results others in the field have achieved ; so also, for the verification of the inner truths of life or the mystery of existence or for the experience of the supreme reality, the enquirer should possess a background knowledge, develop his powers of observation, penetration and recognition by submitting himself to the required set of disciplines and rules and then conduct his experiment under certain conditions of quiet and calm. If he is not prepared to pay the price, and follow the disciplines, he cannot have access to that experience ; to deny it before verification is as irrational as to accept it without enquiry.

This irrational application of a rational attitude is the blunder of the impatient and unscientific minds. Again, while boasting of his scientific attitude, modern man forgets the humble and cautious utterances of the best of scientists admitting the limitations of science in the face of the infinitude of knowledge. We may recall Sir James Jeans' words in his book, *The New Background of Science*: "Physical science sets out to study a world of matter and radiation and finds that it cannot describe or picture the nature of either even to itself. Photons, electrons and protons have become as meaningless to the physicist as XYZ are to the child on its first day of learning algebra. The most we hope for at the moment is to discover ways of manipulating XYZ without knowing what they are ; with the result that the advance of knowledge is at present reduced to what Einstein has described as extracting one incomprehensible from another incomprehensible. Modern man may be wise and rational and safe if only he maintains an attitude as Goethe says: 'Man's highest happiness as a thinker is to have fathomed what can be fathomed and to bow in reverence before the unfathomable'."

4. As a result of man's possession of the engines of total destruction, nations live in fear and mistrust. Man feels insecure individually and collectively. Nations that are in possession of this power know well

that they cannot use it with immunity to themselves. All the same they go on stockpiling it. To use them is not safe, not to stock them is unsafe. What a paradox! The survival of humanity itself is at stake in the wake of this fear and mutual mistrust. On the slender thread of sanity and responsibility of two or three statesmen of the world stands suspended the survival of humanity today.

5. While science has decimated distance and created facilities to bring people together, science cannot compel people to understand each other, sympathise with each other, accept each other and share with each other. Knowledge of the other is only the first step, and unless the second and the third of sympathy and sharing follow, the first only leads to more problems. The same is the case with national interdependence.

There is a tendency to condemn the advance of science and technology as the cause for all the ills of modern society. There is no justification in this. It is in the very spirit of man to seek knowledge and to make use of the fruits of knowledge. The statement, 'because there are air crashes one should abandon air travel', is typical of a weak mind. But the efforts to improve air travel, increase safeguards and to introduce safety measures are the signs of determination and strength of spirit. So, to halt the progress of science is to kill the human spirit. What is required is wisdom to exercise discrimination in exploiting the fruits of science for the progress and welfare of man. Scientists also form part of society, for society to blame them is to blame itself. It is the responsibility of society itself to form institutions, introduce traditions, create conditions for the proper exploitation of the fruits of science. Dr. Radhakrishnan says: Devices from the spinning wheel to the internal combustion engine are devices of purely social utility. They have no intrinsic moral value. They are valuable, only if they are subordinated to higher moral ends. The means of progress are not ends in themselves. The habit of perverting values by subordinating the eternal to the temporal, the essential to the accidental and the lasting to the transcient can be checked only by a powerful education. Here lies the role of the thinkers in society. And Radhakrishnan adds, "education presupposes the selection of and adherence to supreme values."

In the light of the above observations, the elements of such an education should enable man:

1. to create human wisdom with purposiveness and direction to match with human scope and opportunities,
2. to develop human sense of fellowship and responsibility to match with

human capacity for power, inculcating a spirit of sharing in proportion to the possession of riches,

3. to infuse human faith in the higher values of life and the vision of the immensity of reality to match with human rationality and scientific temper,
4. to inculcate a spirit of toleration and accommodation, understanding and assimilation to match with opportunity for contact and communication.

“Mankind”, Bertrand Russell says, “is faced with a race between man’s capacity for means and his folly of ends” and it is time mankind’s attention was drawn to this dangerous situation. Otherwise, as Bertrand Russell warns, if increase of knowledge is not matched with increase of wisdom, increase of knowledge will mean increase of ruin.

The position, therefore, is that it lies squarely with the superior wisdom and discrimination of man to take advantage of the fruits of science and technology and allocate them their due role in the task of serving total human progress and welfare at all levels. Will modern man be able to do it is the big challenge the scientific civilization poses today.

And this country, with its age-old spiritual culture, can provide a corrective direction to the forces of science and technology. Fortunately, the fundamental and comprehensive concepts of our culture, such as the four values of life, the fatherhood of God, brotherhood of man and the oneness of existence, etc., are not in contradiction with science. On the contrary, these are capable of guiding the scientific civilization to serve social progress and save humanity from suffering and destruction.

Sociology of Science

AMARJIT SINGH

Science and Technology in a developing Country

IN the panorama of history, one sees nations successively coming up, making a mark and sometimes fading away. The torch is handed over from one nation or society to another and back again. There are many kinds of human activities interacting to produce these ups and downs. Science and technology has been playing an increasingly dominant role in this drama. It is the purpose of this paper to examine how the dynamics of interaction of science with society can be understood and applied to a developing country for hastening its process of development.

One of the theses propounded by the famous historian Arnold Toynbee in his *A Study of History*, is that development and the release of creativity in society is the result of a challenge which is not so strong as to be unmanageable.

The challenge of development is two fold. First of all, a developing nation wants a better physical and social environment for its people; secondly, there is the need to combine a rapid pace of change in the social structure with that of orderliness of development.

Life and its propagation are examples of orderly change, as brought out in the book *What is Life* by E. Schrödinger. The whole life-process consists of innovation as well as preservation of what has stood the test of time. Schrödinger has in particular referred to the genes that carry heredity, and how they provide continuity as well as change through mutations. If either one or the other feature were lost, life would not evolve to higher levels.

The same is true in the life of a nation. There is an imperative need to introduce changes, especially when society has been dormant or stagnant

for long periods. At the same time, there is a danger that all land-marks might be obliterated, and in a sudden onrush of change, the sense of direction itself might be lost so that the whole situation becomes chaotic. In such a case, the transformation may defeat the very purpose for which it was initiated.

It is necessary to be clear about what is sacrosanct and what needs to be preserved and further propagated. In the former category are myths and mere rituals, that become part of any static organizational structure. For instance, an administrative machinery suited to mere regulation of activity would be as out-dated as a bullock-cart in the jet age. If the objective changes over to stimulation of and positive support to the best creative talent in the country, then the procedures have to undergo a change. One would need to employ the principle of "management by exception". In this case, the creative individual would have maximum freedom of initiative and would be curbed only when he violates some of the ground rules.

Myths and rituals have to be thrown away. At the same time, the basic values would have to be preserved in the changed environment. Each successive generation would need to re-affirm their faith in the cardinal principles which do not change with every political or economic cycle: the principles such as truth and justice, honesty and dedication to duty.

In meeting the above mentioned twin challenge science offers help, first of all, through an accumulated body of knowledge and techniques, to build up physical prosperity. Secondly, there is the application of scientific methodology to tackling social problems. Science has grown rapidly because of the spirit of empiricism and free enquiry. At least in his laboratory or in the seminar room, the scientist endeavours to pursue the truth wherever it may lead. Although this endeavour is not always fully successful, yet it does provide a lead in this direction in respect of other human affairs too. Scientific theory also provides a reliable model for change coupled with conservation of what has been judged to be sound.

A newly independent nation starts with many assets and liabilities. The general scene may be described with special reference to India in the following terms:

When a nation does not govern its own destiny over a period of decades or even centuries, it is characterised by a stagnant economy, lack of innovative technology, and lack of machinery for rational public debate on dynamic national issues. In other words, there is a mental lethargy about tackling new and urgent problems. Opportunities for creative work in the field of technology in particular are usually missing. Most of the technology and even finished products themselves are imported. So also the administrative machinery is geared to the maintenance of the *status quo*.

However, at the dawn of independence, the picture is not altogether bleak.

There exists a nucleus of entrepreneurial talent as well as a nucleus of trained scientists and dedicated sociologists. The nation also has a precious possession in the form of 'elan' at the advent of freedom.

The progress of a nation from the dawn of independence towards the promised future for their people, can be compared to the reclamation of a neglected garden. The garden would need careful weeding, proper application of manure, and multiplication of desired plants.

In the case of a nation, this last implies a conscious effort at opening up opportunities for productive talent and provide an environment suited to propagation of this talent. The elan of winning freedom is to be transformed into that of productivity and innovation.

In all this, the key element is discrimination or what the ancients in India called *Vivek*, the ability to distinguish at each stage as to what has to be thrown away and what has to be preserved, and an ability to forge new tools to meet new situations.

The training grounds are, of course, the universities or other institutions of learning. In order to fulfil this role, the universities should be free to set standards. Similarly, the employers whether government or private, should be free to judge the products of each university on their merits. There need be no artificially imposed equality of the first divisioners from different universities.

The inner freedom as well as the mutual interaction of the professions are an essential element for progress. Thus, while the politician may be free to change basic policy, the administrator should be free to work out the details of each situation and not be a subject to pressures from politicians regarding individual decisions. While the politician may even assign a different basic role to administration as such, if he interferes too much in the day to day working of administration, then quick and consistent decision-making may become impossible.

The same is true of the relationship between the administrator and the professional scientist, lawyer, doctor, engineer, journalist, etc. If a society is to make progress, each of the professions should be free to organize the details with the profession. In other words, in each profession the professional societies should play the major role in regulating it. Such professional associations should set the standards of conduct and be the guardians of these standards. Such standards can be better maintained by the profession itself rather than by any general purpose administrators are trying to interfuse in them from outside.

We have talked so far about the creative minority and how it can best serve the cause of the nation. However, in order to be successful, it is equally important that the masses and the general public should also be enthusiastic about the plans and techniques being worked out on their

behalf. It is desirable that the national priorities should reflect the needs of the common man for food, shelter, education, health, and clothing, etc.

A developing country often races against time. It can hope to win the race if the rate of progress is faster than the rate at which population or their expectations are growing. In compressing the time-scale science can again play a major role. For instance, by the use of new media of mass communication, one need not wait until the entire population becomes literate, for it to be aware of the basic issues before the country and how they are to be tackled.

In this way, the scientist can help propagating new ideas in raising the living standards, and by setting an example of a pragmatic approach to solutions of problems.

KAILASH KUMAR

The Esoteric Nature of the Sciences and its Consequences

THE sciences have been with us for a long time. At least, they have been with us long enough to have brought the most profound changes and stresses in our individual lives and in our social modes of living. But we still tend to talk of science as if it were something new and unfamiliar. This is the case even in America and Europe, and with individuals who may themselves be scientists. I think the reason for this must lie in the fact that no one man is intelligent enough to take in all the ramifications of the sciences and of their influences on our life. Usually it is said that the reason lies in the rapidity of scientific advance, but this is included in my previous statement because the measure of speed is the human capacity for it.

The sciences are practised in and by small groups whose members devote most of their time to them, and in this respect they are similar to several other activities. The only activity which has had an influence comparable to that of science is religion. The various religions have been with us much longer and even though we may not fully understand them, we are used to them and we know more or less what to expect of them. We certainly do not have a similar feeling towards the sciences.

Starting from the rudimentary idea that the sciences are esoteric activities we shall try to see in the course of this paper what may be expected of them, how they may develop and interact with each other and what may be the chances of their social regulation. In the course of this discussion I shall comment upon a thesis of Jacques Ellul and another of Frantz Fanon. The first concerns the "technological will" and the second is related to the role of intellectuals in a colonial or newly independent country.

We may begin by recalling the commonplace that what are today known as the physical or natural sciences—and to many they are just the sciences—once sought to gain respectability by styling themselves as “*natural philosophy*”. Even fairly recently in this century a gentleman’s education, i.e., liberal education, did not require him to study the sciences. A complete reversal of preferences has occurred lately. We now have subjects styled as ‘social sciences’ in order to gain a greater claim on people’s attention. We generally lament the ignorance of those who have not been exposed to the sciences. This trend is perhaps strongest in America where the physical sciences receive the greatest support and stand close to the sources of power.

Is it just a matter of power and money or is there a deeper relation? Perhaps the new names, when they first came into use, declared a determination to use new methods—“philosophical” in the first case and “scientific” in the second. But what is the difference between the physical and social sciences today? This long-standing question presupposes that there is a certain uniformity in the two separate groups, and that we can recognise them separately and ask for their difference. We can then compare their respective methods, subject matters, effects upon the society, and so on.

Our approach to this question will be quite different today from what it would have been fifty years ago. The very form in which the question has been put above would be considered old fashioned today. At the turn of the century, when this question was first considered, the social sciences as we know them today were hardly in existence. The famous comparison used to be then between the motion of a body in mechanics and the economic behaviour of man. It was said that in the former case there were only a few significant variables which could be controlled precisely, so that the same behaviour could be reproduced again and again; that is to say, it was possible to do experiments. In the latter case the complexity of the situation was emphasised. It was pointed out that there were too many variables, which could not be isolated, and so it was not possible to make reliable, controlled experiments. But there was presumed to be no difference between the two subjects otherwise: if all the factors were known then it would be possible surely to predict the behaviour of a man just as precisely as the motion of a stone. This was not merely an answer to the question but at the same time a declaration of faith, a prescription of how one ought to study these questions. As an answer it might or might not be correct but as a recommendation of action we know that it was effective. For it determined the form which subsequent investigations in economics took. Nowadays economic theories create, through recommendations to governments, the economic facts, and we might note in passing that they may be also creating their own scientifically verifiable truth. The “econo-

mic man" which used to be the butt of many a classroom joke is at last coming into being.

Today there is in existence a great body of economic knowledge and methods. But returning to our question, what shall we compare today's economics with? Should it be compared to physics as it existed fifty years ago or to physics as it is today or only to some part of physics? We may interpret the question in different ways, and as we do so it appears to lose its original sharpness. Does this mean that the relation of the physical and the social sciences was a good question fifty years ago but is not so any longer? This appears untenable because fifty years ago the question was a vague and perhaps unanswerable one, and now we are in a position to make it precise. Why then does it lose its appeal?

The truth of the matter is of course that it was the earlier *answer* that was appealing. The question itself merely served as a rhetorical introduction to heighten the piquancy of the answer, which was a program: here is a way to understand the economic behaviour of man and society.

In today's version the same question leads to a logical exercise. This may provide a challenge and absorb all the energies of an expert, but it will not provide even to him the exhilaration of a simple belief.

The point to note is that in this discussion we have been able to refer to society, the social sciences, and even to our emotional responses without saying anything about the social environment in which the discussion was taking place. This may be taken as an example of what, for lack of a better word, I call the formal intellectual approach. This approach provides enough scope for discussion within it, and such a discussion may actually be complete in itself. That is, one can go on in this way, piling refinement upon refinement, without ever feeling the need to leave this framework of ideas. One may compare this approach to the legalistic approach in the study of law. To me personally, law is of interest inasmuch as it is a reflection of the social will, but given a legal system of some complexity it is possible to study law purely as a formal system. It is even possible to compare different legal systems without reference to their respective social origins and functions.

Since the formal approach is both possible and complete it also appears autonomous. The remarkable thing is that it should be, at the same time, an approach that is preferred in practice.

These considerations tend to give us the impression that limits set by a society do not play any decisive role in determining the character and content of intellectual activity among its members.

We cannot but be reminded, therefore, of the contrary thesis which holds

that social limits do play a decisive role. In its extreme form the thesis of social determinism asserts that social factors are not only decisive but completely determine all activities that take place in society. The complete social determinist is obliged to dismiss all evidence to the contrary as extraneous, a matter of mere appearance or even as the clever invention of a degenerate class with some vested interest in perpetuating old ideas. It may be of interest, therefore, to present such contrary evidence in a different form.

Apart from doctrinaire social determinists, people with a commonsense, practical temperament also tend to underestimate the autonomous character of intellectual development. But the fact is that once a society has decided to allow a certain activity to take place on a regular basis, it will, unless checked by conscious efforts from outside, develop in such a manner that it becomes more and more remote from social needs and less and less amenable to social control.

We may review some well-known historical examples. The ancient Egyptians were greatly concerned about the proper redistribution of land after the recession of the regular floods of the river Nile. They, therefore, patronised the development of mensuration. Similarly, they entrusted the problem of determining the exact needs of the armies of the Pharaoh to the scribes. Out of these needs arose geometry and algebra. Once a body of knowledge and methods was formed, however, it detached itself from the needs of the Egyptians, indeed from Egypt itself. It began to attribute greater significance to the contemplation of abstract properties, and as time went on it became more and more abstract, leading up to modern mathematics.

Mechanics arose out of a preoccupation with the trajectories of stones and planets, but fairly soon experts in mechanics considered it the highest aspect of their science to deal with the most abstruse and detached sets of symbols.

The same process can be traced with even greater clarity when the subdivisions of certain specialist subjects are considered. The process occurs in practical professions just as much as it does in "pure" ones. Take for instance the engineers: when the graduates of our first institutions of technology became available there was a period of considerable embarrassment when their employers found that these engineers did not possess any great mechanical aptitude, were not good with their hands nor with any practical problems. The social explanation was then quickly forthcoming. It was feared that once again social attitudes generated by the caste system, the reluctance to dirty one's hands, etc., had frustrated the designs of technology. I remember meeting at the time a professor from one of these institutes who projected the opposite social explanation. He said that it was the employers who were at fault; they were mostly *sethia* types who did not realise that

they could not expect highly trained graduates to do their dirty work for them! It is possible that both these social explanations are correct, and that with greater understanding some reconciliation can be achieved. The point I wish to make is that there is an irreducible *technical* problem involved—does the employer need a mechanic or does he need a graduate engineer?—and that this cannot be decided by looking into anyone's *social* attitudes. To the extent that many such technical problems exist and are of crucial importance, the development of the professions will also be independent of social attitudes.

The idea of the institutes of technology came from America. America is a country dedicated to the concepts of efficiency and is very practical-minded, but even there the engineers who are most highly regarded are those who are the most abstract and mathematical in their considerations. This group is highly esteemed, moreover, by the generality of practical-minded engineers.² I believe that this happens also in the Soviet Union.

In a way it is an inevitable process. Any intellectual activity tends to purify itself in the course of time and this puts it more outside social control. Specialized intellectual activity must tend to purify itself because it must trust to the judgment of its own practitioners. Since these practitioners must undergo a long period of apprenticeship and initiation and must attain a level well beyond the reach of the uninitiated, they must for all practical purposes become independent of the latter.

In this respect the physical and the social sciences are similarly placed. They are both esoteric activities now generally encouraged by society. They have or are capable of having independent method and their own criteria of significance. In this they are similar to organised activities connected with defence, public administration, and religion.

Now when several such activities are in existence, they will have to enter into competition sooner or later for the attention of society, either because they want to recruit more people or because they want more resources or rewards for their practitioners. Efficiency and social usefulness is only one of the arguments that might be used in this situation and the argument could be more or less effective depending on the circumstances. We can see that by posing the problem of mutually comparing the sciences in the way that we did, one effectively transforms the problems. What begins as a social question (which science should receive more from society?) becomes transformed into a seemingly detached question (what is the relationship between the sciences?), and in the latter case the social ends are to be achieved by greater skill in argument and persuasion. To say this is not to impute ulterior motives, for the social consequences follow whether or not they are consciously intended.

The advantage and appeal of such a transformation is evident. By remov-

ing all reference to social competition one has eliminated the source of what could be a very complex and perhaps unpleasant discussion. It is rather as if two confronting armies had decided to let the issue be settled by a discussion among poets nominated from either side. There are situations in which this would be a welcome alternative even to the generals. Another reason for the popularity of the transformation is that it leads to a type of activity that is very familiar and natural to a group of scientists; it is more in their line to argue about abstract matters than to justify themselves in a more direct manner.

I do not wish to imply, of course, that the question of comparing different sciences is nothing more than a reflection of their competition for the attention of society. That would be an oversimplification.

There are certain dangers inherent in the situation described above. They are seen most clearly by considering developments in mathematics because mathematics is perhaps the most esoteric of all intellectual activities. I should like to illustrate this development by giving three quotations. The first is taken from the preface of one of the most influential books on mathematical physics, written by the revered and influential mathematicians Courant and Hilbert :

“Since the seventeenth century, physical intuition has served as a vital source for mathematical problems and methods. Recent trends and fashions have, however, weakened the connection between mathematics and physics ; mathematicians turning away from the roots of mathematics in intuition, have concentrated on refinement and emphasized the postulational side of mathematics, and at times have overlooked the unity of their science with physics and other fields. In many cases, physicists have ceased to appreciate the attitudes of mathematicians. This rift is unquestionably a serious threat to science as a whole; the broad stream of scientific development may split into smaller and smaller rivulets and dry out.”³

This was written in 1924. Since then the two disciplines have continued to separate further, but a gradual change in the attitude towards their relationship has developed. Contemplating the same problems Von Neumann wrote in 1947 :

“... Mathematical ideas originate in empirics, although the genealogy is sometimes long and obscure. But once they are so conceived, the subject begins to live a peculiar life of its own and is better compared to a creative one, governed by almost entirely aesthetical motivations, than to anything else and, in particular, to an empirical science.

“... At a great distance from its empirical source, or after much ‘abstract’ inbreeding, a mathematical subject is in danger of degeneration. At the

inception the style is usually classical; when it shows signs of becoming baroque, then the danger signal is up."

Von Neumann was well-known for his interest in physics and applied mathematics, and it is, therefore, interesting to note that what was the "vital source" for Courant and Hilbert has become for him "a genealogy sometimes long and obscure", and their concern for the unity of science as a whole become replaced by a desire for the health of mathematics alone, and that the state of health is to be judged by prevalent styles and tastes. If by such tests mathematics is found diseased or atrophied, the cure is to be as follows:

"In any event, whenever this stage is reached, the only remedy seems to be the rejuvenating return to the source: the re-injection of more or less directly empirical ideas. I am convinced that this was a necessary condition to conserve the freshness and vitality of the subject and that this will remain equally true in future."⁴

We must note here that very few people are or can be in a position to judge whether or not the undesirable stage has been reached. As long as the subject exists in a more or less organised form, individual doubts will be ineffectual in stopping the trend; and it appears that nothing short of a complete break in the continuity of the subject will be required before a return to the rejuvenating source can take place. It is thus interesting to look at the latest views prevalent in 1966:

"... Most people in the mathematics profession are no longer interested in particular problems and their detailed solutions. Instead, we are interested in the method by which the solution was obtained."

Thus attention is now directed towards the "abstract structure" of the problem: "To investigate such a structure one would have to learn many new concepts and study their properties (a study which in many cases seems tedious and even trivial) and finally develop a whole theory based on these concepts, until at the end, the difficult problem becomes a trivial corollary to a more general result."⁵

The question of what mathematicians are trying to do is answered today by saying that "they are trying to make precise the intuitions of poets".⁵ Today one revels in abstract generality and in the study of structures given to us by an intuition completely unfettered; there is no fear of ill-health and no desire for a return to the source. Instead, it is confidently expected that physics and other practical sciences will find structures appropriate to them in the more abstract setting and they are likewise enjoined to become more abstract. There is every indication that this recommendation is being widely accepted. The theoretical superstructure of even the applied sciences is becoming more and more abstract. As such, the road seems open for the autonomous development of these abstractions, their inbreeding and consequent final degeneration of these sciences.

It helps us nothing that these activities are called sciences, that they deal with physical or with social phenomena, or that their apparatus and language is impressive. A great deal does depend upon what we outsiders are impressed by, and it is an inherent part of these organised activities that they themselves determine what shall impress us.

Let us look, for instance, at the process by which decisions are made to set up laboratories for research in pure physics. Consider the setting up of high-energy accelerators where the cost of one machine is quoted in the range of 300 to 500 million dollars⁶. The scientists who ask for them do not promise any direct return to the community ; the big machine is simply to test certain of their theories whose soundness can be judged only by a very small number of people. When pressed up to a point, even this testing function is forsaken as a justification, and the experiments that can be undertaken with the machine are promoted as good in themselves. In effect the scientific, intellectual reasons are either unintelligible or actually non-existent. The reasons which actually weigh more with the governments who put up the money are of the following kinds: (a) the operation of such facilities keeps the nation in the forefront of science ; (b) it helps to attract scientists from other countries and helps in training new scientists ; (c) it stimulates the development of advanced engineering techniques (in connection with an accelerator these engineering techniques are the production and control of high voltages and strong magnetic fields, electronics equipment of various types, and automatic computational techniques. These techniques are useful for other purposes and are developed for their own sake also, one of the reasons given while claiming extra support or prestige is that the results may be useful for high-energy accelerators!); (d) Finally, it is said that there is always some "technical fall-out" from such programs, which means that they are apt to confer unexpected benefits on the community.

This is the general trend, though the style of debate and its reportage may be different in different countries. To a sufficiently detached person the reasoning may appear circular and to contain a large element of wishful thinking. Certainly, it is very far from the precision, predictability and confidence which we associate with science. I wish to direct attention to the quality of the reasons advanced and to the fact that no one mentions, except in a rhetorical manner, that the certainties of science have to do with only some of its results and, in any case, are not absolute. I have not raised so far the question of what a particular society can afford. To discuss this it is appropriate to consider some more practical projects where the element of sophistication predominates.

For instance, take the manufacture and sales program of supersonic jet fighters. On the basis of plans submitted, governments have to commit themselves to a long series of operations. The commitment implies that all

increases in prices will have to be absorbed and all delays tolerated. Eventually at some point the machine will be declared operative. It may still fall short of expectations, it may kill a number of valued pilots, it may or may not be an effective weapon. In some cases the process becomes so long and expensive that it has to be abandoned altogether.⁷

Similar eventualities have occurred with automatic computers, and the building of bridges, dams and opera houses. The blame is invariably put on faulty planning, on accidents and above all on human failure. In India we blame most things on corruption and the national character. In spite of multitudinous failures the belief remains that what we need is science and still more sciences. There is no clarity of vision and certainty of knowledge in this. I am not saying this to propose an alternative. There is no alternative. How are we to tell if in a few years' time some fairly unimportant looking science may not release a super-atomic power? On the other hand, how can we disregard the prognostications of the recognised experts? If we suspect that they are not doing their best what can we do if they are the best that we have?

Pursued in this fashion the discussion leads us to agree with Jacques Ellul who believes that the criticism of a technological problem can be carried out effectively only on a technological plane, and that all problems will inevitably be converted into technical problems without regard to human or social niceties. This Technological Process is dependent only upon the existence of Technological Will and these two mutually reinforce one another.⁸

Other speakers at this seminar have warned against science and technology in terms of what it has done in the west. I would like to draw a sharp distinction between their view and my own. First of all I do not believe that the technological process will lead us into the same paths as it has led the west. There is no real danger that we shall ever have as many automobiles or television sets as they have in America, nor that we shall have the same problems regarding leisure and work. On the other hand, I believe that the ills brought about by technology are already around us and have to be looked at independently of what may have happened in the west. Furthermore, many previous speakers have followed their descriptions of such ills by proposals to remedy them. For example, suggestions have been made that science should be put under the guidance of some ethical system, new or old, or that it should be humanised by exposing the scientists to the arts. It should be noted that only those proposals which can be incorporated into the technological framework will have any chance of success and that their original aims and ends would be undermined thereby.

Compared to this view the rather journalistic thesis that belief in the

sovereign efficacy of the technological system is a kind of myth or that it is the modern superstition, is almost reassuring, because the modern educated man does not regard myth or superstition as a potent agency that may hold power over him to his disadvantage. Ellul has shown that this other thesis is illusory. The technological process unfolds according to its own laws, without regard to human advantage and outside human control, at least in the normal meaning of the word control. Nothing short of a collapse of the Technological Will can alter the situation, and if that should occur it would lead to the destruction of the Technological Society.

In terms of our previous discussion the conclusions of Ellul must follow if the process of purification discussed above is identical with what Ellul calls "technicising". This need not be so always, though by their very nature esoteric activities must lend themselves easily to technicisation. If this be the true mechanics of these developments, then one might be able to infer some of the factors that may lead to an erosion of the Technological Will. In any given discipline its arguments and their technical elaborations may be carried to such a point that no single mind is able to encompass them. Then it happens that people remain content to rehearse parts of the enormous subject and are satisfied by casual general inspections which serve to reassure them that some sort of broad development is taking place. They may even discern the operation of some laws in this development. At the same time a sudden shift of interest now becomes possible because disenchantment may set in, and this is likely to have greater effect since the original, simpler, and therefore more vital technical programs will have been already fulfilled.⁹

It is true that the sciences seem to advance by practical and manageable steps. The techniques applied inside a factory lead to reasonably predictable and controllable consequences. The so-called Technological Will is, at least to some extent, a reflection of the belief that an agglomeration of such establishments also behaves in a predictable and controllable way. Ellul's analysis casts doubts on the controllability, and the examples cited above cast doubts on the predictability. While men are inclined to accept any gradual erosion of their freedoms and conditions of life they are liable to be impressed by the spectacular. Just as the successes of technology have been spectacular, its failures and their consequences are equally spectacular. For quite some time yet the failures will be explained away, and to redress them even more spectacular programs will be projected. This can continue indefinitely but a stage of complexity will be reached where that complexity itself will be the most spectacular feature, and with it people will be more and more impressed by the unpredictable nature of events. It is possible that even this would lead only to some new, fatalistic adjustments, but increasingly perhaps there would be scope for commonsense doubt. Then

the stage will be set for a withdrawal from the technological commitment. Of course, neither this nor the worsening of the conditions of life can be sufficient to induce such a withdrawal.

People who earn their living through specialist scientific activities stand in a special relationship to society. The role that they are likely to play in society is determined, above all else, by the same factors that determine the development of their specialities. We turn now to a discussion of this role, taking the intellectuals as our prototype.

Earlier in this century the only way for subject, colonial people to acquire a modern education was to travel to Europe. All our universities and institutions of higher learning were staffed by people who had acquired their education in this way. We know now that in pronouncing judgment on the quality of these people and in awarding them higher degrees their European examiners always had one fact in mind: that these people had come from a far country where standards were low or even non-existent, therefore they should be kind to them. This sentiment was present both in France and England, especially in England, where most Indian intellectuals were trained.

After twenty years of independence one still finds fairly influential people in India saying that the country is being held together by its civil service and that all that is good in the civil service is a legacy of the original I.C.S. In the beginning, the I.C.S. people were all British, later on they were British trained. How good were they? I present the view of one who knew those times :

“At my college in Oxford, Balliol, before 1914, any freshman who had no clear idea of what he wanted to do after he went down was put down for the Indian Civil Service by the dons as a matter of routine. An I.C.S. career was assured to any Balliol man who could not do better than that...”¹⁰

I have received two kinds of responses to this quotation. First, that Balliol was so good that its indifferent products were better than what we had ; and second, that, after all, academic excellence itself was not the chief point, but it was the training, etc. We may well disregard the first response ; and the second might represent the facts correctly, but then it would seem that the implied lesson was not learned. Today's I.A.S. selections are based on academic merit, so much so that success in these examinations is a matter of proud intellectual achievement to our aspiring young people. In my time at Allahabad, I was appalled by the complete distortion of academic values that this attitude had brought to the University. I do not know if the situation has changed since then.

We may ask, how is it possible that true knowledge of I.C.S. intellectual merit should remain unknown to the public at large and that the academic

communities should let their values be distorted to such an extent? The answer lies surely in the fact that academics themselves were selected by a process similar to that of the I.C.S., and both groups were engaged in activities of a kind where it was more important to emphasise the foreign connection than to work out a set of values appropriate to local conditions. It is true that the class and caste origins of people who went for these activities also had some influence, but it could hardly have been the decisive one.

The same problem is important for us today in quite different contexts. We now have a considerable scientific establishment and it is staffed in almost exactly the same way as before, though there may be some minor variations. People of an earlier generation, who were educated in Europe and particularly in England, may affect some contempt for the younger people now coming back from America. The younger people in their turn may feel irritated at the elders' ways and wish that things were done more in the way that they are done where they have been. But the one thing which none of them can afford is to admit that they are not themselves part of the world-wide groups of specialists in their subjects. However tenuous the connection, however small the attention that the world-wide group may pay to them, our specialists must claim that the verification of their worth comes from abroad. As long as the outside group remembers to furnish recommendations and local society imposes no sanctions or no stringent restrictions, this situation will continue. Indeed the situation even creates an incentive to work in the more exotic fields so that there are no local experts close by. As long as the employers give more weight to foreign recommendations, it will be better to have foreign connections; and since, as we have seen, the judgment of foreigners tends to be kinder, there will be no incentive to form local professional groups. (This is not to say that the same kindness exists when Indians seek jobs at a higher level in these countries.)

These seem to be the reasons behind the often-made observation that, while individual Indian scientists are sometimes very brilliant and effective, there have been no major self-sustaining scientific schools based on cooperative endeavour in our country. Probably the same causes lie behind the relative lack of vigour of professional organisations in India.

It is an inherent characteristic of such activities that the attitudes of the elite come to be widely adopted. We thus find that teachers' organisations in India are also not very effective. This should come as a surprise when one remembers that teachers are former students who were very used to the ideas of agitation and collective organisation. That they have to abandon these ideas on becoming teachers is usually explained in terms of human weakness and need for security and status. But such causes could have led, just as well, to an intensification of organised activities. The explanation

must lie elsewhere. Thus we see that the people whom they must look up to professionally have no sense of community among them and do not organise themselves. There is no recognised means by which teachers can express their legitimate concern with the problems and conditions of work that they face every day, and which have been worsening. Clearly teachers have some things to learn regarding, and a great deal to contribute towards the solution of, the various problems which our educational apparatus is now facing, but they see no examples of professional behaviour that may give them a useful lead. Decades of steady inflation have introduced a further element in the situation, in the form of an intense concern with salaries and prices, and it is remarkable that even this has not led to any serious efforts of collective organisation. Indeed the teachers themselves fear a trade union type of appeal to the public, since that would undermine the esoteric character and structure of their activity.

It will be an illusion to think that anything can be achieved with regard to organising the professions in India, or raising local standards, or even about choosing what intellectual disciplines will be fostered here, without also bringing into question the entire structure of relationship of the professions with their counterparts in foreign countries. When we come across an Indian who has good recommendations from abroad our instinctive and immediate reaction is to try and absorb him, even though we may not be in a position to judge just how good or useful he may be to us. Normally there is no question of a conflict of opinion between the foreign and the local experts; if there were, the natural tendency would be to favour the foreigner. We attribute this to the fact that the sciences are the same everywhere, and that the foreigner knows them better. In these circumstances local professional organisations can acquire no confidence or prestige, and these are the essence of their existence. Local professional organisations cannot take an independent stand, nor arrive at a genuine understanding with their foreign counterparts.

These factors not only affect organisations but also determine the attitudes of individuals. By the nature of the foreign or foreign-oriented training and his dependence upon foreign connections, an intellectual of a colonial or newly-independent country is unsuited to play a progressive role. In a most penetrating study of the psychology of colonial people Frantz Fanon has described the essentially reactionary role played by intellectuals in such a society. He, however, ascribes this to their bourgeois origins and to their greed.¹¹ Nonetheless he acknowledges that: "In those under-developed countries which accede to independence, there almost always exists a small number of honest intellectuals, who have no very precise ideas about politics, but who instinctively distrust the race for positions and pensions which is symptomatic of the early days of independence in colonised countries. The per-

sonal situation of these men (bread-winners for large families) or their background (hard struggles and a strictly moral upbringing) explain their manifest contempt for profiteers and schemers. We must know how to use these men in the decisive battle that we mean to engage upon which will lead to a healthier outlook for the nation".¹²

While not everyone will agree with the form of the struggle proposed by Fanon, his concern with a healthier outlook for these nations will be generally shared. My point is that the problem of knowing how best to use intellectuals cannot be solved merely by honesty and good faith. It is really a question of knowing what to do at the technical level. If one knew that, perhaps even dishonest persons could be made to work properly. It is also a question of being able to continue to work and to improve in spite of errors and setbacks. A revolutionary situation may indeed introduce a welcome simplification by setting definite goals and above all by creating an atmosphere in which honest errors can be discussed, be tolerated or corrected without recourse to foreign arbitration. It is certain that no one can carry on a revolution and at the same time insist that this or that science must be practised exactly as in America or some other country, and that foreigners should continually verify that it is being done in their way. Of necessity there is an element of risk in intellectual independence as much as in independence of any other kind, and it is possible that in a revolutionary situation this risk would be undertaken along with all other risks, but intellectual independence is something very different from political independence and is always the more difficult to achieve.

I began this paper by trying to show how the problem of social competition between the different sciences is habitually converted into an apparently abstract intellectual problem. Now we see how purely intellectual problems can be converted into problems about exertion of the social will. In both cases these transformations can be made to look complete but in fact they are not.

NOTES AND REFERENCES

1. Ellul, Jacques, *The Technological Society*, trans. from the French by J. Wilkinson; Jonathan Cape, London, 1965.
2. To completely satisfy oneself on this point one may look at professional journals put out by the Engineering Societies. For instance, the following is from an editorial in a journal of the Institute of Electrical and Electronics Engineers Inc. (IEEE): "Let's support basic research. We live in an age in which there is scarcely anything that we do—personally, professionally, nationally, internationally—

that is not dominated by the applications of scientific knowledge that finds its roots in undirected basic research; in knowledge that was first gained by dedicated men who searched for fundamental truth with little idea of how it might be used. Beyond that, our hope for future health and prosperity, even survival, depends on the application of knowledge and understanding we do not yet possess." (Cutler, C. C.; *IEEE Spectrum*, vol. 4 no. 11, 1967, 6. 39.)

The fascination with "undirected" research and the "understanding we do not yet possess" is here recognised as the source of progress at all levels. A typical expression of this attitude's consequences on the system of values favoured by modern engineers is the following:

"It is certain that a considerable upgrading of the engineering profession is imminent. A powerful factor that will contribute to this upgrading is the widespread use of computers. They will free the engineer from his routine chores and make him available for more creative work." (Greber, Henry, 'The Philosophy of Engineering, *IEEE Spectrum*, vol. 3 no. 10, 1966, p. 112.)

3. Courant, R. and Hilbert, D., *The Methods of Mathematical Physics*, vol. 1, Interscience, New York, 1953, Preface, (quoting from preface to first German edition).

4. Neumann, J. Von, in *The Works of the Mind*, ed. R. B. Heywood. (Uni. of Chicago Press, Chicago, 1947). Also reprinted as *The Mathematician* in J. Von Neumann, *Collected Works*, vol. 1, Pergamon Press, London, 1961).

5. Friedman, B., What are the Mathematicians doing? *Science*, vol. 154, 1966, p. 357.

6. Views concerning the reasons for doing expensive high energy physics are available in:

Yuan, L. C. L., *Nature of Matter: Purposes of High Energy Physics*, Brookhaven Natl. Lab. report no. BNI. 1888, 1965; and in:

Policy for National Action in the Field of High Energy Physics, U.S. Atomic Energy Commission White Paper, 1965.

Summaries of the above and discussions relevant to our points have appeared in *Nucleonics* (Feb. & Apr. 1965), published by American Institute of Physics. For a more general discussion see: Weinberg, A. M., *Scientific Choice*. *Minerva*, vol. 1 (winter 1963) and *Physics Today* (Mar. 1964);

Weisskopf, V. F. and Weinberg, A. M., Two Open Letters. *Physics Today* (June 1964).

7. I refer, for example, to the vicissitudes of the military aircraft industry in England and America, the intricate story of revisions of costs and deletion of contracts connected with TSR-2 and various versions of F-111 aircraft.

Information about operational problems and the mechanism of pricing is not easily accessible but some idea may be obtained from: *The Assault on Fortress I.B.M.* *Fortune* (June 1964), p. 112.

The Battle of Computer Marketeers. *Fortune* (January 1965), p. 171.

Note that *Fortune* is a business magazine and the articles were meant to paint a glowing and favourable picture.

8. Ellul, J., *op. cit.*

9. Compare the following discussion of the decay of Greek mathematics: "Sometimes it is said: 'Greek civilization got old and lost the spark of life.' Very true, but this is only a general summary, not an explanation.

"Political and economic conditions of course play a very important role. We have already seen that science had become the concern of courtiers, depending

upon libraries and upon royal subsidies. When it hapened that the kings did not wish to spend money on science, the subsidies shriveled. Wars, crushing taxes, and, later on, the Roman hegemony with the accompanying exploitation, brought about the end of prosperity in the Hellenistic countries. When Caesar was besieged in Alexandria, a large part of the famous library was burned. The Roman emperors had very little use for pure science, and wealthy Romans, while importing Greek sculptors, pedagogues and historians, did not invite mathematicians.

"All this is certainly very important, but it does not furnish a complete explanation. For it only accounts for periods of inactivity, but not for retrogression and actual decay. . . . There must be inner grounds for decay of antique mathematics." (Waerden, B. L. van der, *Science Awakening*, English transl. by A. Dresden (Noordhoff, Groningen, 1954), pp. 264-65.) These "inner grounds" are connected both with the local completion of certain lines of development of the geometrical method and with the actual mechanical ways of doing geometrical work. Thus: "As long as there was no interruption, as long as each generation could hand over its method to the next, everything went well and the science flourished. But as soon as some external cause brought about an interruption in the oral tradition, and only books remained, it became extremely difficult to assimilate the work of great precursors and next to impossible to pass beyond them." (*Ibid.*, p. 266). Moreover: "A further development of mathematics urgently required a concise algebraic notation; further development of the rigorous Greek methods could not lead to such a notation. It was necessary to return to the primitive Babylonian point of view, to multiply *and* divide magnitudes unconcernedly, to treat expressions like $2 + \sqrt{5}$ simply as numbers without worrying about their irrationality. To progress it was necessary first to take a step backwards." (*Ibid.*, p. 267)

This last excerpt shows that it need not be a catastrophe if a particular sophisticated, highly developed, and well-regarded science is given up for some time or is not cultivated in any particular country.

10. Toynbee, Arnold, in *The Age Literary Review*, Melbourne, 18 July, 1964.
11. Fanon, Frantz, *The Wretched of the Earth*, trans. from the French by Constance Farrington, Penguin, Harmondsworth, 1967, p. 137.
12. Fanon, F., *op. cit.*, p. 142.

IRAWATI KARVE

Science and Society

WE have records of the beginning of science, for about six thousand years, i.e. since writing was invented. But actually scientific activity can be said to be as old as the beginnings of human culture. To observe carefully and try to produce certain effects is one of the fundamental and preliminary activities of science. Preservation of fire and, later, creation of fire, learning to float rafts on water and, later, to build canoes or dug-outs observing the night skies and fixing on certain stars for purposes of navigation so as to cross from one ocean to another, to shape stones, make harpoons were all activities indicating keen observation and creativity. All this involved knowledge of different types of materials like stones, woods, and an experimentation with them. Once a discovery was made, the knowledge passed from the original thinker to a craftsman, and so making of canoes, etc., became monopolies of craftsmen who took the ideas from the scientist. Comparison, analysis, and classification into similar groups is also a primary scientific procedure. This activity brings an understandable order into the bewildering variety of things with which a man is surrounded.

In this way order was brought into the seeming chaos of the star-studded heavens. In the same way, larger and smaller areas of earth and water were charted. This activity went on for ages and quite a lot of knowledge must have remained untransmitted because all communication was oral. When writing became known, the knowledge of one generation became available to another generation and it became easier to start at a point higher than that reached by the ancestors. This was the time for tremendous

scientific advance ; the skies were mapped, the time of the rising of certain stars was accurately measured and surprisingly exact calendars were made. These calendars helped to understand the cyclical changes in the earth's atmosphere, rainfall, etc., so as to foretell certain events. This ability to foretell brought the power, to use the event or to protect oneself against the event, (e.g., a flood). In this age also were laid the foundations of mathematics in the form of enumeration, simple geometry, and trigonometry. The latter two imposed a certain order on areas of earth in length, breadth, depth or height. Simple enumeration is in certain ways one of the most abstract concepts. The most diverse things can be put under one caption through the simple act of enumeration, and in enumerating we bestow on each thing the quality of individuality. When things are enumerated, distances measured, and regularities of processes are established, generally ever larger and larger number of things and processes are brought under one description or what is called a formula. Science and scientific activity of today, in this respect, has remained the same as the scientific activity of thousands of years ago.

Such an activity, if based on immediately by felt need, becomes a technology or a craft but, when this activity is due to inherent and insatiable curiosity, it is truly scientific. This is a thirst for knowledge and an impulse at bringing order. When people looked at the skies or went ever further on land or water or watched keenly the effects of friction, the impulse was curiosity, and the end was a new glimpse into the forces of nature. In itself curiosity is an idle impulse. It carries with it another impulse ; that of imitating, building, reproducing, and all this is done at least primarily for the pure satisfaction of this impulse rather than for any ulterior motive.

The first such observers were men, a little mad, a little possessed, and only incidentally having certain knowledge which could be put to use. They were the wise men, the seers, the magicians ; sometimes, but rarely, they combined in themselves the roles of the ruler and the scientist, but more often the seer and magician was a priest who could be used by political power, but who many times controlled political and social situations and gave them a turn for good or bad. An activity in some ways akin to it is that of the artist. While the scientist wants to impose an objective order on nature, the artist is concerned with representing the outside world as his fancy dictates. Primarily his activity is self-expression, and this might be in geometrical art, naturalistic art, or some representation which is neither. The artist has expressed himself in all media throughout the ages, and the art of ancient days is as complete as the art of today in basketry of different types, in pottery, in weaving, in building a house, in drawing, in painting, in music, dancing and acting. The artist in man has expressed himself in hundred different ways in ancient times as he is doing today.

Some of that art may have been used to make useful articles or to serve religious ceremonies, but primarily the impulse of the artist is certainly not for the sake of the utilitarian ends but for self-expression. Even in imitative naturalistic art of representation of nature there is the artist's interpretation of nature.

The artist also is possessed sometimes. He combines in himself the functions of the priest, but rarely of the seer. The artist through religion has been able to influence society, so as to raise it to pitches of ecstasy or fling it into the depths of despair and mourning. But on the whole he has stayed apart in his fantasy. He expresses himself but at the same time he wants to communicate his expression to society. His activity can rarely be called useful, except when it has allied itself to religion. One can think of plain unadorned basketry, pottery, weaving or pictureless walls. There is an abstract possibility of a living where there is no art, though there never has been such a living on earth. On the other hand, science and the knowledge it provides have, in each generation, become the necessity of humdrum everyday life. The impulse of curiosity which is at the basis of science and the impulse of self-expression which is at the basis of art, are both impulses which are not utilitarian in origin; but the scientific impulse lends itself to utility, and so the fate of these two impulses has been different in the history of human society.

In one more important respect these impulses are akin to one another. They are both creative and amoral. Society may make use of the scientist and the artist for good or for bad, may try to coerce them to fit their activities in a socially approved framework, but the scientist and the artist are both difficult to manage and direct. They have a knack of not caring for the social values or for the social opinion. Defiance is their usual attitude. The impulse of one is to know beyond what is already known or to understand what appears chaotic and understandable. The scientist strives to reduce the universe to some order. The artist, on the other hand, wants to give expression to things as he feels them sometimes symmetrical and calm; sometimes chaotic and turbulent. He does not care for an objective order. What the scientist represents is the revelation of an order; what the artist represents is the emotional creative frenzy. Art has borrowed many of its techniques from processes and things perfected by science. But still in some ways it is an antithesis of science, it is a protest against science and order. The order against which they protest is the logical order imposed by science (Dostoevsky — *Notes from the Underground*), and the order imposed by the framework of society (Kafka, Camus, Sartre and the modern painters, sculptors and poets). Both the scientist and the artist, as already said, were a little mad, mostly to be tolerated and sometimes to be suppressed. They were feared because they possessed certain insights. This

belief in the possession of certain qualities by the scientist and by the artist sometimes endowed them with the power to sway the will of the king or the masses.

The scientist is primarily not against society as such. He is involved deeply in his pursuit of knowledge ; that pursuit sometimes brings him face to face (as in the case of Copernicus) with a new type of knowledge which may go against traditional beliefs. It may reveal a source of power (atom fission) which may give undreamt of power to society. The scientist, however, is not *per se* opposed to the value framework of the society. He is unaware of the consequences of his discoveries. It is after the discoveries that the awareness comes. On the other hand, the role of the artist, especially in the last quarter century, has been that of a conscious angry fighter against the social order. The writers of prose and poetry and drama, the painters and the sculptors, have deliberately tried to flout the social norms and to bring to the notice of society a new conception of reality. They have gone about this task with angry determination..

We find through history the political and religious power forming an alliance with science or with art whenever it suited them. On the other hand, there were occasions when both quarrelled with the powers that be.

A true scientist or a true artist did not care *per se* for utility; in fact, the word utility was anathema to both of them. In this respect their activity is comparable to the play activity of a child. The child explores, builds things, picks and arranges what appears attractive to it, not because these activities have any use but simply through an exuberant creativity. In this respect I would like to refer to Shankara Bhashya, in which the reason for which the Creator created the universe is given and which, translated, means "pure play activity as we find it in this world". लोकवत्तु लीलाकैवल्यम् ।

During the last few hundred years both art and science have flourished through patronage. Art was supported by a powerful church, and science by learned academies established under royal patronage.

Science has not lost the patronage of the ruling power even when royalty had vanished. This was because scientific discoveries have proved useful for all human activities. It has shown its ability to produce adequate food, clothing, shelter, and luxuries for human societies. It has helped communications by devising new modes of travel and transmission of messages on a world-wide scale. It has devised more and more horrible weapons of destruction. It has shown how to preserve all life, and has also shown how to destroy it most effectively. In all these activities science has needed extremely costly apparatus of work which can be provided only by the established power in society. He is no longer the lonely seer working in isolation and away from the crowd. His output depends so much on ever finer and more elaborate instruments and co-operative efforts that he has to fit

himself into the value framework of the society. His former position was that of a lonely free seeker of truth; today, he has become the domestic slave of the political power. He has to prove his utility before he can indulge in pure unadulterated curiosity.

It has gone the other way round with the artist. For the modern artist the world in which he lives is a world without order and without justice. The artist is still patronized, manages to get money and admiration from the ruling powers not because he conforms to but because he chooses to protest against and aberrate from the given order. He is, as never before, at loggerheads with the professed values and with the traditional framework of society.

One can say today that the scientific knowledge of the world, if pooled together, is capable of giving all the good things to human beings which the scientist of the 19th century had never dreamt of. On the other hand, all this knowledge seems to be utterly useless to bring about human justice. The loudest protest in this respect comes from the artist. There is a general feeling that science has failed, and there is a strong feeling that a scientist should either curb his activities or somehow re-shape human society.

I do not think that we are right in placing the burden of our present pitiable condition on science. Even artists who are so keenly aware of what is wrong with the society or the individual are not capable of re-shaping the society. The best among them show a bitter realization that humanity is so perverse that it cannot be persuaded to do good to itself. Neither the scientist nor the artist is ultimately concerned with social order. The social order is a moral order, and I have already pointed out that scientific curiosity and artistic self-expression are both primarily amoral activities. The product of their imagination can be abused or well used by society. They pose problems for social regulations, but they are not capable of creating social regulations. We must clearly realize the fact that a social and moral order has to be created for society in which science and art have definite places; but we cannot expect a new social order to arise from their activities. They make us aware of our abilities, our innermost impulses, our shortcomings, but they cannot impose an order on society.

There is an effort to make the scientist aware of what is called humanities, i.e. history, literature, etc. It is a good effort if it only means widening the horizon of a man, but if it is done in the hope of bringing a sense of social responsibility to the scientist, it appears to me to be a vain effort. Ultimately, even in as complicated a society as of the present day one expects that every normal person has an idea of the rights and the duties of individuals to society and of society to individuals. Scientific activity, artistic activity, economic activity, are all social activities, but over and above all these separate activities, there is something like social thought which has to solve

the problem of living together in freedom and security. The living together is to be construed as a wide and understanding way of life of human beings among other living things, like animals and plants and the non-living world like the hills, the rivers and the atmosphere. We need to protect and live with all these, not posing to ourselves the question of utility of this or that, but we must find out a way of living together, without grief or without quarrel. For doing this we have to ask fundamental questions about life in society and as an individual, and make use of our knowledge of science and technology and other things so as to create the social framework which we think is just. Science cannot mould society; it is the other way round. It is the society which has to keep science in its place.

Science is used in manufacture. In many types of manufactures injurious chemical substances are used, and these may harm the worker. The fumes from certain manufacturing process may poison a whole locality, so that one lives in a condition where water, plants, and earth are all contaminated. This contamination and poisoning of the whole earth is not the fault of science but of the whole society. One can find safer methods of manufacture and not indulge in making and detonating hydrogen bombs. Bombs detonated in deserts and on oceans may have horrible consequences over wide areas. These are either not studied or systematically connived at.

Enquiry and experiments conducted on scientific principles are giving us new glimpses into the working of the human mind. Instead of receiving this knowledge in awed respect we are using it to perfect our control over human beings, to brain-wash them, to enslave them. Man and all nature, animate and inanimate, have become a means, an instrument for wielding power. All are *used* for some purpose and the purpose is exploitation. We have ceased to think of each individual as an end in himself, we seek to understand only to turn him into an instrument. For the society utility is the criterion and justification of science. When even man is swept into this all-embracing category, it would appear ridiculous for a person like me to talk of a community and comradeship of man and nature. We have succeeded in polluting, and in almost destroying nature, and in so doing we have laid the foundation of our own destruction.

We are all aware of our guilt and are trying desperately to find a scapegoat. By naming science as the criminal we wish to conceal from ourselves our own responsibility. A crime and a criminal are both creations of society, and the society cannot shirk its own responsibility. As I said before science and art are amoral; they can find out and create. How they will be used is the concern of society. They are fed and nurtured by society. To that extent they are not autonomous and independent of the society which has given them birth and which has nurtured them. Neither of them is either the god before whom the society should kneel or the criminal whom it

must punish. Society must assert its right to erect a social, i.e., a moral frame-work within which all activities including scientific must be made to fit.

An English saying known to all is "knowledge is power", just as "honesty is the best policy". A type of utility is suggested for knowledge and for virtue. It is expected that these advantages may lead people to seek knowledge and be honest. I suppose that is how things are taught. A prize and an inducement is offered for persevering in some initially unpalatable or difficult pursuit. Knowledge is power, but to be so power-conscious is dangerous. Among us our sages have equated knowledge with freedom (*Dhyana=Mukti*). We have a classical saying *Ya Vidya Sa Vimuktaye*. "That is knowledge which liberates". The freedom is from the coercive impulses. The most coercive of such impulses is power. It wants to bind and imprison others and oneself. It destroys all equality and comradeship. It leads to an all-round, all-embracing destruction of man and nature.

The fault again is not of science or knowledge but of the whole society and its value frame-work. Science cannot be made an alibi to prove the innocence or *uninvolvement* of society in the crime which is the social life of today.

K. J. SHAH

Some Patterns of Thinking— a logical appraisal

IT is true that quite a few people who never studied logic reason quite logically, and quite a few others who have studied logic do not reason any more logically than the rest. This, however, does not rule out the possibilities that those who have studied logic reason more logically than those who have not, but I do not know of any empirical study which tests this hypothesis. One might imagine, however, that a study of logic might help one to reason more logically in one of at least two ways. One, it may do so by providing one with some mechanical methods of checking an argument. Two, by emphasising a particular mode of presenting an argument, it can help one to communicate more effectively, and such facility in communication can lead to cumulative results in terms of the precision and the fruitfulness of discourse. But this, as I have already said, is imagination, at best it is a hope. And if it is no more than hope about the role of logic with reference to reasoning in general, the role of logic would be still smaller in the field of social or moral thinking where other factors, like prejudice, play a dominant part. Moreover, the passage from thinking to action presents further difficulties of its own. In this situation perhaps it would be best, for the purposes of altering modes of thinking and action, to leave logical considerations alone and concentrate on other methods. However, I cannot do any better than put forward some logical considerations involved in some of the issues relevant to the topic of our seminar.

The first question I want to consider is : how do we distinguish between a scientific belief and an unscientific one? I shall not consider this question in this general form, but with reference to a particular case, namely, belief

in astrology. The belief is so obviously unscientific to some that, according to them, there is no point in arguing the question; but to some others, the scientific status of the belief is equally obvious. But is either claim tenable?

One reason that may be advanced against the scientific status of the belief might be that the frequency of correct predictions, if any, in relations to the total number of predictions is very small. To this it might be replied that, until recently, the position of meteorology was similar, but its scientific status was not denied. The position of astrology is worse today only because we lack data. The wonder is not that so many predictions go wrong, but that some come true (I think most of us would remember some relevant story, or at least having heard one). It is true that at this basis the belief cannot be said to have a scientific status in the sense that it is an established law, or in the sense that it is a respectable scientific hypothesis. In support of this it may be said that in spite of a still poorer performance the scientific status of the hypothesis that particular perception is the result of a particular change in the brain is accepted by the scientists. To deny a similar status to astrology is a mere prejudice of the modern against the ancient.

To such an argument it might be replied that there are further relevant differences between the belief in astrology and the belief in the physiological basis of our perceptions, which turn the scales in favour of the scientific status of the latter. One relevant difference is that though a detailed relationship between, say, a particular visual perception and the changes in the brain has not been established, a broad relationship between the two has been established. The other relevant difference is that the hypothesis falls within the general conception of natural order which provides the framework for scientific activity. (By a general conception of the natural order I mean the sort of conception which attempts to explain, say, the biological phenomena in terms of the physical phenomena, rather than the physical in terms of the biological, as was done by the alchemists, and by the ancient Hindus when they explained the physical world in terms of *sattva*, *rajas* and *tamas*.) To return to the belief in the scientific status of astrology, it is not supported by even the establishment of broad connections between the planetary conjunctions and what befalls on individuals. And as for its falling within the general scientific conception of the natural order, such a subsumption, for several reasons, is only apparent and not genuine.

First, the belief in astrology may be plausibly subsumed under the scientific conceptions of the natural order only with the help of some such statements as: "not a leaf moves but disturbs the most distant star", or "not a polar bear sneezes but disturbs every particle of sand in the Sahara". If so, why should not the planetary conjunction determine the course of the life of an individual?

I do not propose to go into the philosophical implications of pure state-

ments and their limits and possibilities. At the scientific level, even if a chain were to be established—a very large assumption indeed—between the sneezing of the polar bear and the movement of a sand particle in the Sahara, it is not at all clear what it would mean to say that the sneeze of the bear contributed to the movement of the particle. What is that contribution? A is related to B, and B is related to C; to say that A is therefore related to C is not always true, nor is it always to the point. The first two propositions are neither scientific theories, nor scientific hypotheses, nor facts supported by science. At best it is an expression of a faith in the order and stability of the universe, at worst it is a trick to deceive oneself or others.

Second, the course of life of an individual can be understood in other ways—social, psychological, and physical, without reference to the planetary conjunction.

Third, if we probe a little deeper, the belief in astrology does not want to subsume the course of the life of an individual under the scientific theories of nature, rather it wants the world of nature to conform to human needs. This can partly be seen from the various devices used for the pacification of the planets if their conjunction is not propitious. The relationship between man and nature is conceived by astrology, not to understand the relationship, but to help man out of trouble. To assimilate astrology to science is to subvert both astrology and science.

I hope I have put forward some considerations which are relevant to the consideration of the issue with which I started. I do not believe that this exercise will convert those who hold that a belief in astrology is scientific. The point of the exercise was to show the complexity of the factors which are relevant in the consideration of the issue. It was also to point out that in the determination of the scientific status of a belief the role of relationship to observation is limited. More important is the role of the general conception of the natural order under which the observations are ordered. And such a conception very often is unrelated to observation—e.g. the conception of a body moving continuously at the same velocity is not instantiated.

If so, our attachment to the immediate and the observation world was a more important factor preventing the development of science than our ignoring the world. (The world may have been ignored metaphysically or religiously, but not scientifically.) This can perhaps be supported by the pattern of inference as it is stated in Indian logic. As is well-known, the use of the generalisation in the pattern of inference is always—as more often than not—supported by an example. It is not possible, therefore, to use a generalisation for the purposes of inference, unless a positive instance can be

produced. As such, the Indian pattern of inference is more rooted in the observative world than the Aristotelian.

MORALITY—INDIVIDUAL AND NATIONAL

In this section I want to consider the following argument in support of the conclusion that it is wrong for a nation to resort to war for the settling of international disputes :

- (1) It is wrong for A to do x, then it is wrong for the community or the nation to do x or to do that which involves the doing of x.
- (2) Surely it is wrong for an individual to resort to violence or to kill in any situation.
- (3) Therefore it is wrong for the nation to engage in war or warlike actions which involve the killing of individuals.

I am well aware that I have simplified almost to the point at which they become unacceptable. But I hope that this will not detract from some of the logical points I want to make.

First, I shall consider (2). It might be said that even Gandhiji who put a great stress, if not an absolute stress, on non-violence recognised exceptions. For example, he recognised that a woman whose chastity was attacked might use violence even to the point of killing. He also recognised that resort to violence was better than cowardice. I certainly do not want to deny that Gandhiji recognised these exceptions; but what I do want to deny is that he failed to recognise the theoretical and practical implications of these exceptions. The theoretical implication I want to draw from the recognition of these exceptions is that non-violence is only one among a number of competing moral values, and not an absolute moral value. And, therefore, it is possible to conceive a number of practical situations in which it would be not only expedient but right to resort to violence. From his theory of the relationship between means and ends, he could have argued only that wherever the use of violence can be replaced by the use of non-violence it would be wrong not to do so; and that in many situations where one thinks that the use of violence cannot be replaced by non-violence one may not be right.

If the considerations mentioned above are acceptable, then certainly the statement (3) cannot be right. But what I am more interested in arguing is that even when one can imagine circumstances in which it would be right or commendable for an individual to accept death, it is not easy, perhaps it is impossible, to imagine circumstances when it would be right or commendable for a community to sacrifice itself. The reason for this is as follows :

When an individual is ready to accept death, he is accepting death for himself but not for the values for which he stands. Rather he does so not

only for the symbolic assertion of such values, but also for the greater embodiment of these values in his community. He cannot be certain of this latter development, but at least the possibility is there. I want to suggest that this latter condition is not satisfied in the acceptance of annihilation by a community or nation. The community or nation, at least today, has certain distinctive potentialities which will be completely lost by the acceptance of annihilation. This becomes clearer when one thinks of a situation in which there are only two communities existing in the world.

It might be said that this line of reasoning is weakened by the fact of the possibility of nuclear war where a community faces annihilation — war or no war. Once again it is impossible to deny the importance of this new element in the human situation, but the answer to it may be only the avoidance of war as far as possible, but not the avoidance of a threat of war or of resistance. To do so might be a greater wrong than to go to war. There can be situations where it might be a greater wrong to tempt someone to steal than not to steal, to tempt some one to kill than not to kill.

The point of my argument is not to advocate a particular decision in our nuclear policy, but to bring out that in the case of a nation, moral considerations are relevant, which have different dimensions from those that are relevant in an individual situation. (This is forgotten also when it is said that since an individual must first earn and then spend time, say, in cultural activities, so also a nation. When an individual gives up a cultural activity he is not destroying a tradition, but when a community does so, it is annihilating a tradition.)

I must confess that the complexity of the issues involved is far greater than I have been able to put into this paper. Indeed, they are far greater than those that I have even thought of.

J. P. SINGH UBEROI

Work Study and the Industrial Worker in England

THE SOCIOLOGY OF WORK

The view that human work, worship and play form separate and autonomous spheres of life and thought is a new development of man and society. The modern attitude of self-consciousness towards work, regarded as the chief or supreme value, is intimately associated with the rise and diffusion of industrialism and the scientific outlook. A great encyclopaedia of work and its problems would be a fitting intellectual monument of the modern spirit, just as an encyclopaedia of human suffering and its cures would be a proper monument of the medieval spirit. The scientific or experimental study of work, on the one hand, arose in the factory and the factory remains at its centre. This is the technical study now known as industrial engineering. On the other hand, the analytical and speculative study of man in society, conceived as a secular discipline, equally derived its modern impetus from a concern with the problems facing the new industrial civilization.

Industrial sociology, as it is called in Britain and America, or the sociology of work (*sociologie du travail*) as it is called in a wider sense in France, including the study of work organizations, is a direct resultant of the meeting of the two trends. They are the ideological and practical roots which continue to sustain it. The same is also true of occupational and industrial psychology.

The social origin and function of industrial sociology is indicated by its Anglo-Saxon name. In the opinion of a French sociologist "the very definition of work is bound up with the problems of society . . . it would be easy

to demonstrate how for each group of sociological problems there has always been a corresponding group of social problems on which researchers have sought to throw light" (Benoit-Guilbot 1968: 238).

The American school of "scientific management" was the first one in the field to be considered and it remained dominant until the 1930s. It was founded by Frederick Winslow Taylor (1856-1915), a machine tool designer, whose theory was based on his observations and experiments as a machine shop foreman of the Midvale Steel Company in Philadelphia, Pennsylvania, starting in 1881. Efficiency, measured in the physical output-input sense, was the end and aim of scientific management. Taylor stated that company managers had an inescapable responsibility for eliminating waste and improving the efficiency of the industrial system. He explained that this can be accomplished by (1) defining in detail the precise tasks that the worker is to perform ; (2) selecting the right workman for the job ; and (3) motivating the individual worker through payment-by-result incentive plans to a high level of performance. Taylor worked out specific techniques for the managers to follow in order to achieve these ends (Taylor 1911).

Writers on scientific management in the search for efficiency assumed a theory of work motivation and one of organization. The school was severely criticized for its exclusive emphasis on economic rewards and the individual worker ; its narrow logical methods of physical layout and job design ; and its view of the organization as a kind of formal blueprint or diagram, with a prescribed division of labour and highly specialized personnel under a centralized hierarchy of authority and control. The "human relations" school, which became popular in America following the economic depression of the 1930s, was specially critical of the concept of economic motivation, concentration on the individual worker and the formal concept of organization.

A further assumption of scientific management was that in removing the responsibility for planning work methods from the worker and turning it over to a specialist, the industrial engineer, a net gain in efficiency results. This assumption was widely and ever-increasingly accepted in practice in the U.S. and elsewhere, although sometimes criticized in theory. Taylor's revolution is accomplished in fact and the separation of planning from performance is in full effect everywhere. He laid the foundations of the theory and practice of modern management as well as industrial engineering, an achievement reflected in the fact that the Taylor society in the U.S. merged with the Society of Industrial Engineers in 1936 to form the Society for the Advancement of Management.

The human relations school expressed a reaction against too much Taylorism, and sought to instal the logic of human emotions side by side with the logic of efficiency. It laid stress on the unplanned or non-rational

elements and the importance of the face-to-face work group and of social relations in factory life, especially the "informal organization" as against the "formal organization". This school arose from the pioneer series of field experiments conducted by Elton Mayo and his Harvard colleagues at the Hawthorne works of the Western Electric Company in Chicago from 1927 to 1932. The results of the investigation were reported at length (Roethlisberger & Dickson 1939) and exercised a wide influence. The main conclusions were that (1) the level of output is set not by the individual worker's physical capacity but by social norms; (2) non-economic rewards and sanctions play an important part in the worker's motivation and satisfaction and influence his behaviour; (3) workers respond to management and its methods not as individuals but as members of work groups; (4) the most efficient form of the division of labour is not necessarily one with the highest specialization. Following on these experiments, writers on human relations in industry came to emphasize effective communication between the higher ranks and lower ranks, participation in the decision-making process by the latter and the virtues of democratic leadership.

The American school appeared anxious to ensure industrial peace and progress by way of elucidating the principles of social engineering for the benefit of all, but specifically management. The United Automobile Workers' journal, *Ammunition*, called human relations "cow psychology", as designed to induce compliance (Barkin 1950). The workers' satisfaction and morale was to be assured while side-tracking issues of material conflict. The clinical approach to research expressed in the motto "no research without therapy and no therapy without research" was followed in England by the Tavistock Institute of Human Relations, London (see, for example, Jaques 1951).

A more comprehensive approach is now becoming evident (see Treanton & Reynaud 1963-64), which owes something to each of the two preceding schools but also to the writings of Max Weber on bureaucratic organization and of Marx and Engels on industrial conflict. Its main tenets are to study in the field (1) both the formal organization and the informal organization and their interrelations; (2) the higher ranks as well as the lower ranks; (3) material as well as social and psychological rewards and sanctions; (4) the interrelation of the work organization with its wider environment, including non-work organizations (Etzioni 1965: 49). This approach would perhaps free the sociology of work from its pro-managerial bent. It should be noted however that the old human relations school, losing its home ground under ideological and analytical criticism, still finds supporters in Europe and Asia wherever the workers are less educated than in the U.S.

The new approach is very well illustrated in England by the recent research of Tom Lupton, himself an industrial worker and trade unionist

turned sociologist (Lupton 1955, 1956, 1957, 1963 ; Lupton & Cunnison 1964). It is built on earlier work (for example, Liverpool University 1954). My further remarks will be largely limited to England, and in explanation of this I should say that I possessed some familiarity at first hand with the industrial scene in London and Manchester in the 1950s and that acquaintance has formed the background of my reading in industrial sociology.

WORK STUDY IN BRITISH INDUSTRY

What is called industrial engineering comprises several related components: work study, time study, motion study, production planning and control, procedure analysis, operations research, systems design, quality control, cost control, job evaluation, wage incentives, plant layout and organization analysis. The whole effort is to produce a careful design for an integrated system combining men, materials and equipment towards a given objective and to predict, control and evaluate the results obtained from such systems. The formula for industrial engineering was given by Taylor ; only the procedures have expanded and developed. *The greatest production results when each worker is given a definite task to be performed in a definite time and in a definite manner.* Taylor's own work ensued in the procedure called time study. Motion study or methods improvement, an analytical method of designing human tasks, was worked out and published by F. B. Gilbreth and Lillian Gilbreth in 1911. By 1930 industrial engineering was well on its way to becoming a necessary part of the industrial routine in the U.S., Britain and other countries.

Work study in particular can be described as a short-term approach to productivity. Although its techniques can be used to design layouts and methods for new factories and work study men do also concern themselves with machine design, work study was in fact most often called in to help pre-established concerns, factories where the machines were already installed and in operation. It was little concerned with major innovations of design or method, although this characterization does not apply to industrial engineering as a whole.

Work study can be divided into four parts, the first three of which constitute methods study and the fourth time study. (1) The study of the factory, office or other establishment as a whole, examination of its layout of equipment and materials and of the flow of work. (2) The closer examination of specific jobs of work, aimed at providing and positioning materials and equipment in such a way as to save time and effort. (3) The detailed study of the muscular movements of workers or operatives doing the job so as to establish the simplest, most direct and least fatiguing mode of performance. (4) Work measurement in the sense of timing the duration of each specific task on the job. For this purpose a particular job of work is

sub-divided into a number of separate elements and with the help of a stop-watch the average or mean time taken to perform each element is measured over several repeated cycles of the job. The results of time study can then be used to set time standards for workers' incentive or bonus schemes as well as for the planning and control of factory and office operations.

Methods study and time study are further employed to evaluate work according to its skill, effort, responsibility and other factors. This is called "rating" and is used to fix normal or standard wages.

The first British work study consultants, the Bedaux company, began work in 1925, but work study application really came to the fore after the second world war as a part of post-war Britain's response to the need for higher productivity. There were two considerations that at the time facilitated the adoption of work study as a technique suited to Britain's general economic conditions. Firstly, the improvements that it recommended could be carried out with very little capital expenditure; they were inexpensive to instal and quick in yielding returns. Secondly, the work study training programme was itself short. For example, the main course organized by the Wool Textile Employers' council in their centre to train men who would carry out work study and redeployment programmes in the council's mills, had a duration of eleven weeks only. As a result of such factors Imperial Chemical Industries, for example, employed 1200 work study officers by 1955.

The nature, origin and function of work study are such that recruitment to it comes largely from junior management grades. The work study man is a member of the managerial class and not the working class but he belongs at that point in the hierarchy where management and the worker meet. For this reason some industrial firms occasionally selected shop stewards to become work study men but the trade unions expressed dissatisfaction at such promotions from the one status to the other.

Work study is intellectually removed from the patient seeking and thought of long-term research and development work. It requires the kind of practical ingenuity that can devise improvements immediately applicable within the limits of existing processes and products. With this practical aptitude must be combined the social and psychological skill of persuasion, for the proposed changes must be "sold" to be installed. A pamphlet issued by the Wool Textile Employers' council's work study centre stated that, apart from being able to determine and analyse the facts of a problem and propose a solution and having a reasonable aptitude for handling figures and data, the work study man should possess above all skill in taking people

along with him when proposing and installing changes in established practice.

The work study man must win the confidence and support of both management and the worker. "On the one hand he may know management's long-term plans, some of which it may not want divulged at the moment. On the other hand his detailed observation of jobs and his wide personal contacts may mean that he knows more of what is actually taking place and being thought about in the office or workshop than anyone else — including some things that are usually kept from management's attention" (Dalziel 1956: 279).

The position of the rate-fixer whose time study decides between "loose" times and "tight" times for a job and so affects the worker's earnings and the factory's efficiency, is subject to several pressures, formal and informal. A recent field study of a factory making heavy electrical equipment in the Manchester area puts his position as follows. "The workers, in their attempt to preserve their area of control over the system, which they felt to be necessary to handle the situation of uneven work flow, and the effects of bad design, and mismanagement, resisted the attempt to tighten up times. When the [informal] technique of cross-booking [times from one job to another] to cover losses failed they used the [formal] power of the Union to prevent effective downward pressure on rates. This procedure involved shop management in long negotiations with the steward, the rate-fixer, and the men immediately concerned. Since shop managers and supervisors had to live at close quarters with the men from day to day they did not like to be constantly bickering about rates. . . . The rate-fixer was also dealing with the operatives every day in face-to-face relationships and was subject to pressure. . . . These pressures transformed him from a pure representative of management into a kind of arbitrator" (Lupton 1963 : 150-151).

ATTITUDES OF THE MANAGER, SUPERVISOR AND TRADE UNION OFFICIAL

Management is all for work study, on the whole, regarding it as one more item in the repertoire of efficient management practice. It extends and increases control over man-on-machine production and so facilitates the aim and object of industrial managers to organize, supervise and direct labour to operate machines. Moreover, with regard to its promise of reduced costs and higher profits, managers can welcome work study innovations not only on their own behalf but also on behalf of their employers, the shareholders, owners of the capital invested in the factory. Work study is an aid to both management and entrepreneurship.

Some qualification is introduced in the managerial welcome because workshop supervisors or middle managers may sometimes react unfavourably to

the intrusion of yet another specialist from outside on their work, creating anomalies in work flow and job prices. Shop management and the worker are then united against the specialist departments of the factory, the planners, designers, work study men and rate-fixers. This is probably so where the size of the plant is large, the work flow and layout is complicated and there is greater depth of the management hierarchy (Lupton 1963: 164-167, 193). The situation can be related to the process whereby, with the coming of automation and information technology, middle management itself may be pushed down and so remove the assembly worker still further from the rest of the organization.

The attitude of the workers' representatives, the trade union officials, is consistent with the general aim of the British trade union movement to organize and lead labour and represent its interests so as to secure a balance of power vis-a-vis employers and managers, and to strive continually for just wage-rates and better conditions. In terms of these aims trade unionists support work study in so far as it increases productivity and lessens fatigue. They oppose it in so far as it creates redundancy, increases work loads, makes bargaining about wage-rates difficult and otherwise upsets industrial relations. From its inception in Britain, the trade unions did not promote work study since that was not their business, but attempted to ensure its proper use as they perceived it. In the words of one union official, education officer of the National Union of General and Municipal Workers, the unions want to be sure that they "adequately understand work study, can negotiate and consult upon it, and make sure that as a technique it is properly and fairly used" (Basnett 1956: 8). I quote the same official's general attitude towards industrial efficiency. The unions support industrial efficiency because "as an exporting nation our prosperity and economic stability depends upon it, full employment depends upon it, and finally we stand to gain more for our members from an efficient and prosperous industry than from an inefficient, derelict industry. We add to that a desire to have a say in the way industry is run" (*loc. cit.*)

U.S. labour leaders took a keen interest in work study and industrial engineering from the beginning since it affected almost every aspect of industrial working life, and this forced the constant improvement of industrial engineering procedures (Maynard 1965: 84f). At first the so-called "efficiency experts" caused industrial unrest to such an extent that the U.S. congress added a rider to its appropriation bill in 1915 prohibiting the use of the stop-watch, the essential instrument of time study, and the use of incentives in any army or navy establishment, a ban that persisted until 1951. After the second world war, however, when representatives of western European industry visited the U.S. under the Marshall plan, American labour

leaders played an important role in persuading their western European counterparts to accept industrial engineering practices.

WORK STUDY AND THE WORKER

The applicability of work study is limitless in principle. Agriculture, the army, the retail trade, hotels, hospitals, universities, the kitchen and household work are not excluded from it. But its primary application is to industry and the factory. No one will dispute that the risks, rewards and sanctions of the industrial system are not evenly balanced between management and the worker, and this observation holds of work study. I have not seen any report of managers or entrepreneurs who have work-studied themselves — indeed we are often told that decision-making and management are “immeasurables” — so that work study has been introduced into the factory by factory managers and has been largely applied to shop floor workers. In theory work study is equally applicable to the service departments and offices of the factory, and outside the factory to the linked processes that feed its production or follow upon it. In British practice work study has only too often begun and ended on the shop floor. The worker who sometimes resents this may be right about parsimonious and expert haggling over minutes on the shop floor while hours might be cheerfully lost elsewhere.

For better or for worse, whether the hope of its benefit to him is realized or belied in a particular case, the impact of work study falls hardest on the worker. It will always in some measure alter his relation to the machine, to his fellow workers and to shop management and it will probably affect his earnings. The sum-total of the effect is that the employer no longer buys merely a man's working time or his active presence by a machine or the product of his day's labour; rather he buys an expertly prescribed, counted and measured number of methodical motor actions per hour per day or per job. Nothing could be further removed from the goals of self-realization and autonomy that are said to be universally highly valued by managers for themselves (Haire, Ghiselli & Porter, 1963). Application of the Taylor formula for work study (given in italics above, p. 336) indeed leaves nothing of that and no slack in the system for the worker.

In assessing the worker's response to the situation we have to make allowance for the fact that the interests, attitudes and values of shop floor operatives need not necessarily or always coincide with those of elected or appointed trade union officials. Viewed from the shop floor the hierarchy of official union leaders can seem yet another bureaucracy of organizers in certain circumstances, not very different from management but very different from the spontaneous leadership temporarily thrown up during unofficial “wildcat” strikes. There is a grain of truth in the critical and admittedly

exaggerated remark heard in Britain that the trade unions are in danger of becoming merely that branch of management which deals with labour.

Thus the bird's-eye view and the worm's-eye view, so to speak, are not the same in the sphere of labour or in that of capital or management. We cannot reasonably expect shop floor operatives to be so mindful of the national productivity conspectus, the carrot of work study, to which both employers and the unions subscribe. Where, on the other hand, union leaders and members are mutually close and identified the latter experience the problem of dual allegiance to the union and the firm (an American report on some aspects of this is Stagner, 1954).

There are few studies that give adequate account of the rationale of the worker's response to work study (Lupton, 1957 is an exception; a survey of the general field is Touraine, 1965). An unfavourable response to the innovation is too readily written off as mere traditional prejudice, an emotional reaction showing lack of knowledge or a legacy of the trade depression. Such explanations, originating in the scientific management school, rely on a simple view of workers' motivation and of the industrial system and undervalue the workers' comprehension and apprehension. The human relations school added another dimension to this with its interpretation of what is mis-called "restriction of output", i.e. workers' collective control over output and earnings (see Rice, 1951; Roy, 1952, 1954; Lupton, 1956). This school explained that the main impediment to fulfilment of management's high expectations lies in the informal social groups formed on the shop floor. According to this interpretation, on the one hand, management formulates the expected level of output on considerations of technical efficiency and then directs workers through incentive schemes and so on to achieve that level of output. The social group in the workshop, on the other hand, is based on considerations of friendship sentiments and sociability, adhering to values that are "traditional" rather than "rational". It develops its own customs, system of social control and norms of what is a proper level of output, which may be maintained well below that which management expects even though workers are paid according to how much they produce. The "fiddle" against management ("fix" in the U.S.), manipulation of piece work and overtime rates and workers' resistance to innovation are to be understood in such terms, counterposing the rational logic of efficiency versus the workers' logic of emotions.

T. Lupton (1963) has carried the debate to a new level through two field studies in Manchester. He found that both management and the worker made a rational and sensible appraisal of their situation in the firm and the industry and acted according to their respective and joint interests as they saw them. "A great deal of the field material ceases to make sense unless one admits of a realistic appraisal of interests, and of discrepancy — even

conflict — between the goals of workers and managers” (*ibid.* : 196). The “fiddle”, where it was found, was a form of social adaptation in this situation, allowing a form of workers’ control over the job environment. The workers maintained a ceiling on bonus claims to safeguard against rate-cutting by management and to stabilize weekly earnings. Time “banking” and “cross-booking” practices similarly served to minimize the effects of waiting time, faulty design, etc. (where the efficiency of management fails to live up to its good intentions) and assured some control to the worker over the relationship between effort and reward. In the circumstances, Lupton concluded, “management might prefer to live with the ‘fiddle’ at the cost of what they believe to be some slight loss of output, and regard this as the price they pay for a good relationship with their workers” (*ibid.* : 183).

Lupton also attempted to determine the internal and external factors affecting the workshop situation (Lupton, 1963 ; Lupton & Cunnison, 1964). The internal factors comprise the man-machine production system (layout of the job, pattern of work flow, system of job allocation, length of the work cycle), the method of wage payment, the nature of the labour force, the workshop social group and the management-worker relationship. This internal factory organization, technical, formal and informal, is not self-explanatory but exists in the wider context of external factors: the nature of the firm’s *product*, its cost ratio and its market ; the competitiveness, scale and location of the *industry* ; and the nature of *trade union* organization. All these factors must be taken into account I think in the sociology of work study and in interpretation of the worker’s response to technological innovation. The internal system and the external system affecting the work situation must be correlated before one can proceed further to correlate the non-work systems overlapping into the workplace, for example religion. The problem of variation in individual and group behaviour cannot be fully understood until then (for an early U.S. attempt see Collins, Dalton & Roy, 1948).

The work of Lupton finds support from the U.S. on the essential rationality of the worker (Whyte et al., 1955) and on labour and management conflict (Dubin, 1960). More may come from the new dissection of management. A very interesting finding is that voluntary restriction of output, informal social groups and norms and resistance to authority are not confined to the workers but are found also among managers (Dalton, 1959). The importance of the external system of the factory and the firm has been known for long (see Warner & Low, 1947 ; Friedmann 1955: 301-323) but its correlation with the internal system is still not wholly satisfactory.

CONCLUSION

We can now reconsider an aspect of work study, the relation of work measurement to workers’ incentive systems and wage negotiations, where the

prestige and weight of science was thrown against the side of the workers. On this issue British trade unions and their members were united in attitude.

The value of industrial incentive systems is open to question (Marriott 1957; Gross, 1958) but in the U.K. 42 per cent of wage earners in 1961 were on "payment by results" plans. As a system of management incentive plans and piece work payments can be effective only if standardized job conditions are established and maintained. The installation of an incentive system thus requires the establishment of job performance standards or "rating" but the very making of such measurements by work study men almost always leads to discoveries of how a given job can be simplified or improved. Work study and measurement is therefore a continuous process, constantly affecting rate-fixing and wage negotiations as well as the job of work.

How scientific is work measurement and performance rating? As it was put in Britain in 1956 "Time study practitioners themselves would say that while rating may not be 'scientific' (a change in their position from the early days of time study), it is the result of systematic, objective observation by trained and experienced people, and that their judgments, though subjective, are far more accurate than any other method yet devised, and that a consistency of $\pm 5\%$ can regularly be obtained both within and between firms" (Dalziel, 1956: 282). In the same year trade unionists, on the other hand, pointed to the findings of Winston Rogers in a study sponsored by the Nuffield foundation of "an overall disparity of $\pm 21\%$ in the consistency of time standards amongst some 30 time study operators" (Basnett 1956: 11).

Beyond noting the wide gap between the two sets of figures I should also make the general observation that Britain is a manufacturing country living in a competitive technocratic world where the continued existence of a particular English firm or even industry depends on its keeping up with the latest developments of applied science, so that the adjective "scientific" signifies high praise while "unscientific" is almost a term of abuse. Perhaps one cannot blame the practitioners of work study and of the art of management if they strove, as they still do, to burnish their image through scientism. The trade unions have responded in the same idiom and both sides now fling "science" and "statistics" at one another.

But what is at stake in rate-fixing and wage negotiations is not the method of work measurement or its degree of objectivity. The real issue is to arrive at a just, equitable and workable compromise between the interests of the employers and the workers in a changing world. This conflict of interests owes nothing to mensural unclarity about work and even a wholly agreed measurement will not cure it. Likewise, the common interest of workers, employers and managers in keeping the factory running, which

induces their representatives to strike a practical bargain before too long, bears no determinate relation to the statistical results of work study measurements. The dynamics of conflict and cooperation that are reflected in such negotiations belong to the nature of the industrial system itself.

This nature is what every investigation in industrial sociology must seek to illumine. I have therefore attempted to describe and discuss work study with a view to showing that its meaning and effect cannot be fully understood without taking into account the wider social structure of industry. This is not a matter merely of placing a particular industrial innovation in its broad socio-economic or historical perspective, but of appreciating that the social structure of the industrial system is implicated in every significant event, whether innovative or traditional, that occurs within it. I first explained that there is a technical side and a sociological side to work study. A consideration of the work study man's position in British industry showed us how his work is related to union-management relations and to social norms, and that he finds solutions to work measurement problems in terms of them. We then distinguished between the interests, values and attitudes of management, shop supervisors, trade union officials and shop floor operatives. All are concerned with and affected by the work study innovation but their varied response is determined by their respective roles and their power and reward within the British industrial system.

To say this is not to deny that the different groups are functionally inter-related within the wider national system nor that work study effects can benefit all concerned to a degree since it aims to increase productivity, reduce costs and lessen fatigue. What I wish to controvert is the easy assumption circulated by writers on scientific management and human relations in industry and others that exact principles of management exist which, if only they could be wholly applied, would organize all concerned efficiently and happily and for equal benefit. It is often stated or implicit in such discussions that uninformed obstructiveness, innate traditional conservatism or "human emotion" shown by lower-level workers is a stumbling-block of technical advance. It is also denied or forgotten that a certain conflict of interests between workers, employers and managers is inherent in the industrial system, and there is nothing "scientific" about supposing it not to exist. Scientific responsibility in sociology would be better served by a constant effort to ascertain by observation and inference different views of the industrial system as it appears from different positions within it, setting them in context and then evaluating their rationale.

Firstly, in the age of automation the worker's work is not what it was: "a multitude of jobs have been created in which one or several fragmented operations designed by management are repeated *ad infinitum* by workers who are never called upon to exercise any initiative. Thus the worker be-

comes more and more dependent, until he loses all vestige of autonomy" (Benoit-Guilbot 1968: 235). Work study, separating further the planning from the performance, is an integral part of this trend.

Secondly, the British worker's motivation to work is also not what scientific management assumed it to be. When the national wealth per capita, including that of the worker, has arisen sufficiently, the worker is educated and has a strong well-organized union behind him, the old pulls and pushes of economic life, the attraction of individual economic self-interest and the fear of redundancy and unemployment, no longer operate on him as before. His motivation becomes more complex. Considerations of sociable shop floor relations, for example, and of the worker's general place in industry and society become more important.

Thirdly, unlike managers shop floor operatives often work in groups in everyday life and such workshop groups possess their own informal organization. This observation of the human relations school we accepted, but not its interpretation. To make and keep the factory floor a sociable, friendly and pleasant place to spend one's working life in is a rational form of job satisfaction in the circumstances. So is the attempt of shop floor workers to exercise some self-regulation in matters affecting the job environment and the relationship of effort to reward. The introduction of work study, we have seen, narrows down the limits of self-regulation by the individual worker and the group in these very matters. If the British worker should find the development unwelcome, as he sometimes does, are we to conclude that he is showing irrational resentment of scientific advance? Or that he is simply averse to more and more external control over his every activity made by management in the name of science and efficiency? I have argued that shop floor workers behave like reasonable human beings in the light of their position in the firm, industry and society. We must be careful not to convey an emotionalist picture of the worker as against an intellectualist picture of management, for it cannot and should not be a task of social science to distort the humanity of the disprivileged.

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PART THREE
DISCUSSIONS

Chairmen

Professor Nirmal Kumar Bose

Dr G. D. Joglekar

Dr A. Appadorai

Dr R. Ramanna

Dr Y. Nayodamme

Mrs. Irawati Karve

Rapporteurs

Dr Arabinda Poddar

Dr M. K. Chaudhuri

Dr. S. C. Biswas

Dr Margaret Chatterjee

Dr (Miss) Sabira Zaidi

Mr Matinuzaman Zuberi

SECTION A

Interaction of Science and Society

MARGARET CHATTERJEE, Of Maps and Navigators

Discussion

DR A. RAHMAN said that what generally was forgotten in a discussion about science was that science during the last fifty years had changed totally. Previously it was limited to the discovery of natural resources, but now it can even create matter. The primary question is the choice of the goal. Once the goal is determined, science can do the rest to bring it to fruition. But what should be the criteria of selecting the goal? In this question economic, political, technological, and moral factors are involved; all these factors are to be taken into consideration before selecting the goal. Moreover, we have to evolve national ethical standards. In our country ethical systems are hardly developed. Without this we cannot formulate the basic choice as to which area we are to navigate. In the development of ethical standards also science has to perform a function. For this a total change of outlook is needed. Without that the values created by science and technology cannot be applied for the transformation of our life.

DR KAILASH KUMAR contended that Dr Rahman's analysis did not do justice to the complexity of the situation. Both in his and in Dr (Mrs) Chatterjee's view it is taken for granted that human suffering can be alleviated but there is nothing to support this in human experience. The point of view of most religions has been that human suffering can not be alleviated.

The CHAIRMAN elaborated the statement of Dr Rahman, but asked 'How do the sciences come in the field of choice?'

DR M. K. CHAUDHURI sought to point out that the possible consequences of the introduction of automation was missed in the original paper. With the introduction of automation volumes of repetitive work will be reduced. More people will be engaged in research and creative activities. Work will be more creative, and only a small proportion of people will be engaged in dull work.

CHAIRMAN: The number of slaves will be reduced, but will it *ipso facto* be more progressive?

DR M. K. CHAUDHURI: Yes, if more people are engaged in creative work.

DR NIHARRANJAN RAY mentioned that less work would mean more leisure. Now, what is to be done with leisure? It was his impression that more leisure might lead to unhealthy esoteric practices, which point he illustrated by citing the example of an American community which indulged in black-magic and other sordid practices.

DR MULK RAJ ANAND referred to the disastrous situation in the west. In his opinion, extreme mechanization of life and 'commodity-fetishism' has generated viciousness, and they are using science in a way in which life is not worth living. The disastrous situation of the west is recurring here. We cannot draw the cultural map of India on the lines of the mechanical civilisation of Europe and America. An exact carbon-copy of either USA or USSR would be disastrous for India. Technology run amuck would obliterate human values ultimately.

DR R. RAMANNA said that technological development and organisation cannot be very different from what it is in other countries. There is a definite thing as Indian philosophy and perhaps even Indian science, but except for minor local variations the technological approach to a problem cannot vary very much from country to country.

At this stage there was an exchange of words between Dr A. R. Vasudeva Murthy and Dr Niharranjan Ray on the definition of culture. DR RAY said that culture was not the product of leisure but of labour. There are many instances of beauty produced by slave-labour. He was supported by PROF. C. D. NARASIMHAIAH who also maintained that culture was the product of the "fiercest activity".

DR K. J. SHAH said that if there was increased leisure, the people would have also the option to use it in the way they liked. Now, the question is, can we find the solution without first creating the problem?

DR JAMAL KHWAJA gave examples, quoting John Gunther, of the creative utilisation of leisure in the USSR. In his opinion the problem of leisure can be solved by creating suitable condition of its utilisation. But we have to accept automation, it cannot be avoided; and we will have to find out what can be done to adopt the scientific attitude.

MISS C. B. MUTHAMMA made mention of the labour-saving devices which are meant to make labour for all more productive. In her opinion we are not isolated from the rest of the human community; so we have to be competitive, otherwise isolation will be fatal for us. Practice of black-magic cannot be associated with increased leisure. The poor in India have no leisure at all, but many of them indulge in such and other sordid things.

DR G. P. CHATTERJEE held the view that culture may be defined as integrated human behaviour. Physical sciences help the growth of a certain cultural pattern by providing the means of verification. Spiritual sciences

similarly do help the growth of certain other cultural patterns by defining the destination. And human activity or action could be made playful and fruitful by a synthesis or integration of physical and spiritual sciences.

DR SATYA PRAKASH expressed the view that introduction of automation would involve certain financial and practical problems and it could not be supported. He divided the scientists into different categories and said that they illustrated well the split-personality of modern man.

DR A. APPADORAI referred to the Indian way of doing things and said that one of the solutions to our problems could be found in Gandhiji's principle of limitation of wants. Multiplication of our wants, said Gandhiji, leads to conflict. Keeping this ideal in mind we should organise our technology, and organise it in such a way that it caters to the needs of the village people through inventing small machines also, while not neglecting essential heavy machinery.

DR MARGARET CHATTERJEE in her reply said that there were two sources of drudgery — (1) primitive labour, (2) mechanical labour. She never meant that labour *should* be mechanical. As to automation, the crux of the problem lies in the time factor, whether it is introduced before or after full employment. Our problem is to provide work for all, so indiscriminate application of automation cannot be supported. While making the map of India we should proceed cautiously, each area should be studied empirically even though the maps of other countries are consulted. Decisions have to be taken as to what amount of science is to be absorbed. Human suffering *can* be alleviated ; technology should be applied for that purpose and also for the purpose of mass education. Something can be done by our own initiative, without leaving everything to the government. Finally, work would be so organised as to give people a sense of participation in national affairs.

M. K. CHAUDHURI, Role of Social Organization in the Utilization of Science for the Benefit of Man

Discussion

SMT. IRAWATI KARVE pointed out that science was employed for the production of certain things by certain agencies. The result it yielded depended upon the nature of employment. So proper organisation of men was needed before science could be properly organised.

DR M. K. CHAUDHURI on a point of clarification raised by Dr Appadorai said that the role of the factors of production did not remain the same for

all times. In these days of technology the entrepreneur has become dissociated from production. The managers can run the whole business without his help. So there is no ethical justification for private ownership.

DR NIHARRANJAN RAY said that he very much doubted the validity of the assertion. He said that if the different figures of investment in scientific research and production were consulted they would give a different picture. In his opinion science in USSR is slowly approaching a saturation point. So the assumption that the investment and production figures will always bear an exact proportion is not true. If the input is 10, very likely the figure of production will be in the neighbourhood of 3.

MR KAILASH KUMAR asked whether it was correct to conceive of science and society as separate entities to the extent it had been done in Dr Chaudhuri's paper. He suggested that the terms like "degree of productivity", "mode of production", "interaction" etc., were being used to imply a greater precision than was possible in this type of discussion. He pointed out that the similarities now emerging between the Soviet and American systems may only mean that social control was either not possible or irrelevant.

DR A. RAHMAN: Dr Chaudhuri had said that once the social system was changed the problem of utilization of science and technology would be solved. But it may not be so. In Czechoslovakia where he had discussions with fellow scientists it was revealed that research sponsored by the factory was not utilized for the simple reason that its utilization would upset the production schedule and that it would affect the workers' wages. In India we have our own problems. Science and technology were imported and utilized almost within a decade of its utilization in the UK. However, the situation had been quite complex. The area of investment in research has not been the area of import or investment in industry. The consequent result has been that research has not been interacting with industry. Lack of far-sighted policy has also to be considered. This perhaps explains why the scientific revolution did not take place here as it did in other countries.

PROF. V. V. JOHN held the view that the benefit of science and technology must accrue to the whole community. In his view, even in our own types of the 'socialistic patterns' of production the business community seems to get the optimum benefit and seeks to perpetuate that kind of socialism. So socialism cannot be offered as the panacea of all social evils. He said that there could be a third alternative to capitalism and socialism.

DR A. APPADORAI said that to say that socialism would always result in better utilization of science and technology is to utter a hollow truth. Britain in the 18th and 19th centuries made tremendous advance in those fields, and all of it was done by private enterprise. The same is true of

USA. From the point of view of distribution there may be more socialism in those countries than in India or even USSR. But of course social welfare is much better in the last named country than in India. So, there is no reason why private capitalism properly regulated would not lead to better conditions. India—a mixed economy—has to solve her own problems. But he doubted if there was any connection between socialistic pattern and increased production through science.

PROF. N. P. DANI doubted that the gap between the developed and the underdeveloped countries was merely due to the difference in the mode of production. The problem is very complicated and has to be tackled by taking into consideration other factors, such as international co-operation, etc.

DR R. RAMANNA was worried about the attitude of some of the industries in India. It was not clear to him why when some technical developments had taken place in India which had good prospects of finding a big market, our industries were not willing to make use of these developments. One such, he quoted, was the vacuum equipment that has been developed at Trombay. He said that mere technological developments were not sufficient; sociological causes for industrial inactivity have also to be investigated.

DR Y. NAYUDAMME said that science is a revolutionary thing, whereas man and society are static, stable. In India we do not also get the proper benefit of science because we have no scientific tradition. We have only a literary tradition. Without the growth of the scientific spirit we cannot transform our society through science. The ability to absorb science and to popularise science depends upon scientific temper and better communication systems. The interaction of science and society is not something static. It is a dynamic ever-evolving process. With any change in social organization we do not reach an end.

DR MULK RAJ ANAND maintained that social organization did play an important role in the utilization of science and technology. USSR before the revolution was almost barren but within fifty years she could catch up with other great industrially advanced states. Of course it cannot be mechanically said that so much change in social organization would result in so much progress. India cannot blindly follow what other countries have done; her specific problems have to be taken into consideration. It however goes without saying that if we have a socialist economy, instead of a capitalist one, much of the wasteful expenditure can be avoided.

DR M. K. CHAUDHURI in his reply said that in spite of differences among the socialist countries regarding some principles, the mode of production remains socialistic. It is an accepted fact that the socialist mode of production in the USSR has made the development of science so rapid and its utilization so efficient. Not only that, the efficiency of investment has

also increased, as a result there is less wastage than in the capitalist countries. Investment in such fields as education, health services, etc., has also vastly increased. Moreover, the rate of growth in the economic field far exceeds that of other countries; in recent years there has been nearly 8% growth as against 4% in America and 1-2% in England. This example alone proves why it is important for India to adopt a socialistic mode of production.

N. P. DANI, *Economic and Social Aspects of Technological Innovation in Industry*

Discussion

DR Y. NAYUDAMME said that mere talking about the problems would not serve any purpose. We must mean business and for that purpose instead of Bharat Nāṭyam where only one person dances and others surround to appreciate, we should have a ball-dance in which many couples participate. In his opinion, there is only one science the application of which will bring blessings to our progress. All the tools of science including psychology, sociology, economics, etc., have to be taken into consideration. Let us not be divided. Mutual blaming or bickerings wont do. Our failure to arrive at a common culture is responsible for not utilising the research findings. What is required is a firm commitment to science by society and the future depends to the extent social and subjective values can be kept in step with scientific discovery.

MR KAILASH KUMAR wanted to know if there were published writings of Indian scientists concerning science policy and administration of scientific research.

PROF. P. S. SARMA said that our National Laboratories had done much development of our industries.

DR G. P. CHATTERJEE said that we should not be unnecessarily critical of our National Laboratories. Research potentialities of these laboratories have to be more fruitfully utilised for the Defence, the Roadways and the work for application in national industries.

DR NIHARRANJAN RAY wanted to know if there was any social resistance to the application of technology in our country.

SMT. IRAWATI KARVE pointed out that the peasants would not use the improved seed on mere words, but would use it only when given a practical example. Scientific ideas must be sold to the people.

PROF. N. P. DANI in his reply said that the scientific advisers have not the freedom of expressing their views to the people. Their advice may not

be made public by the government. This is the real situation in India. Moreover, there is something in our psychology which makes us run for the foreign goods.

The Chairman PROF. NIRMAL KUMAR BOSE, in summing up, said that the fault was not entirely of the government, but also of the way in which scientific knowledge is presented to the people. Much inefficient work has been done in the recent years in India on many government projects. In his opinion, bad science is not needed in India, nor bad economics. In his submission he clarified the idea of Gandhiji in respect of industrialisation, but he was against the application of industry for the purposes of greed. He favoured the establishment of large-scale industries but was of the opinion that those industries should be nationalised.

ARABINDA PODDAR, Specialization and the Problem of Integrated
Personality

Discussion

DR MARGARET CHATTERJEE appreciated the vein of idealism that ran through Dr Poddar's paper but pointed out that there had been in all the epochs of human history specialized thinkers; for example, the medieval priest was a professional being. Specialization is not in itself bad; indeed what is needed today is not less specialization but more of it so that our knowledge and technique may be perfect. Secondly, why should we consider that the scientists alone determine own destiny? All of us together determine our destiny and are responsible for what happens in our world. Thirdly, the phrases 'integrated personality', 'integrated world view' appear to have been used to convey similar meanings. But there is a real difference.

SMT. IRAWATI KARVE said that the men of science are employed by different organizations and the state. As such they have no freedom, they have to do what they are asked to do. So, they cannot be made responsible for the decisions of other people.

DR A. RAHMAN: Dr Poddar had touched upon the role of scientists in Nazi Germany. I would like to know the source of his information. To my knowledge the role was just the contrary, and would be evident if one read the memoirs of Otto Han, or the account of Anger on French scientists under occupation or Crowther's account. Their accounts would tell us of the heroic battle the scientists waged against the forces of oppression.

With regard to the role of the scientists in the final decision to drop the atom bomb on Hiroshima and Nagasaki, the available records clearly indicate

that only Compton was in favour of the decision on the basis of political expediency. Further, the scientists were not made aware of the total war situation. It may also be worthwhile to emphasise the role of scientists in preventing the misuse of these weapons, through bringing knowledge to people to make them aware of the dangers, fighting for nuclear disarmament and for total peace. There is hardly any movement today, be it Vietnam, fight against racial segregation, and the teach-in movements, which has not been initiated or supported by the scientists, where they have not played a leading role.

Specialization is inevitable, be it science or any other subject, specialization is the cutting edge of modern knowledge; but while the specialists have brought us new knowledge and information and have taken us deeper into mystery, there have been others who have given us the perspective. We should expect every one to give the perspective, just as in other intellectual activities it is only the few who have the sweep of imagination to do so.

DR R. RAMANNA referred to the specialization of sciences like mathematics, and held the view that if the view of the world could be compressed into a few lines it would have been much better. For it would enable us to avoid useless information and study.

DR A. APPADORAI said that science is neutral. It is the politicians or the controllers of the state-affairs who apply science for destructive purposes. Scientists do not come in here. In respect of the USA, the decision is made by the President, so whether right or wrong the responsibility is entirely his. Science is committed to human welfare and is being used for that purpose.

DR MULK RAJ ANAND analysed the contemporary situation and commented that we should not engage in an one-sided quarrel with the scientists. He also said that to say that the problem of alienation did not exist in the socialist countries was an over-simplification. Alienation is a very important problem in both the capitalist and the communist countries, which has to be solved.

PROF. N. P. DANI referred to the various movements of the men of science for the restoration of human dignity, and also to the humanitarian efforts of modern physics and chemistry. Lastly, quoting Russell and Bronowski he maintained that the role of science was as creative as that of the arts.

DR J. P. S. UBEROI pointed out that the other side of specialization is interdependence, and one effect should not be considered without the other. Indeed there can be no interdependence without specialization. Secondly, we should not confuse the unity of man in society with the unity of the integrated *individual*. The social unity of man depends on and cannot exist without the specialization of individuals and groups. On the other

hand, the pursuit of integration within individuals conceived apart from society invariably leads in history to a gulf between an elite of fully integrated heroes and other men.

DR NIHARRANJAN RAY maintained that strictly speaking science could not be said to be amoral. For, cultivation of scientific values leads to the enrichment of human values ; and science itself formed a part of the activity of man. Referring to the imbalance that has been created by specialization he maintained that Dr Poddar had stressed only the negative aspect of the problem. But nevertheless, alienation today is a world phenomenon, it exists in both the capitalist and the socialist countries. Some solution has to be found out, the line has to be drawn somewhere. Moreover, some thought has to be given to the problem, how total mechanization of life is affecting our sense of values.

The Chairman commented that though the pursuit of science was an end in itself, it was also committed to human welfare. That goal could not be taken away, but no scientist can by himself promote the human race ; for this co-ordinated efforts are required.

DR ARABINDA PODDAR in this reply accepted the criticism of Dr Rahman and said that the main purpose of his paper was to provoke discussion and to see how our scientists re-acted to the sweeping remarks that are often made against them. He however asked if an international organisation could be formed, such as international community of scientists, and if it was possible for the scientists to adopt a sort of Hippocratic oath to the effect that they would never allow their inventions to be used for destructive purposes. (Several voices were heard saying 'How can this be?', while the Chairman commented that it would lead to satyagraha.)

P. S. SARMA, Impact of Science on Human Nutrition

Discussion

DR A. R. VASUDEVA MURTHY said that if it could be demonstrated that protein was very essential for the growth of physical and mental powers, then it could have an impact on society. These things are not done in our country.

DR J. P. S. UBEROI pointed out that there existed a great many food taboos in India and also in other parts of the world. In the western world, for example, people do not like to drink the blood of animals although it is nutritious. It is no use to label Indian taboos as irrational and wait for them to go. Improvement of dietary should be suggested piecemeal, within the broad framework of Indian culture.

PROF. P. S. SARMA argued that protein takes a great share in the mental efficiency of a child, and helps it in its all-round growth. Of course over-protein may at times cause some diseases, but yet it should form an important part of our food.

The CHAIRMAN commented that there was hardly any taboo against meat in any part of the world. If we are short of protein we should eat all our rats, which are as good as chickens. Many other things can also be added to our food.

P. S. SUNDARAM, Science and the Classless Society

Discussion

At the outset DR A. APPADORAI wanted to know how this paper was relevant to the subject of the Seminar.

PROF. P. S. SUNDARAM explained that we should not leave things to chance. The politicians are not in a position to know what the people need. So their policies become unreal. The natural inequality of man is a fact to be recognised and social structure is to be modelled on this principle.

DR A. R. VASUDEVA MURTHY said that this theory could not be accepted. Men are not like animals, they are made. This view was supported by DR R. RAMANNA and DR NIHARRANJAN RAY both of whom maintained that man could be improved biologically.

PROF. N. P. DANI stressed the point that because of the development of science, society was now in a position to choose what sort of human beings it would have. He said that gene which determines a man's character can with advance in the science of genetics be manipulated, so that we can have a society of bright human beings if we so desire. For this classless society is necessary. Caste prevented the emergence of a vigorous society in India, so caste should go first and then class. The classless society by removing the restrictions would produce better human beings.

MRS. U. E. CHOWDHURY pointed out that the phrase "classless society" was in any case a contradiction in terms in today's context. It had some meaning when it was first used but its relevance has gradually died out.

DR MULK RAJ ANAND pointed out that the development of a human personality was a psycho-social phenomenon. There should be equality of opportunity for all; this alone can lead to the growth of talent and genius, through all experience and depth.

PROF. P. S. SUNDARAM intervened to say that talent was hereditary and character environmental.

DR A. APPADORAI said that the ideal of classless society was Marxist in origin. There is an element of inequality between man and man, but they must also get equality of opportunity. Extremes are, however, always undesirable. There cannot be absolute equality ; it has to be defined in a relative way. In that sense Prof. Sundaram's point is relevant. Referring to Plato's Republic he said that if caution was not taken then even the beasts would one day demand equality in democracy.

PROF. V. V. JOHN defined democracy as a way of identifying talents, and making the best use of the talents. So one should not blur the issues by being guided by unintelligent egalitarianism that held that one man was as good as another for every job.

Summing up the arguments the CHAIRMAN said that it was not important to stress that men are naturally unequal. What is important is to give them equal opportunity to advance. Why should it be that some people would get an undue advantage over others due to accidents of birth. Let Birla's son inherit all the talents, but there is no moral justification whatsoever for him to inherit the wealth accumulated by others. Human intelligence and talent are to be developed, let them not be fossilised by social inequality. Let us not perpetuate social inequality. For this we have to change our value-systems. Science is dumb on this point, so solution must come from other sources.

SECTION B

Science, Politics, Political Ideologies and the State

A. APPADORAI, Power in the Thermo-Nuclear Age

Discussion

DR NIHARRANJAN RAY pointed out that the very nature of international cooperation promoted international conflict. He also suggested that it was normal for a country like India which was a victim of colonialism and suffered from it to be suspicious of foreign aid. Being suspicious means raising questions. There is nothing wrong in it. Professor Ray informed the seminarists that the foreign aid given for research and known technique was in the proportion of one to ten.

DR A. RAHMAN pointed out that fundamental research in developing countries was not being encouraged by the developed nations.

DR R. RAMANNA said that the claim that foreign aid has been disastrous to India because the aid giving countries created a vested interest, was not entirely correct. The fault lies squarely in the way the agreements of aid programmes are drawn up. If one takes sufficient care to have them carefully examined and worded, the country can greatly benefit from such aid programmes. In this way one can avoid loss of aid money through unwanted experts and other unnecessary expenditure.

PROF. P. S. SUNDARAM said that if India could not go alone there was no use in being suspicious of the intentions of others who wanted to help us.

DR G. P. CHATTERJEE held the bureaucrats responsible for policies and actions which eventually led to the miserable utilisation of aid.

PROF. A. N. PANDEYA, while pointing out the difference between science and technology, suggested that India might participate in the international division of work by concentrating efforts on such fields where limited resources could be profitably utilised. He felt that research in social and behavioural sciences in India might be more profitable than research in certain other fields.

PROF. ASHOK GUHA pointed out that the concept of national state was not homogeneous. The state is primarily concerned with the welfare of the

governors and with that of the governed only to the extent that it is in the interest of the governors. He suggested that just as the introduction of gun powder made individual defence impossible and thereby led to the establishment of national states, nuclear weaponry by making national defence impossible made the concept of national state obsolete. But national governments could not preside over the formation of World Government as it could not be expected of them to liquidate themselves.

DR MULK RAJ ANAND pointed out that under the conditions of armament economics no fruitful international co-operation could yet be achieved as was revealed by the recent UNCTAD II Conference held in Delhi. There would be no money to spare from the preparations for death to be used for the preparation of life.

DR M. K. CHAUDHURI drew attention to the class characters of the aid-giving and the aid-receiving states. He suggested that if it was remembered that a particular class ruling one state gave aid to the ruling class of another state, it was easier to understand the character of foreign aid. Foreign aid may not necessarily promote national interest, but it may serve the interest of the ruling classes of the aid-receiving states as well as that of the ruling classes of the aid-giving states.

In reply to the discussion DR A. APPADORAI said that the UNCTAD II Conference showed only that the developed countries wanted not to help the developing countries in the way they wanted. Nevertheless, the developed nations showed their readiness to help the developing nations on their own terms. He agreed with Professor Pandeya that research in social and behavioural sciences in India might be more fruitful. He expressed his hope that the Indian Institute of Advanced Study might play an important role in it. He added that there was no substitute for self-reliance, vigilance and integrity, and that the nation must develop these qualities if optimum results were to be attained in social and economic development.

G. P. CHATTERJEE, Atom and Man

Discussion

DR SATYA PRAKASH pointed out that for biological processes the knowledge of nuclear molecule was more important than the knowledge of atom.

PROF. N. P. DANI questioned the supremacy of atom as it itself was evolved in the process of creation. Besides, he pointed out, consciousness has an important role to play.

In his reply DR G. P. CHATTERJEE maintained that the knowledge of atom

altered the whole picture of our knowledge of this universe. He pointed out that molecules were certainly important for many processes including biological processes. But molecules are made of atoms. In conclusion he indicated that man's future depends on how far man triumphs over atom. The question of supremacy of the atom, as questioned by Prof. Dani, does not therefore arise.

K. P. KARUNAKARAN, Reason and Faith in Gandhi's Political Thought

Discussion

PROF. NIRMAL KUMAR BOSE said that the techniques of Gandhiji were interpreted from various points of view. He regretted that almost all studies on Gandhiji betrayed a lack of knowledge about his ways of dealing with the concrete situations.

DR SATYA PRAKASH raised the question whether or not the description of Gandhiji as a realist was an underestimation of his personality.

DR J. P. S. UBEROI pointed out that Dr. Karunakaran in his paper was mostly concerned with Gandhi's activities, although its title suggested that he was dealing with his political thought.

DR MULK RAJ ANAND said that the autobiography of Gandhi showed that he was a great man and yet a very ordinary human being with faults. He felt that if the Mahatma were alive today he would certainly be against atom bomb and the economy which goes with it.

DR JAMAL KHWAJA raised the question whether or not India's achievement of independence could be attributed to Gandhiji's non-violent method of conducting the struggle for the same.

Commenting on Dr Khwaja's remarks PROF. NIRMAL KUMAR BOSE said that no one made this claim, that it was obvious that India's achievement of independence was due to many other factors.

PROF. A. N. PANDEYA said that we should emphasize the aspect of experimental approach in Gandhi's way of solving a problem.

DR K. P. KARUNAKARAN said in his reply that all prophets were realists and that they were engaged in bitter struggles against what was then considered as momentary issues. He cited Christ and Mohammed as examples. He maintained that there was no doubt that Gandhi's inner voice had some similarity with the intuition of the scientists. But it could not be denied that there was also an apparently irrational element in Gandhi's presentation of the manner in which he reached conclusions. In reply to Dr Uberoi's criticism Dr Karunakaran said that Gandhi's thought could

SECTION C

Science, Art, Religion, Philosophy and History

MULK RAJ ANAND, Relation of Art and Science

Discussion

DR Y. NAYUDAMME held that the conflict between science and humanities is not basic. It can be got over by the right type of approach. Approach to any problem with a scientific attitude is the important thing whether it is science, art or any other discipline.

DR R. RAMANNA was of the view that the connection between science and art can also come about through an axiomatic study of these disciplines. He mentioned that even in mathematics certain axioms have to be introduced for which there seems to be no obvious reason, much in the same way as music and the visual arts, where they are introduced merely because it suited the human mind. In science one studies problems through the differential behaviour of systems whereas the arts look upon it as an integrated process.

DR MULK RAJ ANAND accepted Dr Ramanna's remarks in general with some reservation and some alteration of terminology.

PROF. P. S. SUNDARAM thought that although there is so much of a talk of conflict between science and the humanities, it is not really so much the *conflict* between different disciplines as the widespread *indifference* prevailing between the two that would describe the situation more correctly.

DR NIHARRANJAN RAY referred to an Italian scholar's work on the role of art in the Scientific Renaissance and of a few others where the latest achievement through the reciprocal relation between science and art has been carefully discussed. He said that there is a certain basic similarity between the perceptions of the scientist and that of the artist. But after a certain limit they differ, and differ mainly as regards their ulterior motives. The real question, therefore, is as to how this difference can be bridged. Perhaps, he thought, this might be possible through proper education. And to this problem we must look into, he said.

For PROF. V. V. JOHN the conflict between cultures is very largely due to

an inadequate appreciation of science and humanity of each other. Had this fact been fully realised, perhaps, the result would have been different, and each would have turned out to be the pursuit of advantage for the other.

MR KRISHEN KHANNA thought that the whole question of synthesis has been wrongly approached, since there cannot be any conscious approach towards the synthesis. It is, on the contrary, a process which goes on largely unconsciously. He illustrated his point from the Renaissance and contemporary literature. For a proper assessment of the situation the question of simultaneity and chance and so many other factors has to be taken into account, he said.

DR MULK RAJ ANAND accepted Mr Khanna's analysis with slight modifications of his premises that there can't be a conscious approach towards synthesis. Dr Anand felt synthesis is consciously unconscious.

DR SATYA PRAKASH made three points :

- (1) There is no conflict between science and art. But the domains are different.
- (2) In art the element of subjectivity is primary.
- (3) Science basically represents the head ; art the heart.

DR G. P. CHATTERJEE talked about the multiplicity of cultures in the human society. In nature also one finds varieties and multiplicities of pattern and of forms and functions. Yet there is law and order and integrated behaviour. In human society today, similarly, the problem is not diversity but disintegration. The solution lies in integration, as in nature, of different patterns, forms and functions.

DR A. RAHMAN supported Mr Khanna's contention by giving two further illustrations. Science and art are both striving to read and create new relations, he said.

MR KAILASH KUMAR referred to Dr Uberoi's remarks on the paper of Dr A. Poddar on a previous day as of great significance to the issue. It is one thing to emphasise the similarity, but it is much more important to consider the form in which this is done in these two disciplines.

To the issue raised by Dr Anand's paper: Can the science of design provide a synthesis between science and art by improving the objects of daily life and introducing aesthetic values in the things of use ? — There were no comments from the participants of the Seminar.

On the question of the possibility of a third culture incorporating the values of independence, originality, and dissent, which Dr Anand contended were shared both by science and art, DR J. P. S. UBEROI felt some confusion at the very thought as also at the actual prospect of a synthesis in educational and research institutions. What is crucial is its desirability. Is the synthesis desirable ? And if so, from whose point of view ?

not be divorced from his activities and that he had not thought independently of his actions. He added that although India's independence was not the result of non-violent struggle, independent India was at least free from the climate of violence that existed in Indonesia and Algeria after their achievement of freedom, as a result of the non-violent movement led by Gandhi.

PROF. A. N. PANDEYA pointed out that the difference between science and art relates primarily to the way they experience facts. Science, by and large, is guided by a fixed procedural rules ; to be scientific is to be *according to rule*. But in art there is no such rule. It is mostly subjective.

MR. KAILASH KUMAR pleaded for a more positive understanding of what is called 'synthesis'.

DR A. RAHMAN posed the question: Is it possible to synthesise ? The answer, he said, is to be found at two different levels. And the two answers are different. Possibility of synthesis at the individual level receives an affirmative answer from him, but on the institutional level his answer would be an emphatic 'No'.

DR MULK RAJ ANAND in his reply complained about the inordinate apathy and indifference that prevails amongst the intellectuals of today about art. There is a general lack of appreciation of the objects of art, he said, except superficial and fashionable gallery-going. This must somehow be got over and art-sense inculcated from childhood onwards in some way. What is wanted is an open-mindedness on our part from each side. The third culture must be understood in the true sense, he said, to be the culture of the whole man of tomorrow. There is a vast dying culture today under the aegis of the age of fear.

MR. KRISHEN KHANNA commented that the relation between art and science is much more organic than we realise. It must be *lived*.

DR MULK RAJ ANAND accepted Mr. Khanna's remark with slight modification, again, to the extent that he thought the creative process must be analysed both in art and science to find out exactly what happens in either discipline.

DR MARGARET CHATTERJEE said that scientific art-forms did not exhaust our total aesthetic experience. We need to broaden our conception of the 'aesthetic'.

U. E. CHOWDHURY, *The Dilemma of our Times*

Discussion

DR MARGARET CHATTERJEE argued that accepting that there has been a change in the code of conduct, it could not be denied there *is* a certain code of conduct. She presented a set of three points in support of her argument.

MR KAILASH KUMAR remarked that this is a familiar sort of complaint that the 'code of conduct' of younger generation has declined. This never leads to any understanding of the changes taking place.

DR A. APPADORAI declined to accept the suggestion of Mr Kailash Kumar, since Mrs U. E. Chowdhury has important constructive suggestions towards the end of her paper.

DR MULK RAJ ANAND remarked that the paper very clearly demonstrates that the restoration of human values is the crying need of the time. We must try to examine the possibility of a new Humanism in this regard, which is above both science and religion. DR J. P. S. UBEROI argued that the dilemma described by Mrs Chowdhury is incomplete in so far as it does not take account of the many major alternatives. He illustrated his point with reference to the facts of nationalism and partition which are vitally relevant to our contemporary social life. The role of religion in the rise of Indian nationalism was a positive one, but its role in Partition was negative.

MRS. U. E. CHOWDHURY accepted that she has probably oversimplified some of the issues.

G. D. JOGLEKAR, *Science and Spirituality*

&

SATYA PRAKASH, *Science as Religion of the Future Man*

Discussion

DR JAMAL KHWAJA said that the question: How can religion be transformed into spirituality? ought to be discussed.

DR A. APPADORAI suggested that the issue of the beneficial aspect of the mutual respect of science and religion for each other might be taken up.

DR JAMAL KHWAJA clarified his meaning at some length and suggested that in order to improve our educational system we must prescribe a kind of valuational geography and scientific methodology in our schools.

PROF. YUSUF HUSSAIN KHAN asked if ethical ideal is possible unless there is a theistic order?

PROF. N. P. DANI selected some quotations from both the papers to show that in both, starting from a purely scientific basis, we gradually pass on to the region of what has been called spirituality. And going deeper and deeper into this realm we find ourselves entirely lost in it and our scientific foundation with us. He illustrated his point concretely.

DR MULK RAJ ANAND remarked that 'spirituality' and 'Cosmic Consciousness' have become cliches.

DR G. P. CHATTERJEE appealed that the tremendous power at the command of science be utilized in the understanding of the inwardness of man—his 'self'.

DR J. P. S. UBEROI pointed out, regarding Dr. Satya Prakash's paper, that the term 'Islam' is preferable to 'Mohammedanism'. Muslims prefer the former. Regarding Dr Joglekar's paper he questioned the conclusion that the author has drawn from the figures that he has given. The figures quoted were all absolute figures, and no sources or definitions were given. In any case it is extremely difficult to get equivalent statistics on such questions from different countries for a systematic comparison. Secondly, even if the phenomenon could be established as Dr Joglekar assumed, we must ask if it is a product or a by-product. Thirdly, beyond a solitary reference to UNESCO, the paper followed the tradition of several other papers presented which completely ignored the institutional frame-work of both science and spirituality. This was unsatisfactory.

DR K. P. KARUNAKARAN pointed out certain limitations in the analysis presented by Dr Khwaja, and illustrated by means of concrete cases.

DR NIHARRANJAN RAY asked: Can ethicality be inculcated by giving lectures in the class-room? Morality, Dr Ray thought, has to be *lived*. So those who thought of class-room lectures on the morals of a nation, are under a hopeless illusion.

DR A. APPADORAI supplemented Dr Ray's remarks by saying, "An example is better than a precept".

SWAMI PRANANANDA supported the same point by saying: What you *are*, speaks louder than what you speak. Liberating spirituality from the undesirable types of dogmatic religious forms—this is what is more urgently needed, he said.

DR M. K. CHAUDHURI said that if codes of morality follow from certain social relationships then it can certainly be explained and taught.

DR A. A. KRISHNAN said that matter is only a condensed form of mind and mind is a condensed form of what is called spirit. He tried to illustrate his point through an analogy.

PROF. V. V. JOHN remarked that no one would deny that an example in life is better than just teaching them through lectures. But, he said, we should recognise the value of rebellion of the younger generation from the mere practices of values without any intellectual basis. An intellectual basis must always be there to supplement our practices of ethical behaviour, if for nothing else, at least for providing the *rational satisfaction* of our youth.

SMT IRAWATI KARVE thought that the whole discussion is over the eternal quarrel between *form* and *content*. Morality changes, yet it changes not: accordingly as we look at it from the point of view of form or of content.

MR KAILASH KUMAR supported Smt Karve's remarks.

DR J. P. S. UBEROI said that at present scientific methodologies are being neglected in studies of religion by disregarding the *discontinuities* altogether

while glorifying even the slightest *continuities*. We must study differences as well as similarities before our approach can be called scientific.

SWAMI PRANANANDA thought that time will prove the vital need of co-operation between the two realms.

In his reply DR G. D. JOGLEKAR accepted the wisdom of this statement "example is better than precept". Without minimising the importance of scientific approach which he said he himself values greatly — he only suggested about trying the other approach also.

DR SATYA PRAKASH remarked that to the question: Can morality be taught? his answer is both 'yes' and 'no'. He illustrated from actual practice. To the question: Can ceremonies be given up? his answer was 'not fully'. In some form or other it has a tendency to continue in our society. Without having any metaphysical importance these ceremonies have an important social and regulative function also. About the importance of religious texts, he said: There are two types of texts as regards their nature: 'What we are' and 'What we aspire to be'. To the question: Can there be ethics without God or religion? he said that just as we can move about without believing in the Law of Gravitation, so we can very well be moral without referring to God. But this does not disprove the existence of God.

JAMAL KHWAJA, Science and Religion

&

A. A. KRISHNAN, Science, Philosophy and Religion: the three paths to equilibrium

Discussion

DR A. APPADORAI asked Dr Khwaja to differentiate between the existential and conceptual interpretations of the statement: "Conscience is a spark of the Divine in Man".

PROF. A. N. PANDEYA wanted to know from Dr Khwaja if there is not a relapse, in the case of Dr Khwaja's treatment of the problem to the same sort of a reductionism, which Dr Khwaja himself has repudiated. His model of religion is not merely a cognitive enterprise but it is also largely a fact of a larger experience.

DR JAMAL KHWAJA refuted the charge of reductionism by saying that he had never suggested that religion is just cognitive and referred to the relevant pages of his paper in support.

DR MARGARET CHATTERJEE pointed out that 'Existence' and 'Existential

interpretation' are not identical, as Prof. Pandeya thought. She suggested to Dr Khwaja the term "secular morality" in place of his "scientific morality". This in turn is to be distinguished from "sacramental morality", i.e., a morality based on religion.

DR JAMAL KHWAJA while accepting the suggestions emphasised the inevitability of some variety of value-oriented morality.

DR A. RAHMAN complained that the writer has taken religion as a philosophical abstraction only. But it is imperative to bring it to bear on the social problems in the actualities of life we live.

DR J. P. S. UBEROI illustrated from Dr Khwaja's paper some inconsistencies and divergences between the existential and scientific interpretations.

PROF. N. P. DANI thought that when properly worked out scientific morality may have a great possibility.

DR MULK RAJ ANAND cautioned that pure scientific morality may at best be only partial, in view of the fact that science is limited to a certain restricted aspect of life.

PROF. NIRMAL KUMAR BOSE referred to the Wolf Boy case (which came up during Dr Khwaja's discussion) and mentioned about the scientific studies made on such cases, in our own country and elsewhere, and also about its implication on the problem at issue.

Discussion on the first issue of Dr Krishnan's paper was initiated by DR G. P. CHATTERJEE's inquiry as to the type of "science" which Dr Krishnan had in mind while discussing it in his paper. "Is it just physical science?" he asked, and emphasised the conception of a 'spiritual science' which, like physical science, is also a form of discipline and in fact more fundamental.

DR A. A. KRISHNAN while basically accepting Dr Chatterjee's suggestion said: We must distinguish between the physical and the mental, and between the mental and the spiritual in man.

DR MARGARET CHATTERJEE discussed certain possibilities which follow from giving different answers to the first question raised by Dr Krishnan's paper. Mr Khanna denied the very basis of the question. Dr Krishnan reacted by saying that it all depended on how one looks at a problem.

DR A. RAHMAN wanted to know if peace of mind was really a worthwhile pursuit.

SWAMI PRANANANDA's view (with regard to the basic question of Dr Krishnan's paper) was that to be able to adjust oneself to one's situation is the only way to achieve peace of mind.

DR NIHARRANJAN RAY spoke of the inadvisability of formulating the questions arising out of each paper by their writers themselves. He felt that this process has a tendency to unduly restrict the discussion to a certain limited direction while there might very well be important aspects of the

problem which might not have occurred to the author himself, and on which fruitful discussion is not only possible, but, perhaps, desirable.

A. RAHMAN, Science and Religion in India

&

PHILIP H. ASHBY, Functions of Religion and Society in the Age of Modern Science (presented *in absentia* by Dr A. Appadorai)

Discussion

PROF. P. S. SUNDARAM remarked that the paper of Dr Rahman suffers from what seemed to him to be an initially based assumption that there is an inevitability that science and religion will always conflict. He thought that there need not be, in every case, an either/or relation holding between the two, as was the case in days past. With the open-mindedness of the scientists the conflict has been considerably minimised and we might do much more in this direction.

DR SATYA PRAKASH spoke of the actual and possible growth and innovations in religion.

MRS IRAWATI KARVE thought that religion has been taken in the paper in a double sense, and naturally, in the subsequent discussion some confusion has cropped in, thus vitiating the analysis itself. Religion taken in an institutionalised sense is one thing, and religion in a purely theoretical sense is quite another. The fundamental questions of religion, she said, has remained the same, but the institutionalised forms of it have been subjected to growth or change.

SWAMI PRANANANDA said that change in religion is possible, but whether we can call it "growth" or not is a different question. Religion, he said, is progressively trying to adjust itself to the development of science and society, of which the activities of the Ramakrishna Vivekanand Society is a significant example.

DR G. P. CHATTERJEE said that religion in the true sense is as much dynamic as science (and in fact more so). Like science, it is an everlasting struggle for search after truth. And more so, because it strikes its roots very much deeper (because of its emotional involvement). It is an everlasting struggle for "Being" and "Becoming" — becoming the Good and the Godly, leading eventually to God-attainment.

DR M. K. CHAUDHURI thought that religion did not grow in a scientific manner. It remains as non-scientific as it ever was. There is a perpetual antagonism between science and religion.

DR NIHARRANJAN RAY said that the basic truth which underlies these issues is the fact of man's eternal quest for knowing himself. Such a quest, he thought, will ever remain, since it is a part of the very constitution of the human nature. And the moment man ceases to go on in his effort to unravel the sense of mystery—with the loss of this sense of wonderment of his—he ceases to be human.

DR K. J. SHAH did not quite agree with all that Prof. Ray said. The forms of the answer of the religious quest may be the same but the content is not only changeable but is bound to change, for, each individual will have to spell out the answer for himself in each individual experience.

MISS C. B. MUTHAMMA said that the problems as formulated by the author has been simplified almost to a fault. The more significant issues were certainly not these, she thought.

DR MULK RAJ ANAND supported Miss Muthamma. He declared as ridiculous the idea of a continual dichotomy between science and religion which had been advocated by Dr M. K. Chaudhuri in his remarks. Modern science is a part of contemporary philosophy, he claimed. Institutionalised religion is the enemy of both science and philosophy. And science, he thought, has not only to co-exist with other disciplines but to go on reinterpreting them. In that way the postulates of religion may be questioned and destroyed, leaving room for creative thinking.

PROF. ASHOK GUHA said that there was change in religion. But the process of change is held back by the existing religious establishments. About this, he said, there seems to be a general consensus. Both science and religion are involved in the interpretation of certain domains of reality, about the correctness of which it is difficult to say anything with certainty. The Newtonian interpretation, we know today, is not correct. And no one knows if Einstein's interpretation also will continue to prove correct in times to come. Similarly about religion.

MR KRISHEN KHANNA spoke of a certain dogmatism underlying the remarks made by Dr Rahman and other participants in the course of this discussion. And he seriously questioned the justification of such assertions. One must first seek to understand a certain discipline (if not to accept it), before one can have a right to make sweeping statements about the different basic facts concerning different types of experiences. He referred, as an example of this, to Dr Rahman's criticism of personal religion.

DR R. RAMANNA could not quite agree with Dr Rahman that there is no such thing as a sixth sense. Without calling it as such we have to admit that there is such a thing as "intuition" in mathematics, science and the arts.

DR MARGARET CHATTERJEE said that religion as such need not be backward-looking as stated by Dr Rahman ; it may, however, be so when it is in an

institutionalised form. She cited the eighteenth century attitude to miracles as an example of the impact of science on religion. Science gradually eroded the area of the miraculous. Berkeley pointed out that only if we regard God as a Power who interferes in natural laws does the association of this agency with regularity become unacceptable.

DR K. P. KARUNAKARAN argued with a fund of illustrations from India and the west that the more important thing is to see the *link* between science and religion rather than their differences in the context of society and social progress.

PROF. V. V. JOHN remarked that all these obsessions about institutionalised religions is very unreal. Agnosticism may be the fashion in vogue in the country today; but it can hardly be taken to be true for that reason. He refused to believe that our institutionalised religions are retarding our progress. What, on the contrary, is doing this is our tendency to minimise (in the name of progress), the truths of such religions, he said.

PROF. A. N. PANDEYA said that logic is a science. And logically analysed the assumptions of an either/or logic in Dr Rahman's statements is itself quite primitive and is hardly true in the actualities of life. Thus, Dr Rahman is guilty of a gross logical fallacy having allowed this basic dichotomy to run through his entire paper.

PROF. ASHOK GUHA questioned Prof. A. N. Pandeya (in an earlier context) if there is really anything logically wrong in the manner Dr Rahman has posed his problem. Empirically, Dr Guha thought, that Dr Rahman was basically correct in the context of actual life in the present society.

In his reply DR A. RAHMAN said that the relation of science and religion is merely different co-ordinations in different points of time. He accepted, however, that he may not have expressed his points quite effectively. The *nature* of institutionalisation is all that matters. The way we work it out is more important in such cases. And in our actual society we experience something which goes against what Mr. John says.

PROF. V. V. JOHN gave some concrete factual illustrations to support what he had stated.

DR A. RAHMAN confessed to a certain looseness in his argument. Referring to Prof. A. N. Pandeya's argument he pleaded that his was a functional approach and not a cold static analysis. Whether these developments have taken place in the form of reactions or conflicts or from the inner mechanism of religion itself, needs careful study.

DR A. APPADORAI sought more clarification of the concept of what Dr Rahman called the "inner mechanism".

DR A. RAHMAN illustrated at some length as to what he had actually meant, from the scientific and other fields.

DR M. K. CHAUDHURI expressed his agreement with Dr Guha and his sharp difference from Mr John in his main contentions.

DR J. P. S. UBEROI thought that Dr Rahman had hardly referred to the concept of religion that is really *accepted* in the particular society under discussion. The significant approach of the social scientist had been entirely missed. He suggested that account be taken of the very valuable contribution made by the sociology of religion in the course of the last eighty years, which viewed religion as a system of symbolic thought and actions. Institutionalised religion has not always been a supporter of society, but, on the contrary, such religion can constitute a critique of society. He illustrated this from the role of Islam as a religion in India in its relation to society and the State.

DR A. A. KRISHNAN thought that the particular type of answer that follows depends entirely upon the types of questions asked.

SWAMI PRANANANDA regarded that religion, far from being contradictory, is essentially complementary to science. Whether it is science or religion, when put in insecure hands certainly does great harm to society, he said.

R. RAMANNA, On some Philosophical and Sociological implications of the Discoveries of Modern Science

Discussion

DR A. APPADORAI asked what Dr Ramanna's reaction as a scientist would be to the statement "God exists". Would he call it scientific?

DR R. RAMANNA confessed his predicament about such a question and replied by citing the classical answers of two very great mathematicians of the 18th century, Laplace and Lagrange, who replied to a question put by Napoleon that since they had both written books on celestial mechanics how it was that neither of them has referred to God. Laplace replied: 'I do not need that postulate, Sir'; and Lagrange replied: 'A very useful assumption, Sir'.

DR MARGARET CHATTERJEE pointed out that Russell had written about the beauty of mathematics. The origin of this attitude goes back to Pythagoras' theory of numbers. The Greek conception of 'harmony' was based both on music and on mathematics. She enquired whether incompleteness of systems is to be equated with inconsistency. She raised some points with regard to Indian, Japanese and western tonal music.

DR G. P. CHATTERJEE supplemented Dr Ramanna's point on beauties of nature by citing a number of illustrations.

DR MULK RAJ ANAND asked: Do you use beauty in the sense of 'coherence' or in some other sense?

DR R. RAMANNA did not answer this question.

MR KAILASH KUMAR remarked that while Dr Ramanna has shown certain inconsistencies in mathematics, one should be careful about interpolating similar arguments in respect of philosophy.

DR R. RAMANNA fully accepted the corrective of Mr Kailash Kumar, and said that in applying mathematical logic to philosophy, one must be very careful in the interpretation of the terms. Answering DR MARGARET CHATTERJEE he said that inconsistencies may arise because the theory is incomplete. In fact, all inconsistencies must be due to incompleteness, but some are more fundamental than others. The inconsistencies in mathematics seem to be of a very fundamental nature.

DR NIHARRANJAN RAY said: The root of 'pause' (व्रिषम्) in Sanskrit comes from (रम्), meaning 'to please'. Here is an example of apparent inconsistency.

SMT IRAWATI KARVE asked if mathematics can explain the existing reality of the sciences, what other theory could exist except the one we know in the presently understood mathematics.

DR R. RAMANNA said that while set theory is very general it can be applied to Euclidean and non-Euclidean systems; the fact that one has to use an axiom, i.e., the axiom of choice, arbitrarily suggests that there may be other logical systems of thinking, but what such logical systems can be is not quite well understood. Regarding Dr Joglekar's question about particles which can move faster than the velocity of light, Dr Ramanna quoted the work of Sudarshan where without contradicting the theory of relativity we can have particles moving faster than the velocity of light, provided that the mass of these particles is imaginary.

PATRICIA UBEROI, Mr Science and Mr Democracy: Aspects of Chinese Modernization

Discussion

MRS U. E. CHOWDHURY expressed the opinion that the paper gave too facile an impression of the whole Chinese cultural movement. What the paper suggests is that the Chinese development was a straight-line development. Unless the paper was substantiated by more historical facts, its thesis could not be accepted.

MRS PATRICIA UBEROI replied that her paper, as its title indicated, was of

limited scope, referring only to certain specific aspects of China's modernization and response to western influence. She was aware of all the other movements to which Mrs Chowdhury had referred, but she did not feel them to be relevant to the limited frame of reference of the paper. Mrs Uberoi said that she would willingly supply an outline of the historical facts on which the thesis of the paper was based.

DR M. K. CHAUDHURI supported Mrs Uberoi's statement that a paper of such a limited scope did not need to bring in the large number of facts to which Mrs Chowdhury had referred.

DR K. P. KARUNAKARAN commented on two points: (1) The exposition given of Confucianism presents this system as somewhat secular, and (2) why was it that revivalism flourished in a country like India, but was rejected in China?

With regard to the first comment, MRS PATRICIA UBEROI agreed that Confucianism was indeed to some extent a state, political or secular philosophy, in contradistinction to the two other Chinese systems, Taoism and Buddhism, which contained no prescriptions for political action or government. The Confucianist philosophy of government, as it was interpreted in Imperial China, was not identical with the original philosophy of Confucius. Referring to Dr Karunakaran's second comment, Mrs Uberoi said that revivalism had been tried in China in the late nineteenth century, but that it had proved a failure. As a result, the intellectuals of the early years of the twentieth century were impatient to try more radical solutions.

DR NIHARRANJAN RAY remarked that the Chinese in the twentieth century had developed a great appreciation for scientific values and technical knowledge, but that no similar revolution had taken place in Indian thought.

DR K. P. KARUNAKARAN supported Professor Ray's point by citing fresh examples.

MR KAILASH KUMAR, analysing the situation with reference to China, Japan and India, said that there were three distinct historical stages in the reaction of under-developed nations to western science: (1) complete rejection of science-based values; (2) an attempt to reach a compromise between traditionalism and science; and (3) total rejection of tradition in favour of a scientific attitude to life. India had failed to reach the final level.

DR J. P. S. UBEROI taking up the point of Dr Niharranjan Ray and Dr Kailash Kumar referred to the three important implications of the paper. (1) Confucianism had lost its hold because it was proved useless or inadequate in practice. The pragmatic temper was uppermost in the change of ideology in China. (2) The kind of nationalism that the Chinese had was different from the type that we had. The Chinese accepted that they had to be internationally-minded in the interests of their nationalism itself. This had lent to their nationalism a special colour. (3) The particular con-

ception of the relationship between ideology and the state that prevailed in China was not present in our country. In traditional India, Hindu and Muslim, different institutions were important as carriers of ideology.

In conclusion, MRS PATRICIA UBEROI summed up her paper as an attempt to illustrate the process whereby "science" or a science-based philosophy had become the twentieth century Chinese substitute for religion.

SECTION D

Science and Human Values

S. C. BISWAS, On Science and Human Values: a study in the analysis of values underlying science, philosophy and religion

&

RUKMINI DEVI ARUNDALE, On Science and Human Values (presented *in absentia* by Mrs U. E. Chowdhury)

&

SWAMI PRANANANDA, Certain aspects of the impact of Science on Society

Discussion

DR G. P. CHATTERJEE complimented Dr Biswas on his analysis and synthesis of the situation. He pointed out that the scientist does not claim he can predict everything; he does admit areas of unknowability.

DR SATYA PRAKASH said that the three-fold classification into 'science', 'religion' and 'philosophy' should be replaced by a two-fold distinction between science and religion. Philosophy should be classed under science.

DR MARGARET CHATTERJEE appreciated Dr Biswas' plea for a wider connotation of the term 'experience'. People like William James and Rhiley have investigated religious and extra-sensory experiences, respectively, in a scientific way. A problem did, however, arise when one thought of the relation between one kind of experience and another. She suggested that both science and philosophy were inspired by the spirit of criticism and construction. Both of these could well inspire our thinking about society. With reference to Dr Satya Prakash's point, she thought that contemporary philosophy of analysis *was* scientific. Earlier philosophy or metaphysics resulted in propositions of high generality. The scientist also deals with propositions of high generality but the two types of propositions were not the same.

DR Y. NAYUDAMME thought that words used in Dr Biswas' paper betrayed

a prejudice against the scientists, but it was thought by many that he had torn these words out of their context in the paper. This particular point was not pursued.

DR MULK RAJ ANAND did not think that experimentation in science is encroaching upon other areas as long as intuition was admitted as a possible approach in all disciplines. We should not lose ourselves in terminology. Philosophy must be allowed to consider the totality of human life. Art is much more intricate, as it is a matter of sublimation. Art has become the weapon of creative humanism. Art is a part of the method of deeper understanding of the psyche. There is a paucity of art experience in all classes and sections of life in India.

The CHAIRMAN pointed out that the point of Mrs Arundale's paper was that art creates sensitivity in people. Perhaps philosophy does this too.

DR A. RAHMAN thought the papers presented were too general to be relevant to our present crisis. Science tries to inculcate respect for fact in contrast to the vague term 'truth'. This is connected with a healthy scepticism. There is a trinity of situation between question, fact, and answer. The scientist's findings are subject to criticism by the scientific community. The scientist accepts progress and change, i.e. that there is no such thing as final truth. Are these values new or are they not precise manifestations of earlier values? Can they help us build a new society?

DR M. K. CHAUDHURI asked whether the gaps in our knowledge must necessarily be supplemented by concepts like that of 'God'; was this not unscientific?

DR A. APPADORAI felt that the relation of the various disciplines to the question of values had not been brought out yet. What is the attitude of each of them for example to the value "Love"?

SMT. IRAWATI KARVE, commenting on the concept of 'fact' said that an animal's suffering is undoubtably a fact. Mrs Arundale, in her paper, was *reacting* to facts and not disregarding them. The number of people who have died through scientific discoveries may be more than the number saved by medicine and medical practices based on experiments on animals. Disregard of facts may lead to an imbalance in ecology which may eventually be as destructive as the atom bomb. Heart-transplanting poses new value problems. There are new experiments which tell us that animals who have acquired a certain skill, when killed and fed to other animals, impart this skill to the entangled animals. This opens up a vista of horror. The imperative is that we should evolve a value system such that (1) humans can live together, and (2) humans and non-humans can live together in a balanced way.

PROF. P. S. SUNDARAM thought that we should not make the mistake of

applying the same method to diverse phenomena. For example, literary criticism is not comparable to Euclidean geometry.

PROF. P. S. SARMA thought that Mrs Arundale had succeeded in bringing out the question of the right of non-human organism to exist in a world of increasing experimentation. Science does inculcate moral values, but the scientific spirit is hardly prevalent in this country. The humanist and the scientist need to tackle the problem jointly.

Dr Appadorai was informed by DR SATYA PRAKASH that science accepts 'love of fellow men' as a postulate. But how it was to be promoted has not yet been answered.

DR NIHARRANJAN RAY pointed out that the respect for fact pre-dated the scientific era. He cited, for one example, Roman jurisprudence. Commitment denotes detachment no doubt, but exclusiveness is unscientific.

DR MARGARET CHATTERJEE said that the human family was a single species but within this one species there is great differentiation, mentally and culturally. Differentiation is the law of the biological realm. Even if we are able to achieve common physical conditions in various parts of the world these cultural differences will remain. Therefore, Swamiji's point about people accepting and sharing each other's experience is most important. Science by itself cannot bring about sympathy and the spirit of sharing, even though it can certainly promote physical modes of communication.

DR A. RAHMAN considered that our civilisation has enough strength to meet the challenge of the times. The trouble is that our scientists are not encouraged to enter the fields of history, art, etc. They should not be barred from these areas.

DR MULK RAJ ANAND then suggested that the answer from the side of 'art' to Dr Appadorai's question would be this: The sharing of art experience by as many as possible is a real means of promoting fraternity and solidarity.

In answering to various questions raised in the discussion DR S. C. BISWAS made the following points: Sometimes the scientist *does* make predictions; and so far as he does it, the remarks made in his paper become quite relevant and effective. Accepting Dr Margaret Chatterjee's comment on the question of the relation between experiences, he said that the various experiences *are related*, he did not deny this; but to work out the details and the nature of these relations was certainly beyond the scope of his paper. In reply to Dr Rahman's remarks Dr Biswas said that he has himself emphasised the urgency of 'respect for facts' more than anybody else; but then facts need not necessarily be empirical facts. There is a whole range of facts, and empirical facts are only one type of them, he said. And the point of his "feather" example was that the human element, which was so much more complicated than this, can never be fully predicted. He further pointed out that he has at no stage suggested new types of values,

but has only tried to see the existing ones in a particular perspective. With reference to Dr Anand's comment, Dr Biswas said that he has never complained of science's encroaching upon other domains; on the contrary, he would rather welcome the men of science with a broader outlook to try to look beyond their set domain into others, and with an open mind to recognise the fact of their being significantly there. That precisely was his point, Dr Biswas said.

SWAMI PRANANANDA in answering to questions put to him said that whether people come together or not depends on various values, otherwise there would be a meaningless monotony in society. The concept of oneness of existence is basic to Indian thought. This would provide one answer to Dr Appadorai's question.

A. R. VASUDEVA MURTHY, *A Scientific Approach to the Study of Ancient Indian History*

Discussion

DR A. APPADORAI said that Dr Vasudeva Murthy raised the question of the application of Marxist theory to ancient history. How did the mode of production affect distribution? For example, USSR and USA had the same mode of distribution but different modes of production. The curse of the caste problem is reflected in marriage relations. Even in this century marriages are largely based on caste.

PROF. V. V. JOHN thought that matters like religion, incidence of wars, etc. could not be brushed aside by the historians.

DR B. L. ABBI challenged the view that the prevalence of hand-made pottery was associated with matriarchy.

DR NIHARRANJAN RAY confirmed this point. Scientists however have given archaeology and anthropology many new tools and techniques. Marxist tools can often be used to advantage, as say, Dr Kosambi did. The methodology, however, cannot be used in all situations. A recession from a commercial to an agricultural economy cannot be explained on Marxist principles, and yet such recessions have often taken place in Indian history. The Marxist can only account for the shift from a commercial to a mercantile economy. Indian literature records nostalgic laments for mercantile prosperity in certain periods of Indian history.

PROF. N. P. DANI wanted to know whether anthropologists differed with Dr Vasudeva Murthy regarding his thesis.

In answering questions DR A. R. VASUDEVA MURTHY said that other inter-

pretations of history were not excluded by him. He insisted that the mode of production did generate a certain mode of distribution and that he had consulted anthropologists on the examples he had given.

The CHAIRMAN concluded the session by mentioning the utilisation of science in archaeological research in the Kaveri delta.

SECTION E

Sociology of Science

Before the papers for the day were taken up, DR NIHARRANJAN RAY posed the following problems before the seminarists. During this seminar, he said, there have been two distinct trends of thought ; one stressing the over-all importance of science, while the other, represented largely by people from the humanities, emphasising the significance of other modes of thought. He posed the question whether such a polarity was necessary. Since it was a session on sociology of science, he added, the seminarists should discuss whether this microcosmic polarity was a reflection of the polarity one finds in social-macrocosm. The second problem, according to him, was the necessity to examine the present social situation in India. There was, he said, an unmistakable resistance amongst certain sections to the attitude of science and technology. He enquired how this resistance was to be broken. Dr Ray also pointed out that the viewpoint which considers that only the measurable is knowledge belongs to the eighteenth and nineteenth centuries. He added that early twentieth century has given up that notion and recognised the validity of other facts and situations.

Dr Ray then referred to the situations obtaining in Russia and China, and said that the education systems in these countries aimed at building up new attitudes. In this connection he also mentioned Nehru's experiment of establishing Vigyan Mandirs in villages. The experiment failed, according to him, because of the bureaucracy as well as because of the reluctance of scientific workers to work in villages. He said that it was essential to build up a broad scientific base as a pre-requisite for a good super-structure of science. To achieve that he thought we should start teaching science and mathematics early in school.

Thereafter, the CHAIRMAN of the session sounded a note of caution by saying that we should not over-emphasise science, because we don't want to create a special Brahmanical caste of scientists. Being scientific and rational meant, he said, respecting other peoples' viewpoints. Culture, he added, was based on that principle.

KAILASH KUMAR, *The Esoteric Nature of the Sciences and its Consequences*

Discussion

DR A. RAHMAN referring to Dr Niharranjan Ray's earlier remarks commented that the two attitudes discussed by Dr Ray were related. He posed three questions:

1. Why did not the scientific revolution take place in India inspite of some sort of scientific activities in ancient and medieval India?
2. What base has India built in science and technology and what are its characteristics?
3. What role is this base able to play?

Elaborating on his questions he emphasized the necessity of studying the character and role of science in ancient India including its relationship with society. With regard to present-day efforts, he posed the question whether science was enough for the transformation of society. Quoting figures, he showed that out of 3 lakhs of scientists 50,000 were doing some researches, publication being one of their main activities. He wondered whether they constituted a scientific community with a code of conduct. He also posed a question regarding the correlation between investment in science, national growth, and industrial development. He also pointed out that we have built up an adequate know-how.

DR NIHARRANJAN RAY, intervening in the discussion, pointed out that the average circulation of any scientific journal has never been more than 1000. Disagreeing with Dr Kailash Kumar, he said that it was not true that teachers were not organised in trade unions. Actually, all the significant improvements were due to the activities of teachers' trade unions.

DR A. R. VASUDEVA MURTHY wanted to know what practical steps Mr Kailash Kumar would suggest for organising professional bodies and making them effective.

DR K. J. SHAH joined issues with the author of the paper saying that social considerations were necessary in understanding technical problems which could never be decided purely by technological standards.

DR K. P. KARUNAKARAN posed the question about the reactionary role of intellectuals in underdeveloped countries. He enquired whether it was in the nature of the profession and why was there such a complete divorce between so-called intellectuals and social problems. He cited the instance of negative reactions of Muslim and Nambuderi scholars to the new system of education introduced by the British. The modern intellectuals, according to him, were disinterested in the important social development taking place in the country e.g., in Madras, Bengal, and Kerala.

Replying to Dr Ray's comments about teachers' unions MR KAILASH KUMAR said that such organisations could be more active. In his reply to Dr Murthy he agreed that so long as the dual membership of Indian and foreign learned bodies continued, the Indian learned bodies would not be effective; since the recommendations of the Royal Society, for instance, would be more acceptable compared to those of local societies. He could not suggest any solution.

The CHAIRMAN at this stage intervened to enquire whether it was because of slavishness in our blood. Thereupon MISS MUTHAMMA remarked that this question should not be taken up in isolation. It was, she said, not a question of national slavishness but one of absence of national policy and vision.

DR A. APPADORAI was interested in knowing whether scientific research was related primarily to the needs of people or were inspired by outside ideas and inspiration. The latter, he said, are useful, but they do not percolate sufficiently. He thought there was not adequate co-operation between industry and research.

MR KAILASH KUMAR in his reply said that American engineers had better reputations than their Indian counterparts, and that the latter got their verification from the former. Referring to Miss Muthamma's point, he said that Stalin had a definite science policy which condemned cosmopolitanism of scientists, but, later, the Russians had to go back to international standards. Replying to Dr Karunakaran, he said that class origin of intellectuals was not the only explanation: the type of activity was also important. He further observed that even Soviet scientists must refer to American and other standards. He said at the end that in any revolution risks have to be taken. For example, the Soviet policy brought forth people like Alexandrov and Landau who were internationally recognised, but it also brought forth Lysenko who was not, although he also did useful work.

DR G. P. CHATTERJEE emphasised the need to do some deep and hard thinking and for the development of the man "within". He further said that the trouble lies in the fact that the state of affairs of the world within man has gone wrong. However, there is no room for pessimism on this account.

IRAWATI KARVE, *Science and Society*

Discussion

PROF. P. S. SUNDARAM, commenting on the paper, said that the artist is not required to be moral. It is old fashioned, for example, to say, that a piece of music or painting is moral or unmoral.

DR SATYA PRAKASH said that he was glad that the author had mentioned the non-material and non-mundane. He continued saying that science had a limited application as well as non-limited application, mentioning the new type of epistemology as an instance of the latter. Earlier, he said, we tended to ignore simple phenomena, although they were conducive to significant results. Science, he also said, teaches that the world was not unreal; but it could not throw any light on the interaction of matter and non-matter.

DR R. RAMANNA commented that the artist requires society around him for his creative work, whereas the abstract scientists do not need society for their work. However, he said, the applied scientists were like artists in this context.

DR NIHARRANJAN RAY said that a fundamental question of a philosophical nature was raised by Smt. Karve and he wanted to probe into it. He added that science is not so amoral as it seems to be. A scientist has a definite value system; he has to be rational in respect of facts and their interpretation, and this is a moral value. He has to discipline his intellectual and perceptual organs and this is also a moral activity. He said that in India till recently no difference was made between ethics and aesthetics. In Indian scriptures, he said, art has been defined as an important means of cultivating the self. Dr Ray also posed the question of difference of attitudes towards nature between India and the west. Whereas in the west, he said, conquest of nature is emphasised, in India the accent lies on living in harmony with nature and on a desire to understand the mystery of nature.

DR A. APPADORAI talked about the dilemma of the scientist, when he is asked to do something which he considers wrong by the powers that be. If he refuses to do it, he commented, it will be done by others.

DR A. RAHMAN, referring to Dr Satya Prakash's comment, enquired whether it was true that in science we always proceed from the simpler to the higher. With referring to Dr Ray's point, he enquired whether it was really a difference in the scientific attitude towards nature or merely a psychological attitude of the people.

DR B. L. ABBI commenting on Dr Appadorai's remarks said that the dilemma applies to every body, and was it then correct to say that morality was not relevant?

DR MULK RAJ ANAND commented on the two attitudes, the conquest of nature and living in harmony with nature. He said that the trouble is that Europe has come to Asia with its loss of moral values. He further said that historical parallels of 19th century Europe do not apply to our 20th century. Against greed and aggrandisement we have to evolve a morality of need. To illustrate his point he said that in the west, the

artist is responsible to his patron, who 'pays the piper', whereas among us today, his responsibility is towards society as a whole.

DR J. P. S. UBEROI referred to the attitude to nature in the Chinese scene ; mentioning the change from the traditional Chinese attitude to the one where conquest of nature is envisaged.

DR A. R. VASUDEVA MURTHY commented that even in our tradition there is an element of influencing nature. In this connection he referred to certain rituals.

SMT. IRAWATI KARVE, in her reply, said it is true that the scientist is aware of the ethics of his time, but in the process of his work, he is not concerned with it ; while the artist in his work often protests against the very fabric of society. Therein lies the difference. She said while it is true that science requires a rigorous discipline which has been called a moral value, it leads to good science and not to good morality.

K. J. SHAH, *Some Patterns of Thinking: a logical appraisal*

Discussion

DR R. RAMANNA referred to a paper of mathematical logic of Indian thought which he said holds that Indian logic was not different from Indo-Aryan thought. He also said that this paper claimed that all this could be found in principle in Mathematics. About meteorology, he said, it was only apparently similar to astrology. It was yet incomplete, more data would make it a better science.

DR A. APPADORAI, referring to the distinction between private and public morality, said that the major difference was that the government was in the position of a trustee: and that it can not always know precisely the will and interests of the whole community.

DR SATYA PRAKASH wanted to know on the basis of what type of logic could one justify logic itself. Now-a-days both deductive and inductive logic, he said, were considered inadequate ; now it is statistical logic which is accepted.

PROF. P. S. SUNDARAM wanted to know whether astrology kept pace with new discoveries in science ; for instance, do the newly discovered planets have any influence on human life ? Referring to the exception admitted by Gandhi with regard to non-violence, he said that it happened to be the only exception, and enquired what was one to do if, say, an innocent child was to be murdered or a nation to be attacked. Absolute non-violence, he said, was foolish. He further pointed out that the founders

of the Vedanta philosophy did not consider Sankhaya philosophy as correct. But we now accept everything as correct. This attitude, he said, of accepting all that is old uncritically, was adopted during the national struggle.

SMT. IRAWATI KARVE said that the notion what is good for the individual is not necessarily good for society is taken axiomatically. She further observed that our refusal to make atom bombs was not due to non-violence but other reasons.

In his reply DR K. J. SHAH said that a belief or even a hypothesis has to conform to the general frame of reference of the scientific community. About public and private morality, he said, he wanted to point out a logical distinction. Individual morality has only a limited relevance when applied to society, he said. Indian logic, he admitted, is not different from logic elsewhere, but here it was applied differently. The role of systems here was regarded as minor and there was a tendency to speak of other systems presenting accounts of reality at different levels. About this basis of logic, he said, today there are more logical systems than Aristotle or Russell ever thought of. The ultimate basis for logic should be the life led by communities, since the former formulates the discourse involved in various activities. Further, he suggested that our ancient ways may be responsible for our not doing enough.

J. P. SINGH UBEROI, *Work Study and the Industrial Worker in England*

Discussion

DR G. D. JOGLEKAR said that perhaps work-study reports might have been published by the National Productivity Council, and if so, Dr Uberoi may consult them.

DR SATYA PRAKASH wanted to know if there was a distinction between British and Indian workers in England. He further enquired about the effect on worker's outlook of the fact that 50% capital in Britain is American.

DR B. L. ABBI wanted to know the effect of automation on the attitude of modern workers.

MR KAILASH KUMAR wanted to know if this discussion could be related to the discussion on science and religion. DR JAMAL KHWAJA enquired if similar studies were made in the USSR and other socialist countries.

In his reply DR J. P. S. UBEROI said that he would like to know more about such studies carried on in India. As for the USSR it was difficult to get the details, he said, since there were no sociological journals, and sociology was not a separate branch of teaching. Dr Uberoi further pointed

out that studies of Indian workers in England were started because the Indian workers' Trade Unions were very effective, were considered among the best organised bodies there. Replying to Dr Satya Prakash's enquiry, he said that the effect of American capital was more pronounced in management practices than in the attitude of workers. With reference to Dr Abbi's question he said there was no change in the nature of work, but relationship between work and play was totally different for workers and managers. All the work, he said, fell on the workers, all the worry on the managers.

Thereafter, PROF. ASHOK GUHA, after the Chairman's permission, made a few observations about the conquest of nature and harmony with nature, referred to earlier by Dr Niharranjan Ray. He said these differences were not due to differences in culture. Classical western thinking, like Indian thought, he said, also maintained that man should adopt himself to the natural order. It was rather the pressure of economic expansion which led the western man to conquer nature. Something, he said, happened in the west in the 17th century which was absent in India.

Concluding Session

SMT. IRAWATI KARVE said that for the natural scientists rationality divested of superstition is the basic value. But objects and their relationships have as much validity as conceptual thought and ratiocination. The contribution of science lies in its attempt to create harmony between man and his natural surroundings. Mutual tolerance, if not mutual help, should be the goal of all human societies and for this it is necessary to devise a code of minimum conduct. The discussions have shown that it is possible to improve the material conditions of the people in India. It is not so much our social structure as the population explosion which is hindering our progress. She urged the scientists to find ways and means of tackling the problem of population control.

DR MULK RAJ ANAND said that he could see symptoms of a Cultural Revolution in India. The younger generation is asserting the values of independence, originality, and dissent. He was happy to see a galaxy of brilliant young minds at this Seminar. He congratulated Dr Niharranjan Ray for the breadth of vision and the great skill shown in the organisation of the seminars held at the Institute.

DR A. APPADORAI said that the approaches and methodologies of natural and social sciences are different, but it is necessary to correlate them. The seminar has highlighted many important issues which need further investigation.

DR G. P. CHATTERJEE said that he was going back enriched from the discussions with other participants and thanked and congratulated Dr Ray for the splendid opportunities of intellectual and cultural contacts.

MRS U. E. CHOWDHURY said that the seminar provided a rare opportunity of exchanging ideas with experts from different fields. Modern scientific techniques have made the task of improving the material condition of the people in India a little easier. But industrialisation and modernisation have also posed new problems.

DR G. D. JOGLEKAR said that he had participated in many seminars on scientific subjects but this inter-disciplinary seminar gave an opportunity to explore areas of common interest.

PROFESSOR V. V. JOHN said that the intellectual community in India must discover its identity. Referring to the impatience of the younger participants

with the views of the older generation, he narrated the story of Nicholas Murray Butler who was greatly vexed by the attitude of his elder colleagues at Columbia University. One day he said to himself, "Nicholas, get out into the open air. Fill your lungs with fresh air. Keep good health. All these old men will die". And they did.

MR KAILASH KUMAR said that we should not attempt to draw immediately applicable conclusions. Commitment to optimism can distort our perspective. The problem of description should be separated from the problem of application. There is evidence of technology everywhere in India and an objective analysis of the contemporary scene is a necessary pre-condition for any programme of action.

DR SATYA PRAKASH said that it was for the first time that he had attended a gathering which included social scientists. He had benefited from the discussions and would like to end on a note of benediction:

स्वस्ति पन्थामनुचरेम सूर्याचन्द्रमसाविव
पुनर्ददताड घनता जानता संगमे महि

May we follow the path of goodness, peace and prosperity, like the Sun and the Moon, again and again with give and take, without damage and injury to anyone, with mutual understanding, and progress together.

DR A. RAHMAN, said that the elder generation had made great sacrifices for all their rebellious views, and this awareness impelled him to be impatient. He thanked his senior colleagues for the tolerance and patience shown to him.

DR R. RAMANNA suggested that while we appreciate that civilisation and culture have many good points and self-correctives and have survived through the centuries, we now have to ask ourselves whether the old traditional values can help us in the task of rebuilding India. He said, the younger generation was impatient about some of these matters because it seems that the material conditions under which the people of India live, particularly in the cities, are so substandard, and the question therefore arises whether there is any value in a culture which allows people to live at these low standards and which has produced a population which allows itself to live under such miserable conditions.

PROFESSOR P. S. SUNDARAM said that he preferred a gradual transformation of the social structure in India to a complete and sudden break with the

past. He added that science has an important role to play in dealing with the forces of revivalism in the country.

All the participants expressed their warm appreciation for the courtesy and hospitality extended by the Institute.

MR K. VENKATARAMAN, the Registrar, then thanked the participants for their contribution to the Seminar.

DR NIHARRANJAN RAY, in his concluding remarks, said that his generation was nurtured in the liberal tradition which cherished the ideals of encyclopaedic knowledge. The specialisation that we see around us now is inevitable. But it should be integrated with the wider spheres of knowledge. This has been his main pre-occupation in organising the seminars at the Institute. He said that every age has to analyse its inheritance and face the challenges of the time. Our traditional values form part of our inheritance, but if certain traditions hinder the progress of the country they should be courageously got rid of. He was happy that some of the intricate problems which the challenge of science and technology has posed were discussed and analysed during the Seminar.

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