Towards Understanding the State of Science in Pakistan

Edited by
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Council of Social Sciences
Pakistan (COSS)
Islamabad

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Preface

Under its Science and Society programme the Council of Social Sciences, Pakistan (COSS) organised a seminar on the theme of "The State of Science and Technology (S&T) in Pakistan and Factors that Determine it". A number of natural and social scientists participated in it to develop a shared understanding of the issues within a common conceptual framework as well as to set a pattern for more intensive seminars in future on the themes related to development of S&T.

Prof. Atta-ur-Rahman, Minister of S&T, initiated the discussion on the subject followed by presentation of written papers and oral statements. Some of these papers were revised and edited and are included in this volume.

Some papers presented at the seminar forcefully argued that the impact of development of nuclear science in the country has negatively affected the progress of non-nuclear sciences. A few participants in the seminar contested this view but they did not write down their disagreement. On the request of the editor some of them, however, did write down their comments on papers with which they differed. These comments appear at the end of such papers.

Another issue that emerged in the seminar was the relation between science and religion. A number of papers presented in the seminar argued that lack of compatibility between culture of science and culture of religion affects the creativity of Muslim scientists. Again, some participants differed with this view but did not write down their arguments. In order to reflect their point of view, we have included in this volume two papers already published "The Impact of Islam on Science" by Asghar Qadir and "Islam and Science" by Khwaja Masud and an unpublished paper "Religion and Science: Exaggerating the Conflict" by Tarik Jan which was written on request of the editor and in response to the latter's paper "The Ideological Predicament of Contemporary Muslim Scientists".

COSS is grateful to several persons for making this volume possible. They include all the paper writers, Prof. Atta-ur-Rahman, the then Minister of Science and Technology; and the Islamabad office of UNESCO and Pakistan Science Foundation for covering the printing cost of this book and ActionAid Pakistan for providing money to COSS to establish office and recruit some research staff.

COSS is particularly grateful to Dr. Anwar Nasim, now Chairperson National Commission on Biotechnology, for persuading COSS to create a section named "Science and Society", which reflected his continuous interest in bringing natural and social sciences closer to each other. He also supported the idea of holding a seminar and bringing out this volume. In addition the editor is grateful to Working Committee of COSS which gave support to establishing the section of "Science and Society" within COSS and to Dr. Zarina Salamat, Dr. Rais Ahmed Khan, Dr. Kamran Ahmad and Dr. M. Naeem Qureshi for their help in editing the book. The editor is personally indebted to Ms. Foqia Sadiq, Research Associate, SDPI, Islamabad for writing notes on the proceedings of seminar and Ms. Fakhra Hassan, now with Khuldunia School, Islamabad for proof reading and making comments on some papers. For editorial assistance, I am grateful to Mr. Yassar Arafat M. A student in the National University of Modern Languages (NUML) and Mr. M. Anwar working with COSS.

PS. While the book was ready to go to press, I came across an article by Dr. Asghar Qadir, formerly Professor of Mathematics in Quaid-i-Azam University, Islamabad entitled "Islam and Science". As the paper dealt with issues relevant to the theme of this book it was split up into two articles, one appears in the book under the title of "The Changing Conception of Science" and the other as "The Impact of Islam on Science".

Dr. Inayatullah
Editor
September 12, 2003

Foreword

Pakistani scientists like most of their counterparts in the world generally remain so occupied with their professional work that they do not focus on broader issues concerning science. Except a few, most Pakistani scientists have rarely raised and systematically investigated important questions about development of science in Pakistan. These questions include: why S&T in Pakistan has not achieved a level of development commensurate with its human and financial resources; what specific conditions have obstructed the development of science in the country; what role the character of state, social structure and cultural patterns of our society has played in determining both the direction and pace of the development of science; what particular interests have shaped the formulation of the science policy of the country and whether the needs of the less privileged strata are incorporated in it.

Even social scientists in the country whose profession equips them to raise and investigate such questions and for which considerable literature is available in the West, have not yet shown interest in studying them. As a result, no literature dealing with above questions in the specific context of Pakistan has emerged. In the absence of such literature, science policy was based not on well-informed rational discourse but on the wishes and desires of a few individuals. While choosing a particular goal from among several competing goals of science policy, the framers of this policy randomly chose a goal without full awareness of its long-term costs and consequences. Consequently science policy was formulated under extraneous considerations unrelated to development of S&T. Thus formulated policy lacked coherence and consistency and became difficult to implement.

Literature investigating above mentioned questions did not emerge partly because there was no common platform for scientists and social scientists on which they could discuss, and articulate problems facing science and enter into a productive dialogue. I am glad that the Council of Social Sciences, Pakistan that came into existence as recently as year 2000, has created such a platform. As part of its work programme in the year 2001 it organised a seminar on "The State of Science and Technology (S&T) in Pakistan and Factors that Determine it", which was attended by a number of prominent scientists and social scientists. I myself had the pleasure of participating in it

I understand that the Council has commissioned a study on "History of Science in Pakistan" and is planning to hold similar other seminars and publish books and monographs to promote understanding of the problems science faces in our country. I am sure both scientists and social scientists in the country will participate in this intellectually stimulating and useful task and will help the Council to develop and implement its plans. I particularly urge government and civil society organisations to give necessary support to its work.

Prof. Atta-ur-Rahman
Chairman, Higher Education Commission
Islamabad

September 10, 2003

CONTENTS

Introduction

Inayatullah

This book is outcome of a seminar organised by Council of Social Sciences, Pakistan (COSS) under its "Science and Society" programme on the theme of "The State of Science and Technology (S&T) in Pakistan and Factors that Determine it". Well-known natural and social scientists whose names appear at the end of the book participated in it. The main goal of the "Science and Society" programme of COSS is to promote understanding of problems in development of S&T in Pakistan, help establish a dialogue between scientists and social scientists, develop a common conceptual framework and promote a shared understanding of the issues involved in development of science in Pakistan. COSS hopes that publication of this book will stimulate discussion in the academia on the above issues.

The central issue before the seminar held on June 9, 2001 and the papers that emerged from it was to determine the level of development of Science and Technology (S&T) in Pakistan and identify the conditions that foster or retard their growth.

Determining the level of development of S&T in a country runs into several difficulties. The first is to determine what exactly is science and what constitutes its development. Despite impressive advancements in the philosophy of science and unusual importance which science as a vocation and a cognitive system has achieved in contemporary times it is yet not possible to state in definitive terms what constitutes "science".[1] An alternative way of knowing science could be to identify the generally accepted elements of scientific methodology, which are summarised below.

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[1] See Asghar Qadir's paper "The Changing Conception of Science" in this book, pp. 9-23.

Scientific community in general recognises only that knowledge as scientific which is acquired through a process of verification of an interconnected set of propositions constituting a theory against empirical data. As no theory can be proven absolutely true, the theory that stands less falsified and from which a certain number of predictions come out to be true is held tentatively valid. It holds the field till a new theory with greater explanatory power replaces it. This process makes all scientific knowledge tentative and without claim to final and absolute truth.

The next task in evaluating the development of science is to determine the meaning of "development". One generally accepted view is that science develops, as it becomes more general, more systematised and more exhaustive.[2] Its existing laws and theories are replaced with new ones that can explain larger number of facts. It becomes more systematic when mutual inconsistencies between the theories and laws and the facts are eliminated. Thus conceived development of science is not an accumulation of information in a particular territory or cultural division but a process of growth of exact, systematic and universal knowledge that discovers new facts as well as explains all known facts. A scientist who by his findings accelerates this process contributes to the development of science.

This internationally recognised measure of the development of science is also generally used in Pakistan. The number of books and articles written by Pakistani scientists published in international science journals and the frequency with which they are cited in scientific papers is considered Pakistan's contribution to the development of science.[3] Useful as it is, the "Impact Factor" does not measure direct or even indirect

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[2] Bernard Barber, "The Sociology of Science," *International Encyclopaedia of Social Sciences*, 1972, p.93.

[3] Pakistan Council of Science and Technology has used the "Impact Factor" in evaluating the contributions of Pakistani scientists in its publication *Leading Scientists of Pakistan,* prepared by S.T.K. Naim and published by the Council in 1999. Some Pakistani scientists have questioned the adequacy of Impact Factor for such evaluation.

benefits of such contributions to the welfare of the people who pay for these contributions. Though, on an ideological level most scientists support the idea that science should contribute to the welfare of the people and humankind as a whole, they also claim that they have no control over the use of their contributions for which the responsibility rests with those who decide on their use. They can use it for the welfare of people or for adding misery to their lives, providing security to a section of the people or creating insecurity to humankind at large. Such a claim may be true for those scientific contributions that scientists make without any immediate material reward, without inducement and control by state and without contracts with donors and corporate interests. The claim becomes questionable when scientists convert their knowledge of basic science into technologies, which they can clearly see would be harmful to the human race.

The problem becomes even more complex if one is to determine the definition of “welfare of people”. Does it mean only the satisfaction of the basic needs of the citizens or should it also include the contribution of S&T to the security needs of a country. If security needs are also included then a further issue arises as to who will determine priority between the two in conditions of scarcity of resources - the perception of the military elite or people's perceptions of their welfare. In poor countries security demands and welfare needs seldom go together and when perceptions of a powerful military elite determines allocation of scarce resources, welfare needs often receive low priority. Some papers in this book have addressed these issues but their resolution remains elusive.

Identification of societal conditions or causes that foster or retard S&T globally or in a particular country faces serious difficulties as well. In addition to the ambiguity of the concept of the development of S&T, assigning to different causes out of a cluster and isolating the most critical cause creates problems. Still another difficulty is to establish the sequence between causes and effects as sometimes what appears to be the effect at one stage becomes a cause at another stage of development.

Methodological difficulties, however, cannot be considered a significant factor that prevented both scientists and social scientists in Pakistan to investigate the social, cultural, political and economic conditions that facilitate or impede the emergence and development of S&T. This could be due to a lack of interest in the issue as well due to an absence of necessary academic training in subjects like sociology of knowledge and philosophy of science. It could be also due to a belief among many scientists that scientific knowledge grows by its own internal dynamics and critique, independent of historical development and social environments. In words of Nandi they assume that the text of science is independent of its context.[4] Regardless of the factors involved most Pakistani scientists seek the cause of the development of science or the lack thereof in the competence of scientists, their training, provision of funds and facilities to do research, quality of leadership and management in research institutions and reward for their work. These are indeed important causes but not sufficient to explain lack of development of science. They do not answer broader questions such as; why in certain states, societies and cultures science has developed and is developing faster than others, why some states allocate greater resources to science, why in some countries science becomes subordinate to security perceptions of the rulers regardless of their serious negative effects on the welfare of people and why in some societies scientists enjoy greater freedom to choose their agenda than in other societies.[5]

If Pakistani scientists and social scientists have not raised these questions,[6] it is by itself significant. It is possible that they

[4] Ashish Nandy, "Towards an Alternative Politics of Psychology," *International Social Science Journal,* Vol.35 (2), 1983, pp.323-338.

[5] Indeed a shift has occurred from studying development of science in isolation of societal conditions to understanding it in its social context. See a special issue of International Social Science Journal on this subject particularly Hebbe Vessuri, "Introduction: Science and its Culture," *International Social Science Journal*, 168, June 2001. Also see "The Changing Conception of Science" in this book.

[6] Indeed from their own experience Pakistani scientists know that societal conditions do affect their work. But these experiences have yet

apprehend that if it is established that development of science is shaped by the characteristics of society in which it takes place, and that if social background, social position, personal attitudes and values of scientists affect their professional work, it could weaken their claim to be detached and neutral observers of reality.

Literature produced in the West has established that development of science occurs neither randomly nor through its internal dynamics alone and that science is a social product and its development occurs in certain social conditions. Social scientists particularly sociologists of science who have studied the subject have identified a number of such conditions that facilitate or impede development of science.

While writers on this subject generally accept the above generalisation, they differ with respect to the weight to be assigned to different social factors. Some stress the role of values, others of class structure and still other the character of the state. The well-known Weberian thesis claimed that Protestant Ethics was the driving force behind the emergence of capitalism, modernity, and rational thought that in turn produced modern science.[7] American sociologist Merton further developed this thesis and added other factors such as social mobility and religious pluralism to explain the development of modern science. He argued that " ...the emergence of modern science requires a basic change in general social outlook in which rational understanding and mastery of environment and human affairs replaces tradition as supreme criterion of

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to be studied systematically and put together to arrive at broad conclusions for shaping science policy. Some contributors to this book have offered preliminary propositions on this subject that need to be tested.

[7] Several Muslim writers in this book make a somewhat similar claim for Islam. See the papers of Tarik Jan "Religion and Science: Exaggerating the Conflict," Khwaja Masud "Islam and Science" and Asghar Qadir "The Impact of Islam on Science". For other writers see Inayatullah "The Ideological Predicament of Contemporary Muslim Scientists".

conduct".[8] He stressed that the presence of what he called "cultural ethos" of science, whose ingredients are "organised skepticism", "disinterestedness", "universalism" and "Communism" was a necessary condition for the development of science[9] and that major scientific breakthroughs occurred in the West because of the presence of this "cultural ethos".

Recent developments in literature have shown that the relations between values and the development of science are complex. Some values support the development of science directly and others indirectly. These developments are summarised in the following quotation:

> The high value the modern world puts on rationality as against traditionalism, on this-worldly activities as against other-worldly activities, on libertarianism against authoritarianism, on an active striving as against passive, on equality as against inequality - all these values support the development of the several components of science. Sometimes the support is direct, as in the case of the value of rationality and this-worldly interest, the values which are especially powerful in combination, as they are in the modern world. Libertarianism is essential for academic freedom, which is one kind of important foundation for scientific progress. Sometimes the support from the values is indirect as when the value of equality increases the amount of social mobility and thus helps to select better talent for scientific roles.

Indeed the above-enumerated values as a cluster play a significant role in the development of science. However, they can affect this process only if they are internalised and institutionalised. Their verbal articulation and mechanical repetition does not affect this process. Slow development of

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[8] Joseph Ben-David, "Introduction," *International Social Science Journal*, Vol. 22 (1), 1970.

[9] Robert K Merton, *Social Theory and Social Structure,* Glencoe Illinois, The Free Press, 1957, pp.550-554.

science in the Third World can possibly be explained by the fact that these values are not institutionalised in the organisation of the state, universities and research institutes. Besides, strong and autonomous communities of scientists (that can uphold these values) have yet to emerge in these countries. On the other hand, in some of these countries, the values antagonistic to the development of science are strongly institutionalised and prevent this development.

A different approach de-emphasises the role of values, suggesting that they are subordinate to the structure of power and resource distribution in a society. This structure determines what kind of knowledge needs to be developed or suppressed. For instance this approach suggests that constellation of power in a feudal society blocks the development of science. The emergence of the capitalist class, which found science as its ally in rationalising the contemporary society and maximising profit using new technologies, promoted science.[10]

Due to the low interest in Pakistani academia towards understanding the process of the development of science particularly in an explicit theoretical framework, the question of which of the two approaches better explain the development of science and technology in the country, has not yet arisen. Some writers in this volume such as Abdullah Sadiq, Anis Alam,[11] Inayatullah, Tariq Rahman and Asghar Qadir to some extent root their analysis in explicit or implicit theoretical assumptions while most other papers are description of empirical facts often done in order to derive practical policy conclusions. Most papers that evaluate the state of S&T in the country arrive at a common conclusion. The country has not achieved a level of development of S & T commensurate with its resources and talents and that S&T in Pakistan needs to be geared to promote socio-economic development that directly benefits its people.

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[10] Claude Ake, “Commodification of Social Sciences,” *International Social Sciences Journal*, Vol.36 (4), 1984, pp. 615- 616.

[11] Sponsored by Council of Social Sciences, Anis Alam is preparing a study on "History of Development of Science in Pakistan” in which he is exploring these issues.

What binds the papers in this book together is its theme and interest in explaining the state of S&T and not necessarily its theoretical coherence and similarity in approach. Therefore it should be regarded a first exploratory step. It has raised some important questions without answering all of them. Future research on the subject needs to investigate these questions comprehensively and systematically and identify other questions that should be researched. For a list of such questions see Appendix I.

1
The Changing Conception of Science[1]

Asghar Qadir

Introduction

There had been a common belief, which is still prevalent among non-scientists, that science is the process of "discovering" hidden "laws of Nature", which exist in themselves. According to such a view, there can be no significant effect of any cultural attitudes or religious beliefs on science. All that can happen is that the "discovery of the laws" can be accelerated or retarded by societal support or opposition. The current view of science is a different one, which allows for science to reflect social norms and attitudes. Would it be valid to regard the current view as correct and ignore the previous one? May it not be that the earlier view was correct, or that both are wrong? I will argue that the present view, while it may not be "correct", is at least better than the previous one. For this purpose it is useful to place the present view in historical perspective. As such, I would like to trace out, in broad outline, the development of the current view of science. There was one phase in the development of science when the Muslim civilisation played an important role in the view of what science is. In a companion article I will go on to discuss why, in my opinion, it was the world of Islam, and not some other civilisation that played this role.

One may wonder whether it is reasonable to take any one view if there remain disagreements on what science actually is. Many "anti-scientists" (who actually argue that science is not correct and, in any case, is not relevant) harp on the disagreements between the philosophers of science to decry the whole scientific enterprise. Our admission that there is no absolute

[1] This article formed part of a talk presented under German Academic Exchange Programme (DAAD). I would like to thank Dr. Falk Triebsch, Director of DAAD for permission to print it here.

agreement on it, and that the view has been changing, lends colour to their arguments. The point is that at any one time there is a general consensus with minor differences. Philosophers, of course, focus on those differences.

The Ancient View of Science

The origins of science, religion and mythology are not separate. In ancient times they started out as one and the same. Some phenomena had obvious explanations, when things were *made to happen* by some living being. At other times there was no observed cause for the occurrence. It was natural to suppose that there were unobserved "living" beings responsible for the occurrence. These were designated as "spirits". The proliferation of spirits led to a need to find some order among them. The order was assumed, again quite naturally, to be similar to that of tribal human societies. There would be stronger and weaker spirits. Some would be more important than others. There would be a chief of the spirits. As society developed in complexity so, too, did the spirit world postulated. At some stage some of the spirits were given a higher status than others as "gods". Ordinary human proclivities were attributed to these gods and spirits and stories were woven round them. This was the primitive religion and mythology. What was the primitive science? *Why --- exactly the same!* The same, because science is the attempt to explain observed phenomena. The spirits and gods *were* the "science" of ancient times. The "technology" of the times was that practised by the priests and the shamans --- the attempt to get the forces as understood by them to do the will of the person trying to manipulate them for human purposes.

Even in ancient times there were attempts to find a rational systematic order to occurrences. For example, heavenly objects were seen to generally move in perfect circles about a point in the sky, more or less where Polaris is at present. Tides were seen to rise and fall regularly. Solar and lunar eclipses were predicted. The floods of the Nile were predicted by the priests, using an early warning system. Similar developments are claimed for the same period, or shortly after that, in China and in the Indo-Pak subcontinent. However, there is no clear documentation of those claims and there are no clear remains that show the use of devices for purposes like the Egyptian flood predictors.

Greek Science

The first properly recorded attempts to provide explanations for phenomena that were not based on the arbitrary action of "living" beings come from the Greeks. Recall that there was no single Greece but a number of independent Greek states. Correspondingly, there was no single Greek attempt at science but a number of independent attempts. However, there was one approach to science that survived through the ages as the "accepted" view. The others, of which the records still exist, can be regarded as "minority views". The main view is that epitomised by the philosophers of Athens, and especially by Aristotle.

There is much to be said about the Aristotelian view of science but we would not have the time for it here, nor is this the appropriate place to discuss it. As an over-simplified statement of that view, let it suffice to say that the Greek view of science was based on the assumption that there are "self-evident truths" and all phenomena can be explained in terms of these truths. To make this view more concrete, it is necessary to give an example, which I now proceed to do.

There are five solids that can be made from regular figures stuck together --- the so-called "Platonic solids". It is a "self-evident truth" that the elements must be different Platonic solids. Thus there are five elements: earth; water; air; fire; and ether in increasing degrees of "perfection". Since it is also a self-evident truth that the heavens are perfect and the Earth imperfect, the heavenly bodies must be made of ether and the terrestrial bodies of the other four elements. It is another self-evident truth that the circle is the most perfect figure. Thus heavenly bodies must move in perfect circles. However, if some heavenly body is very close to the Earth, it can be contaminated. In that case it is a self-evident truth that the path of the body will develop epicycles (a circle whose centre moves in a circle about the

Earth, or one whose centre moves about a centre that moves in a circle about the Earth, etc.). The more imperfect the body, the more epicycles its path develops. This explains why the planets move as they do. They are contaminated by their closeness to the Earth.

It is worth noting that according to this view of science there is no need to observe or experiment so as to understand how the world works. All one needs to do is to "contemplate one's navel" as they say. In other words, introspection will provide all the insight needed and there is no necessity to observe the external world, or interfere with it, to understand its functioning. Further, science tries only to "explain" phenomena in the sense of fitting them into the scheme of self-evident truths. Consequently, many of the explanations would be what we now regard as circular. Thus, we can tell that the closer objects are more imperfect because they follow more imperfect paths. How do we know whether they are closer or more distant? Because they follow more imperfect paths. The point is that in this view there is no conception of testing the "explanation", or quantitatively determining any of the parameters appearing in the explanation. In the Athenian culture observation and experiment were menial activities unworthy of patricians. The true philosopher/scientist would only provide the observer with the "obvious" explanation in terms of self-evident truths.

As I said before, this was not the only view of science. There were those who brazenly observed. For example, by observation and inference Eratosthenes had obtained a remarkably accurate estimate of the size of the Earth before 300 BC. His followers had a (slightly low) estimate of the size and distance of the Moon and a (substantially low) estimate of the size and distance of the Sun. Most scientists regarded the estimates as ridiculous, as they were in contradiction to the self-evident truths and so-called "common sense". For that matter Archimedes (horror of horrors!) actually performed *experiments*. Of course, he pretended that the Archimedes principle had been an accidental discovery --- hence the apocryphal story of his running naked through the streets shouting "Eureka!". He did the work of an artisan when he burned the ships attacking Syracuse, but that was regarded as acceptable since he thereby saved his cousin, the King.

There may have been other views of science developed, of which there is no record. In the absence of any evidence, we can assume that there were only these two views --- observation forbidden or allowed, but no experiments, and the former prevailed.

Muslim Science

By the time Islam came on the scene the Greek civilisation had already been conquered by the Romans. There were pockets of Greek learning still extant, for example in Alexandria. Even those pockets had not entirely withstood the ravages of time. Therefore, the Muslims had to try to piece together what the Greeks had developed so much earlier. There was a concerted effort to reconstruct the books by the Greek masters, such as Plato, Aristotle, Euclid, Ptolemy, Hippocrates and Galen. However, the spirit of the Greeks was lost in the process --- perhaps due to the problem of translating across languages, cultures, and times; perhaps due to the poor preservation and inadequacy of the available manuscripts; perhaps for some other reason.

As so often happens when attempting to reconstruct old ideas, one does not manage a complete reconstruction. However, by the same token, one does get some new innovations. The spirit of appealing to pure reason was, indeed, lost. It was replaced by an appeal to observation and later experiment. There was no taboo against experiment as working with one's hands was encouraged. There were a number of scientists who started building on the previous knowledge of the Greeks with new knowledge. This knowledge was not hampered by having to be the fruit of pure thought, but could derive from the way the world actually is and the way it works.

Thus was the Islamic empirical approach to science born. It came naturally as a response to the sudden burst of new information being collected without enough time for proper collation and assimilation. This led to the development of the encyclopaedists --- people who tried to put together all the knowledge that had been collected. Procedures were required to reduce all the separate pieces of knowledge into an integrated body of knowledge. Such procedures were developed by some scientists like Al-Beruni, Ibn-Al-Haytham, Ibn-e-Khaldun, Omar Khayyam, Al-Khwarizmi, Abu-Sina and many others. However, they covered only some areas and not the others. As a general approach to science the Muslim view lacked cohesion. I will later explain why this approach arose naturally among the Muslims and will then assess its impact on science more fully.

Renaissance Science

After the decay and collapse of the Muslim civilisation, science and culture were born again in the West --- the renaissance. The start of this period dates as far back as the twelfth and thirteenth centuries AD, when scholars from the West went to the seats of learning in the East. They brought back the science of the Muslims. There was the inevitable reaction to that new knowledge, which the clergy of the time regarded as threatening the establishment. Consequently, all such ideas were declared heretical and their proponents were regarded as heretics. There were regular witch-hunts to eliminate the harbingers of change. It was unsafe for citizens to pursue the new ideas brought from the East. The practitioners of the new science were taken to be sorcerers and alchemists. The attitude to them may be seen in Goethe's book on Faust or the story of The Hunchback of Notre Dame. (Of course the books mentioned are written much later but may be regarded as a hangover from the earlier attitudes rather than as newly developed attitudes.)

Paradoxically, the introduction of the new science into the mainstream of Western civilisation, owes much to the Christian monasteries. Monks were entrusted with the task of preserving old manuscripts by making fresh copies and translating them into Latin, the language used by the Church. In the process they learned much of the lore of the Greeks, passed on through the Muslims and much of the new Muslim-generated knowledge. A famous example is that of Nikolaus Copernicus. He was able to put together the various arguments for a heliocentric view of the universe, starting from the Greek sun-worshippers, on through Aristarchus and Eratosthenes and their followers, to the work of Ibn-al Haytham. There were some innovations in the development of the argument and it was not totally a summary of previously existing reasoning. Similarly, the work of Abu-Sina, was propagated under the name of Avicenna, of Al-Khwarizmi, under the name of Algorizm (later changed to algorithm and shortened to logarithm and log --- as in Captain's log star-date xxx), etc. This thrust of new, Muslim knowledge brought about a reaction and a tendency to identify with and adopt the Greek science, being Western, as embodying the Christian knowledge. Ironically, Aristotle became its epitome.

Classical (Newtonian) Science

It is unfair of me to call the science of the seventeenth century "Newtonian" science. There was so much more to it than was covered by Newton. There were all the developments of Chemistry and Thermodynamics, for example. There was the taxonomic approach to Biology followed by Darwin's theory of evolution. Putting all of these developments into Newton's bag, smacks of reductionism in the extreme. However, it is no more unfair than crediting Aristotle with all the Greek developments. In fact there is a very real sense in which it *should* all be credited to Newton in the context of the philosophy of science.

The point is that the view of science changed with Newton's formulation of his laws of mechanics and gravitation and his use of calculus for explaining the orbits of planets and motion of bodies on the Earth. It must be admitted that not all the laws were due to Newton. His first law of motion was discovered by Galileo. His law of universal gravitation is an extension (without giving credit) of the law of celestial gravitation proposed by Robert Hook and the law of terrestrial gravitation propounded by Al-Kindi. The calculus was invented by Leibniz and not by Newton. (He did have a strong tendency to grab credit with both hands.) Nevertheless, it was his formulation that brought all the different ideas together and he did unify apparently very different concepts. Also, he stated his ideas without any doubts or provisos. This led to the belief in some pre-existing "laws of nature" awaiting discovery. It may take a Newton to discover them but without any doubt they existed. This is brought out in the epitaph written for Newton:

> Nature and her laws lay hid in Night
> God said, "Let Newton be!" And all was light.

I shall, later, be discussing the modern view of science and will give a later addition to this epitaph then. Here I want to bring out the fact that this total faith in Newton's laws warped the view of the world of physicists at the time, of many scientists till considerably later, and of the general populace to this day! The modern view of science has yet to be absorbed by the common person.

This attitude led to the modern dichotomy between the "natural" and the "supernatural". The impression one gets from these terms is that the former are phenomena that occur in nature and the latter are those that do not. This is not actually the sense in which the terms arose. The former were those phenomena that fit in with "the (Newtonian) laws of nature" and the latter were those phenomena that do not. It was assumed that all "natural laws" must be derivable from Newton's laws, at least in principle. Even those areas that seem far removed from the physical arena which Newton addressed, should be obtainable from the laws of Mechanics. This view gained further credence when James Clerk Maxwell showed how the science of thermodynamics could be obtained from Mechanics and when he almost managed to fit the phenomena of electricity and magnetism into that scheme. In fact, the very discrepancies that arose became further cornerstones of the faith in Newton's physics, when it was found that the attempt to fit in with Newton's physics gave correct predictions. The same validity was found in the celestial motions predicted by Newton's laws. The discrepancies had to be interpreted as undiscovered planets, and subsequent observations validated those expectations.

"Understanding" any phenomenon came to mean that it could be explained in terms of Newton's laws. The "scientific attitude" came to mean an absolute, dogmatic, faith in Newton's laws and a refusal to admit the possibility of any phenomenon occurring that deviated from those laws. When one came across some phenomenon that did not fit in with the perceived requirements of Newton's laws, one had to label it as "supernatural". This is why the Westerners who came across the so-called "primitive" cultures found them more at one with nature. The "primitives" did not try to mould nature into their perception of the rational. To those cultures there was nothing "supernatural" about the occurrences that the Westerners found unbelievable. I am by no means claiming that the understanding of those cultures about nature was "better" than the Newtonian view. In fact, in most cases the views were untenable at the time and become absurd in the light of subsequent developments. I merely want to stress here that this Newtonian attitude is *not* the modern attitude to science.

Modern Science

The modern view of science can be traced practically totally from the developments of the turn of the previous century, i.e. just about 1900. At the time, a famous scientist had said that everything in science was understood and except for "two clouds on the horizon" science would only involve fitting facts into the known framework of theory. The "two clouds" developed into quantum theory and relativity. The former, particularly, changed the way we think of science. The latter is commonly, though mistakenly, regarded as having been responsible for this change of view. There is another, largely ignored, development that is even more crucial for changing our views on science. Before going on to these developments, I want to spend some time on ideas that were developed in the 19th century but are actually more consistent with the modern view of science.

First is the idea of evolution as embodied in Darwin's biological theory of the origin of species. In the Greek world-view there is a general tendency for systems to degenerate. The belief is of ideals having been created by the gods (or God) and then the effects of Earth and humans making them less perfect. The physical theory of thermodynamics, and especially its second law (of entropy), endorses this belief in degeneration as a principle of nature. In Darwin's theory systems actually develop in complexity from simpler (more primitive) forms to much more advanced forms through the process of natural selection. It is often misunderstood as leading from "lower" to "higher" forms of life. This value judgement of "lower" and "higher" is not justified by the theory or the facts. What is actually claimed is that those forms survive that are better adapted to the environment prevalent at the time. The new forms will generally be more complex. The idea of increasing complexity should actually be taken much more generally. It is developed in what is called the science of complexity. It applies to the development of physical entities, to chemical development, to the development of the brain, consciousness and the mind. It applies to the development of societies. Its implications for the other natural sciences are still being explored and to the social sciences have yet to be explored.

The other idea is of "fields" as in the case of magnetic fields. Newtonian physics depended on the concept of a "cause" and "effect". However, what is regarded as a "cause" for one purpose may be regarded as an "effect" for another. In this way, an "effect" may, to some extent, turn out to be its own "cause". A better description is not to have "causes" and "effects" but to provide all the information at one instant and then see what the physical laws say should be the situation at a subsequent time. As such, one cannot take some small part of the whole and work out what will happen to it in the absence of information about the rest of the world. It is necessary to take a holistic view of the development of any part of a system. This attitude is diametrically opposed to the Newtonian philosophy, where one assumed that one could neglect all other aspects of the system and look at only one part to the exclusion of all else.

I now come to the events at the turn of the century. Many things happened at more or less the same time. For one thing, the motion of the Earth through the ether, which was assumed to be there, was not seen. For another, Maxwell's theory of electromagnetic phenomena had run into snags of internal consistency and fit with observation. Then again, energy was found to be produced through some new process --- called radioactivity --- that could not be understood. When the particles emitted by radioactivity were used by Rutherford to bombard thin sheets of gold, he found structure inside the supposedly indivisible atom. The observations suggested that many light, electrically charged particles are going around an oppositely charged nucleus. Now accelerated charges should radiate energy and so the light particles should fall into the heavier nucleus. But then the atom would take the shape that had been expected to start with, and had to be excluded by observation. Additionally, there were problems with the behaviour of electromagnetic radiation. The dependence of the intensity of the high and low frequency radiation was found to be nearly opposite. Further, it was found that light falling on metal plates could cause currents to flow and the voltage depends on the frequency of the light while the current depends on the intensity of the light. None of this fitted with Newton's physics, or even with Maxwell's field theoretic extension of it. It is easy to say with hindsight that these "little clouds" should have been taken as an indication that there was something seriously amiss with the previous theory.

The resolution of the many problems besetting physics came in two major sweeps. One was Planck's postulate that electromagnetic radiation is emitted and absorbed by matter in discrete *quanta*. This was followed by Einstein's insight that the reason for this fact is that light and other electromagnetic radiation can be thought of as consisting of discrete quanta. This was followed by Bohr's realisation that light is not either a wave or a particle, *but both*! Using the new ideas he constructed a model of the atom, which fitted with observation and explained the chemical properties of atoms. This new understanding led to the requirement that things cannot be talked about without reference to the context in which they are observed. If we look at the wave properties of light we see it as waves and if we look at the particle properties we see it as particles. Further, not all physical quantities can be simultaneously determined with arbitrary precision. The most dramatic aspect of the new theory was that it has no Newtonian basis or analogue. As such, "understanding" had to be given a new meaning.

The other sweep came from Einstein. He resolved the problem of the absence of motion relative to the ether by removing the ether and legislating that light has the same speed for all observers moving with constant velocity, regardless of its magnitude. This led to the understanding that there is no universally defined instant of simultaneity for all spatially separated observers. *Simultaneity is relative*. This theory entailed that we no longer think of space and time as separate, but rather as a single space-time continuum. On extending the theory to deal with arbitrary velocity, in the possible presence of gravitational fields, it was found that we can no longer think of matter as existing in space-time without affecting the space-time, but must rather think of the space-time and the matter as affecting each other. To understand this point more fully think of the space-time as a stage and the matter and energy as actors on the stage. That is the classical picture. The relativistic picture is to make the stage of rubber. As the actors move on the stage, it changes. That causes the actors to move in a different way, which changes the stage. This interaction between the space-time and the matter and energy in it has profound implications. For one thing, it means that we cannot think of space-time existing without matter any more than we can think of matter existing without space-time. For another, it further destroys the definiteness of Newtonian science.

The Modern Philosophy of Science

The rapid changes of world-view in going from Newtonian definiteness to the uncertainty of quantum theory and interaction of the observer and the observed entailed by both relativity and quantum theory, necessitated a change in what was thought to be "science". In fact the ideas needed to be formulated precisely. What emerged, barring minor differences is what I refer to as the modern philosophy of science. It can be put in the form that

Karl Popper put it. (Many would argue that Popper is not the final authority and not everybody agrees with him. They would be right but not relevant. For our purposes the differences are minor and I am following the same procedure that I have been doing, of picking one view to represent a whole class of slightly differing views.)

"Science", in this view is the activity of formulating and "testing" "scientific theories". A scientific theory is a collection of axioms that lead to predictions that are, at least in principle, falsifiable. "Testing" is the process of trying to prove the theory false. So long as it is not proved false, it is tentatively regarded as "true". However, there is implicit in the formulation, the presumption that it will sooner or later be superseded --- either because it is found incomplete or because it is found to be insufficiently general. It is worth noting the contrast, not to say direct opposition, of this view and the Newtonian view of science.

An important development of the 1930's was Gödel's theorem of non-derivability of arithmetical statements. It says that in a formal arithmetical system, consisting of an alphabet, words and a grammar for putting words together, given any finite set of axioms, grammatical statements can always be constructed that can not be derived from the given set of axioms. This was later extended to other formal systems. Though it does not rigorously follow, it can be argued that Gödel's theorem would also apply to the system of axioms constituting a scientific theory. In that case any scientific theory must necessarily be incomplete. In other words, there will always be phenomena that could be either consistent of inconsistent with the given scientific theory. This lack of completeness, certainty and definiteness is totally at odds with the Newtonian view.

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2
Evaluation of Scientific Enterprise in Pakistan

Abdullah Sadiq

Introduction

The scientific enterprise came into being in the earlier part of the twentieth century.[1] It became the most powerful tool at the disposal of any country willing to invest in human resource development for both benevolent and malevolent manifestations. Computers and communications, modern transportation, home appliances, sophisticated medical diagnostic and treatment facilities and the ongoing revolution in information technology and biotechnology are examples of its benevolent aspect. Weapons of mass destruction, which flattened in seconds the entire thriving Japanese industrial city of Hiroshima, smart weapons and the long-range guided delivery systems are its more recent strategic and malevolent products.

Developed first in the West, scientific enterprise has spread into other countries of the world with both its benevolent and malevolent features.

Background: Historical Perspective

The scientific enterprise, as it is practised today, comprises mainly two elements; science and technology. Both of these evolved independently since antiquity but from time-to-time reinforced each other. Initially science developed mostly out of human curiosity, an intrinsic quest for new insights and better understanding of nature. It was pursued as a pastime by financially well off individuals and occasionally some priests. Isaac Newton who discovered the laws of motion is an example

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[1] While science has its roots in antiquity, the scientific enterprise, the systematic and extensive use of science and technology, is a very recent phenomenon dating back to the post World War-II era.

of the first category while Copernicus who propounded the heliocentric view of universe and Mendel who found the laws of heredity represent the second. All the three together laid the foundations of modern science.

The fulfilment of human needs gradually led to development of technology, which was increasingly driven by its utility and demands of powerful groups in a society and less by quest for knowledge. Initially it was the result of inventive and innovative craftsmen in their quest for new, better products and processes. Thomas Alva Edison, the inventor of the electric bulb and the gramophone and Alexander Graham Bell, the inventor of the telephone, represent such inventors and innovators.

By the end of the Second World War a significant change occurred in the structure and forces of production and its relation with science. Prior to this, as mentioned above, science and technology developed independently, albeit occasionally reinforcing each other. During and especially after the Second World War both these ancient and by now highly developed products of human ingenuity were combined into the forces of production. This drastically enhanced the scale and complexity of production as well as of S&T. As a consequence of this merger of science with technology and its close association with production the scientific enterprises was institutionalised around professional and bureaucratic organisations. Most of the new breed of scientists were not driven by curiosity but pursued science as their vocation and job. The same was the case with technologists. Secondly, large-scale production of S&T required considerable funds, which individual scientists could not afford. As a result, in Western countries where S&T flourished, state and industry took over the task of organising, financing and encouraging S&T, most of the time jointly and occasionally separately. The state did so essentially for its defence needs and industry for maximising its profit. Eisenhower, the President of US called this fusion of interest as military industrial complex. Such fusion did not occur in the countries with centralised economies and the industrially less developed countries where

S&T was included in the state guided planning and development.

In Pakistan, as in the case of most less developed countries, industrial development was slow and a strong entrepreneurial class that could have fuelled the development of S&T failed to emerge. This made the state the exclusive sponsor of S&T. This was to decisively shape the direction or lack of direction of S&T policy in Pakistan. Like all states, and especially in Pakistan, the priority was its defence needs. It became its highest priority under external and internal political pressures that the country faced. The high priority that state gave to defence needs pushed down socio-economic development of the country to the bottom of national agenda. Pakistan inherited a weak S&T infrastructure as well as skilled and literate human resources. It took time to build such a structure. In addition, lack of adequate development of mechanism for evaluation, implementation and monitoring of S&T programmes and changing them in the light of their performance did not occur. These arguments are discussed in detail, later in this paper.

The Infra-structural base for S&T

First major difficulty that Pakistan faced was lack of adequate infrastructure for S&T. At the time of independence Pakistan inherited only one university, a handful of small Research and Development (R&D) institutions and very few industries. Local scientific manpower was weak. Most of the scientists who played a pioneering role in building the scientific infrastructure were migrants from India.[2] They made significant contributions to the development of S&T but their efforts were constrained by their small number and absence of a strong pool of local educated talents.

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[2] They included Salim-uz-Zaman Siddiqui, Raziuddin Siddiqi and I. H. Usmani. Abdus Salam, who was to play a major role later, was still a young rising star on the horizon of the international scientific scene. Later he made significant contribution during the Ayub Khan era by mobilising the R&D efforts of the country.

Within this limitation and marred by political instability, the state could not formulate a coherent science policy and commit adequate resources to the development of S&T. The first systematic efforts for policy and planning for S&T were initiated in early 60s. A meeting for this purpose was held in Swat in 1965 just before the war. But the war and its effects changed priorities in country's science policy. Stoppage of aid and flow of Western arms raised the demand for developing local arms industry and importing them from other countries. This aborted the process of formulation of balanced science policy in which both defence and social development needs could be accommodated.

More extensive and exhaustive debates on the science policy took place during the last three decades. In the early 70s, Pakistan was faced with major policy dilemma created by certain external factors and internal political dynamics. The external factor was India's nuclear test in 1974 prompting Pakistan to accelerate its weapon related nuclear programme. This was supported by internal political dynamics. Subsequently West imposed embargoes on Pakistan prohibiting the transfer of nuclear and related technologies, apprehending in fact that Pakistan would sooner or later carry out its own test. As a result, Pakistan government further raised the priority of this programme by further concentrating its limited financial and human resources to achieve quick success. Consequently, there developed two tracks of scientific enterprise in Pakistan: one focussed on development of nuclear weapons and the other on S&T for meeting the needs of Pakistani society and people. Due to reasons discussed below high priority assigned to nuclear programme helped it to achieve its primary goal of testing nuclear weapons in 1998 and made some significant contributions to agriculture and medicine and some contributions to industrial and human resource development, the performance of low priority development-oriented S&T remained poor.

The difference between the two tracks at policy level got amplified at the level of implementation of policies and programme. The strategic track was far more effective, partly due to the reasons stated above and partly because of its better implementation. From the very outset, some of the strategic organisations focused their efforts on inducting the best available professional manpower and arranging their education and training in leading centres of learning around the world. On the other hand, efforts and resources of non-strategic organisations concentrated primarily on the development of the infrastructure of brick-and-mortar type and, to some extent, in importing expensive laboratory equipment. These organisations did not give enough attention to inducting, training and retaining quality manpower that could effectively use these sophisticated facilities. Difference in performance of the two tracks was also due to the difference in calibre and continuity of their leadership. Leadership of the strategic track, by and large, was not only able to motivate and inspire their colleagues but could also convince the governments to continue providing them the necessary resources.

Other weakness of development oriented S&T organisations that affected their performance considerably was their inability to introduce effective monitoring and evaluation procedures. Evaluation received far less attention than monitoring. This led to wastage of their already meagre resources and to encouragement of mediocrity in many non-nuclear R&D organisations. The situation has somewhat changed recently. In the fall of 2000, the Ministry of S&T initiated a process of monitoring and evaluation through a number of peer review committees. As a result most of the R&D organisations have now been reviewed. However, in some cases the recommendations of these committees have not been strictly followed and the funds allocated to them may not be judiciously and effectively utilised.

The growth pattern of non-strategic S&T in Pakistan is marked by long indifference to its development followed by periodic sudden jumps that also adversely affected its performance. Before 1997, during 50 years of existence of the country, only two periods - that of Ayub Khan and Z. A. Bhutto - are marked for serious interest in the development of S&T. The remaining period is characterised by indifference of governments. This fluctuation in interest indicates lack of sustained planning efforts. Following the 1999 coup and after Professor Atta-ur-Rahman became Minister for Science and Technology, a new and much more vigorous period of interest in development of S&T has begun.[3]

Distribution of Benefits of S&T in Pakistan

Generally at initial stage, the benefits of non-strategic and development oriented scientific enterprise accrues to the better off in the society. Later on they gradually trickle down to the common people as has happened in industrialised countries. In Pakistan, this is yet to happen at some significant scale for different reasons. Priorities for R&D work are determined, led and directed by an elite in the scientific establishment. Except for a tiny elite engaged in R&D most of the policy and decision-makers, scientists, including engineers and technologists are not very sensitive to gearing the scientific enterprise to serve people's needs. Consequently no significant research is directed toward solution of people's problems except in the area of cotton and grains where recently local R&D has produced better varieties. Education and research conducted in our institutions is by and large not relevant to the problems being faced by the common man and not related to indigenous skills and technologies. In such a situation the benefits of whatever limited research has been done by this elite reaches only to the upper classes and urban middle class.

Conclusion

S&T planning in our country in non-strategic track has been impulsive and unsystematic without having any specific goals and time-targets. Not much attention has been given to the integration of applications (product and process development) with research (the generation of knowledge) and education (the dissemination of knowledge). Applications, research and knowledge mentioned above have seldom been related to

[3] For details see S.T.K Naim's paper in this volume, pp. 121-131.

economic development. The recommendations of policies and plans have rarely been implemented. In most situations right people have not been given leadership positions and no specific criterion has been laid down for selecting such leaders. At the implementation stage the emphasis has been first and foremost at the brick-and-mortar structure, then equipment and the least of all on the human resource. Except in the case of a few strategic organisations there has not been any systematic effort to attract and groom the best available talent. Then, until recently, there is the familiar problem of not having enough resources for literature, equipment and spares. Nor has any provision been made for any built-in monitoring and evaluation mechanisms.

Recommendations:

As discussed in the main body of this paper the most critical decision that affected the development of S&T was for assigning high priority to the strategic path, a decision, which has been consistently supported by all governments. Given current perceptions about security of the country, it is highly unlikely that there would be any significant change in the government's policy. Therefore, all efforts need to be directed towards improving the performance of non-strategic S&T. To do this it should be ensured that the scientific enterprise takes roots in the local culture and does not remain an isolated foreign element. In order to facilitate this, following steps needs to be taken:

1. Create a better awareness among the practitioners of this enterprise about the contributions of Muslims and as well the earlier indigenous cultures of this region to S&T.
2. Create familiarity with and inculcate a respect for the indigenous skills and local farming and handicraft practices. Improve and enhance these with the help of modern S&T whenever feasible.
3. Encourage multi and interdisciplinary work integrating research and knowledge with applications.
4. Implement existing priority policy and planning decisions and incorporate monitoring and evaluation procedures through regular peer and end-user review processes and

ensure that the findings of such review processes serve as basis for future funding of individuals, institutions as well as scientific and technological disciplines.

5. Give top priority and most attractive financial incentives to attract and retain the most creative minds to the scientific enterprise. Provide such individuals with the necessary working conditions and to challenge them to solve the most difficult problems faced by the society.
6. Give the necessary freedom to those who have an aptitude and passion for creative work to work on the frontiers of knowledge in their respective fields and to reward and award them for excelling in it.
7. Inspire and motivate the talented youth of the nation at crucial stage in their careers to opt for careers in S&T through highly competitive high profile programmes such as the International Olympiad in mathematics and basic sciences.
8. Establish special institutions for the training and education of talented youth, who have demonstrated excellence. Provide liberal scholarships for their higher education in scientific and technological disciplines.

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Comments by Q. Isa Daudpota[4]

As Pakistan's S&T establishment moves towards selecting an 'objective' criteria for assessing research quality, it has failed to expend adequate effort into looking at the relevance of the research being done for solving clearly identified national problems. The current infatuation with crude measures such citation records (and the spurious impact factor) has been coupled with a failure to touch the essential aspects of development. S&T in Pakistan need not ape the West by becoming a competitive game for seeking grants and promotions -- a tendency, which will increase now that the S&T coffers are full. Alas, that there are several proponents of this approach -- something that has failed in the past and will continue to cause grief.

As. Abdullah Sadiq notes in his paper in this book, the most successful area of Pakistan's S&T achievements has been in "strategic" projects (read 'defence and military'). It is essential to question the S&T agenda of the state to check whether it is geared to the real needs of the people. For changing this agenda to serve such needs, civil society's input in all aspects of planning, monitoring and evaluation will be necessary.

To promote a people-oriented S&T policy, Pakistan’s science establishment first needs to identify the most pressing problems of the people. It should then corral the necessary human and financial resources to find technical solutions backed by sensible social practices. It is important to gather a critical number of motivated individuals in teams and give them the freedom to find innovative solutions. Such groups will need monitoring and evaluation by peer groups and enlightened members of the public.

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3
Why Science Doesn't Take Root in Pakistan?: A Few Preliminary Thoughts

Anis Alam

During the colonial rule of over a hundred years, colonial authorities had created an extensive bureaucracy, a highly developed technological system (canals, railways, telephone, telegraph, and myriad of other scientific and technological departments that required a large number of educated and qualified technical staff to maintain. Most of the highly qualified non-Muslim staff manning scientific establishments and teaching and doing research at academic institutions such as University of Punjab left the country for India creating acute shortages. This seriously affected the development of science in Pakistan at very early stage. In a bid to fill this vacuum a massive programme to produce needed manpower was started soon after independence in August 1947. New universities/Colleges were created. To produce e large number of degree holders that could be appointed against available posts the standards for entry level positions were lowered. Many scientific research institutes that were located in India were duplicated in Pakistan like Pakistan Council of Industrial Research (PCSIR). A lot of people were appointed that could not otherwise be selected. As a result standards were compromised. Research was neglected. This problem still haunts most of Pakistani institutions of higher learning.

The scientific and research system has expanded greatly since independence. However, shortages of properly qualified manpower to man these institutions still plagues the system. In 1996, there were 37 public and private universities that had a total faculty of 7,083. Of which only 28% or 1,965 held Ph.D degrees.[1] Out of this faculty, 4,410 were employed in science and technology subjects. Out of them only 33% held Ph.D degrees.[2] M.A/M.Sc. degree holders are employed to teach M.A/M.Sc. classes and in some cases even M.Phil classes. Since the available qualified manpower is at present thinly divided among a large number of institutions because of their rapid expansion, their impact is further diluted undermining academic/research standards.

Very little research is conducted in Pakistani Universities/research organisations. According to PCST report cited above, Pakistani researchers contribute just 0.063 % of the articles published in international mainstream research journals, compared to 2.1 % that their counterpart in India produce.

Pakistan has thus faced the twin problem of quantity and quality. The intake of students at post school level especially in science and technical subjects is very low. In 1996-97 the total enrolment in all of the post school institutions (12 General Universities - 8 Public, 3 Private) Engineering Universities, 4 Agricultural Universities, 5 (private) Medical Universities, one Private University of Management, was 106,258 (only 0.7 % of 17-23 years age group). The ratio of Science and Arts subjects in General Universities was 29 to 71. In addition, 256,000 students were enrolled in 532 degree Colleges. There were over hundred professional colleges that enrolled another 151,000 students.[3] In 1986-1987 the number of students studying science at M.Sc. level was just 9682.[4] (It is to be noted that this is equivalent to an American Bachelor degree). At the M.Phil. level the enrolment dropped to just 1,862. As can be noted the sample that would make up the stock of future scientists is very small. Very few of these went on to do Ph.D. It may be pertinent to note that it is at this level that new knowledge is created

[1] Pakistan Council for Science and Technology (PCST), *Science & Technology Indicators of Pakistan*, Islamabad, 1999.
[2] *Ibid*.
[3] *Ibid*.
[4] Pakistan Council for Science and Technology (PCST), *Scientific and Technological Education Indicators of Pakistan*, Islamabad, 1994.

through research. All over the world most research work is performed at the post graduate level. Since this level is not developed in most Pakistani universities, production of new knowledge is seriously being curtailed.

In the first forty eight years Pakistani universities produced very few Ph.Ds. In the last fifty years several hundred thousands graduates in various disciplines have been produced. However the number of Ph.D. produced by the universities and research institutions remains very low. During the first forty years, only 128 Ph.D. were produced in sciences by all the universities and research institutions of Pakistan. Of these 89 were produced during the 1982-86 period. Most of these Ph.D. were in chemical and biological sciences.[5] Physics, a subject essential for developing a nuclear energy program, has been a neglected science in Pakistan. In the first forty years Pakistani universities and research institutions produced less than a dozen Ph.D. in this field. The number has picked up since then, but is still insignificant compared to India, whose universities were producing over two hundred Ph.D. annually in physics.[6] In fact, of the twenty-two general universities in Pakistan only Quaid- e -Azam University has a viable Ph.D. program in physics. A directory of Pakistani scientists and technologists with a Ph.D degree (mostly from abroad) produced in the late 90s listed just over two thousand names. Ten percent of these had already retired. The situation has improved little since then.

The dismal state of S&T has also been acknowledged at the highest government level. A Prime Minister's High Level Review Committee on Science & Technology headed by the former Chairman of the Pakistan Atomic Energy Commission, Munir Ahmad Khan in its final report on 30th July 1996, noted that "Science, technology and education in Pakistan are in a dismal state and our limited infrastructure is beginning to crumble". The report further noted that there is no lack of S&T organisations. In fact the Federal Government maintains over

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[5] Atta-ur-Rahman, *Higher Education, S&T in Pakistan: A Matter of National Survival*, 1993, Karachi, Pakistan.
[6] *Ibid*.

165 such organisations under fourteen different ministries. However, "barring a few they are under-funded, under-staffed, poorly managed and consequently non-productive. They spend 95% of their budget on establishment charges leaving little or nothing for actual research".[7] The share of Pakistan in the total world scientific publications in 1993 was a mere 0.08 percent compared to 2.1 percent of India.[8]

Despite the dismal state of science in Pakistan its scientists have successfully built nuclear bombs, fired guided rockets, run nuclear plants for decades. However, these achievements have not changed the cultural outlook of Pakistani scientific community, which remains *the most irrational, retrogressive, conservative and least objective professional body* anywhere. I make this statement with full responsibility as a member of this community for over thirty-five years. This is especially true of the Physicist, responsible for producing the bomb and missile programmes. I think the main reasons for this sad state of affairs are to do with the facts that: science in Pakistan has never been introduced, taught, promoted, cultivated and practised for inculcating its critical, rational, liberal spirit and character. It has been generally confused with its scientific and technological artefacts (atomic bomb, rockets, planes, tanks, jets, cars, computers, electrical, opto-electric and electronic gadgetry, diagnostic and therapeutic medicine, chemicals, films, computers, satellites based communications, mobile phones, Internet, etc). The state has always sought to produce scientists who could solve scientific and technical problems while remaining socially and culturally conservatives. This is corroborated by the fact that well-qualified life scientists often publicly deny theory of evolution. Physicists often denigrate cause-effect relationship (causality). No representative body of Pakistani scientists and engineers, for example, Pakistan Academy of Sciences, Pakistan Institute of Physics, Pakistan Institute of Engineers, Pakistan Association of Scientists and Scientific Professions, Pakistan Physics Society has ever issued

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[7] Prime Minister's High Level Review Committee on Science & Technology, *Final Report,* 30th July 1996.

[8] *Higher Education, S&T in Pakistan: A Matter of National Survival.*

any statement or adopted any policy that was critical of government policies e.g., the Islamisation of science, the atomic policy. Relying entirely on state patronage for their sustenance and survival they have almost always operated as spokespersons for the government in power. As a result the government has never had any critical input from professional bodies to their policies that have shaped Pakistani society, economy, politics and culture. The government has always been right in their opinion. There are notable exceptions.

Since 1977, the state has wrapped its education policy in a steely scholastic framework that has decreed that every school science textbook compulsorily carries sections on religion in chapter elucidating methodology of science. The message is unambiguous to the young, study science, but only as a subject with lots of useful information disregarding its critical, rational, objective and sceptical methodology. Theology ruled as it did throughout the pre-industrial era. The kings, queens and nobles ruled through their arm might and the assistance of clergy.

Teaching of science in school, colleges and universities is done on pattern of religious seminaries imparting knowledge through rote learning of facts and theories with ability to recite them at will. In schools students are hardly provided opportunities to observe, experiment and test facts and theories that are thrown at them by the teachers. At post-school level the same practice continues. The students are again bombarded with lots of facts and theories but little opportunities to test their validity by applying them to problems. This is the basic reason that though a huge number of students graduate from colleges and universities in science and technological disciplines but very few of them go ahead to do research. Post-graduate education system has not developed in Pakistan except at very few departments and institutes.

Science was developed in Europe as a liberating force in opposition to the prevalent dominant forces of the clergy and the feudal. In the developing countries Christian missionaries under the protection of European colonial powers in general introduced modern science. In the mind of the public, it was identified as an alien and coercive force associated with an alien power that used it to establish, secure, promote and develop its own political, cultural and economic interests.

Amalgamation of Science and Religion

Even after the departure of colonial powers and announcement of independence, science is seen only as collection of facts and theories to be remembered. Technology is seen only as useful gadgetry. Scientific method, its universal efficacy, its liberating role are generally neglected. In Pakistan a dangerous trend has developed over the last fifteen years or so. Attempts have been made at the state level to undermine the objectivity and rationality of science by rekindling the debates long forgotten in Europe. Throughout the Zia period, (1977 onwards) a confusing mixture of science and religion was promoted. Scarce resources that ought to have been devoted to the promotion and development of science were wasted on activities that only promoted an anti-scientific attitude and values. Federal Ministry of Science and Technology - that was created to promote science - was used to organise an international symposium on "Science and Islam" in 1980. It was sad to see the foremost professional bodies of scientists and engineers in Pakistan to get on this bandwagon. Three years later the Pakistan Association of Scientists and Scientific Professions (PASSP) organised an international conference on "Science in Islamic Polity[9] –Its Past, Present and Future" in collaboration with the government of Pakistan. Millions were lavishly spent on the arrangements. Among the participants of these meetings were almost the entire hierarchy of Pakistani science, professors, deans, vice-chancellors, heads of research organisations, heads of Ministries of science, education, industry and commerce. In 1986, PASSP organised another international seminar on "Quran[10] and Science" attracting luminaries of scientific and educational

[9] Proceedings of the International Conference on "Science in Islamic Polity – Its Past, Present and Future," 1983, Islamabad.

[10] Proceedings of the National Seminars on "Quran & Science," 26th June 1986, Karachi, Pakistan Association of Scientists and Scientific Professions (PASSP).

establishment as in earlier moots. The 80s were thus wasted in such frivolous activities. Competent scientists instead of diffusing their knowledge by writing books in their area of specialisation spent it to prove that religion offers a better understanding of the physical, chemical and biological and cosmic world than science!

Needless to say, these activities neither served the cause of religion nor of science. They only confused public and allowed sycophants to play up to the powerful General Zia. All these state-supported activities facilitated the Talibanisation of Pakistani society, which ripped it apart by continuing sectarian conflicts. When three quarter of Pakistanis are kept illiterate and the rest are administered a dangerous mixture of outmoded customs, practices, views and blatant lies, the average person succumbs to the propaganda of religious bigots. If people are properly educated so as to fully develop their critical faculty and their creativity, then they will be able to penetrate through the smoke screen of intolerance, hatred, prejudice and patent falsehood.

Militarisation of Pakistani Science

The events of 1971 with their culmination in the secession of the eastern wing from Pakistan, however, changed the direction and thrust of Pakistani nuclear programme. The new man in power, Zulfikar Ali Bhutto, changed the goals of the Pakistan Atomic Energy Commission from pursuit of nuclear power for peaceful purposes to the preparation of atomic weapons. Due to this change, foreign suppliers of the Karachi nuclear reactor had suspended the supply of enriched uranium needed to fuel the reactor. Thus, from the mid 70s Pakistan tried to develop self reliance in nuclear fuel, and PAEC started an ambitious programme for achieving self-reliance in basic nuclear technology. A Centre for Nuclear Sciences (CNS) was established at PINSTECH to train the manpower needed for the nuclear programme. Other centres were established for exploration, mining and refining of Uranium ore, for fabrication of nuclear fuel rods, for instrumentation and for advanced computation.

The Prime Minister was in direct control of the PAEC. It was not under government audit. From 1976 the work of PAEC came to be supplemented by the Kahuta Research laboratories (KRL), which were set up by Abdul Qadeer Khan, a metallurgist by training, to produce enriched uranium. By the mid 80s KRL had been able to produce enough enriched uranium to make several atomic bombs. According to Abdul Qadeer Khan, in twenty years KRL has become a full-fledged research and industrial complex. It has around 7000 skilled and professional people. Of these more than two thousand have Ph.D/M.Phil/ M.Sc./B.E. degrees. The number of Ph.D/M.Phil is, however, not more than a few dozens.

It is essential to understand that since 70s, Pakistan's atomic energy programme has been basically a programme to acquire capability to make atomic bombs. This programme should be considered as part of the procurement programme of Pakistan's armed forces to acquire effective and lethal weaponry. Atomic bomb for Pakistan's defence establishment is an extremely effective weapon like any other weapon just more lethal, more effective and far more destructive. The goal of acquisition of the capability to build a nuclear bomb has been pursued with single-mindedness. No obstacle, administrative, material and financial, has been allowed to come in the way. Lavish funds have been provided. Since Pakistan lacks an industrial and technological complex, the needed technical and industrial facilities have been constructed just to serve the nuclear programme. The success of the programme was proved by the May 98 explosions. S&T in Pakistan has come to be associated with nuclear capability only.

Total concentration on nuclear programme for production of atomic weapons has greatly harmed Pakistani science, technology and industry. Even official Pakistani publications have repeatedly pointed out the poor state of Pakistani science especially nuclear physics related sciences i.e. solid state physics, microelectronics, metallurgical sciences and various others. Despite consuming the lion's share of all allocation for scientific research for the last decade and half, direct benefits of Pakistan's nuclear programme to the country are quite limited.

Since its establishment it is yet to add one single kilowatt of electricity to the national grid as no country is willing to sell Pakistan a nuclear power plant for the generation of electricity lest it is used to support nuclear weapon programme. This is despite the fact that the manufacturers of Nuclear power plants in USA and Europe are desperate to export their plants because of stagnant demand in their own countries. Had the human and financial resources spent for developing nuclear capability been allocated to the development of S&T - directly beneficial to Pakistani society - this would have raised both the level of advancement of S&T as well as development of a better economy and society.

Since the mid-70s there has been no significant programme to train manpower in the above-mentioned disciplines. In fact the development has been in the reverse direction. The standards of science education and research have deteriorated to the level that has alarmed all well-wishers of Pakistan.[11] Without trained manpower, scientists, engineers, and technicians in adequate numbers, backed by requisite infrastructure, Pakistan's quest to develop a sustainable nuclear capability will just be an idle dream. It may make one or several crude atomic bombs but she will not have a viable nuclear power programme.

Pakistan will be able to devote her considerable potential to overcome her state of underdevelopment only when she cultivates knowledge in general and science in particular in its true critical spirit.

[11] Moravcsik, Michael, *Letter to General Zia ul Haq, President of Pakistan*, quoted in Abdus Salam, *Science and Education in Pakistan*, pp.22-23, Third World Academy of Science, Trieste, Italy 1988.

Comments by Anwar Nasim[12]

Any assessment or criticism of the funds invested in nuclear programme should also clearly discuss and define, the political options for Pakistan given current scenario in the sub-continent. The statements such as "Total concentration on nuclear for production of atomic weapons has greatly harmed Pakistani science, technology and industry" need to be expanded giving specific examples.

There are areas where Pakistani scientists have achieved success, such as in the field of Agriculture (as reflected in producing enough food for significantly larger population) which needs to be documented given a balanced picture.

In addition, during the past 2 years or so a number of new initiatives have been taken in S&T. Anyone attempting to comment on S&T in Pakistan should briefly review these initiatives also.

It would be indeed worthwhile if Anis Alam can find some time to update the article specially commenting on policy options for Pakistan in nuclear technology and the current initiatives taken by the Ministry of S&T (MoST) since Prof. Atta-ur-Rahman took over as Minister for S&T.

[12] Chairman National Commission on Biotechnology, Islamabad.

Comments by Shahzad A. Mufti[13]

As the title of the article suggests, the contents are indeed quite preliminary. The author has basically identified two reasons for science not taking root in this country. These are, firstly, the theological beliefs and secondly too great an emphasis on nuclear technology for weapon development.

True as these two facts might be, this is far from a comprehensive story. There have been a number of other contributing factors, which the author has not dwelled upon. Starting from 1947, stark economic realities have been such that science education and research had to, by force, take a back seat. The limited financial resources available at that time had to be diverted primarily towards basic needs, such as food procurement. With rampant population growth and lack of resources, with a pitiable state of literacy per se, there was absolutely no environment for scientific development and enterprise. It is also true that there has been and still exists, a definite and hugely influential, feudal (and hence legislative) lobby within this country which has hindered promotion of education and hence S&T. How could there be growth in S&T without a sound educational base in a society? Thus, instead of lamenting lack of scientific research, the first order of business should be to increase the rate and standards of education in this country.

Another important aspect the author has not discussed is lack of a decent service structure offered to scientists in the country. Look at the service structure of Pakistan's Armed Forces, Civil or Police Service – or even Income Tax and Custom Service and compare it with that of a scientist. Who could blame our youth, if they do not take up science as their career?

All these factors have contributed towards the mass exodus of many of our promising scientists, who had still endeavoured to study science and were good at research. They were given

[13] Former Chairman Pakistan Science Foundation, Islamabad.

lucrative offers and many other incentives to emigrate, which they did. This trend exists even today. Pakistani educational institutions still somehow manage to produce scientists of great merit – but hardly anyone stays here. They go abroad and make a name for themselves, but Pakistan does not bother nor has any viable programme – like the one in China or Korea – to attract and retain them. Thus, identifying only orthodox religious culture or excessive expenditure on atomic energy, can only be two of a large number of reasons. The malaise is much deeper and multifaceted.

4
Fifty Years of Science in Pakistan in Socio-Economic Context

Riazuddin[1]

Pakistan is not a small nation. One out of every 43 people in the World is a Pakistani. However, Pakistan is ranked 127th in the world in terms of basic literacy. Though we are only 8th of India's population we have 8,500 research scientists to India's 120,000. Our contribution to the World's scientific literature was one 100th of 8% in 1994. As Prof. Salam says, "Science-based high technology is a word which has not yet entered into current usage in our country". One of the many reasons for this dismal picture may be illustrated by the fact that though we spend about US $2,000 per soldier in Pakistan we spend about US$ 2 per student.

About 44% of Pakistan's population does not have access to health facilities, 50% are without safe drinking water and 66% are deprived of basic sanitation facilities. Put in another way Pakistan is ranked 121st in the world on health expenditure per capita and 95th in respect of percentage of population with access to safe drinking water. Though about 30% of its population live in absolute poverty, its markets are full of consumer goods and do not reflect the dismal state of the social indicators mentioned above. This sharp contrast between apparent economic growth and the above social indicators proves that there must have been something wrong with our priorities. If our national priorities are not rearranged soon, the economic, social and political fabric of Pakistan may degenerate to an unsustainable level.

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[1] Based on a speech given on the occasion of Golden Jubilee of Pakistan Celebration at a special session of 22nd International Nathiagali Summer College in August 1997 presided over by the President of Pakistan.

As Prof. Abdus Salam has emphasised time and again, "the widening gap in economics and in influence between the nations of the South and the North is basically the science gap". It is thus important that we analyse the state of science in Pakistan, which I would like to do with a reference to: (a) political commitment; (b) indigenisation and self-reliance; (c) manpower; (d) internationalisation.

Political Commitment

One of the most important factor that determines the level of development of science in a country is the political commitment of its leaders. Salam has emphasised this in the following words. "It is a political decision on the part of those (principally from the South) who decide on the destiny of developing humanity if they will take steps to let the deprived ones create, master and utilise modern S&T."

Among the South Asian leaders, Prime Minister Jawaharlal Nehru of India was the first one to realise his duty in promoting S&T. Initiating the debate on May 23, 1956, in the Indian Parliament on the 2nd 5-year plan of his country, he stated: "When we talk of planning we have to think in technological terms, because it is this growth of S&T that has enabled man to produce wealth which nobody could ever have dreamed of". It is that which has made other countries wealthy and prosperous, and it is only through the growth of the technological process that we shall grow and become a prosperous and wealthy nation; there is no other way. Therefore, if India is to advance, she must advance in S&T, and India must use the latest technologies. But the fact is that our poverty is due to our backwardness in S&T, and by the measure that we remedy that backwardness, we create not only wealth but “employment”.

With political support of Nehru and the vision and advice of first rate working scientists, like the late Dr. Homi Bhabba, India was able to establish the first nuclear reactor in Asia outside the Soviet Union. Not only did India set up four excellent Indian Institutes of Technology for which the U.S, the U.K., the former Soviet Union and the German government consortia competed for. These Institutes provided an indigenous base for highly scientifically and technologically trained manpower. The result is that, India is one of the advanced countries, not only in nuclear technology but also in other technological fields particularly information technology. It is reflected in the statement of Microsoft Corporation Chairman Bill Gates in a visit to India: "The importance of India as a software country and a place in which we have decided to invest is greater than China". In 1996 the industry was worth US$ 1.2 billion with a compounded annual growth rate of more than 50% which is unheard of elsewhere. In 2000, this industry was worth probably US$ 6 billion.

As of March 2000, India had over 340,000 employed software professionals. A World Bank funded study in the United States confirmed that vendors rated India as their primary choice for out-sourcing. Not surprisingly, as of Oct. 2001, India had 32 companies at SEI CMM Level 5 when there are only about 58 organisations across the World, which have acquired this assessment.

Even after 55 years of its creation, Pakistan has not made a strong commitment to S&T and a part of its planning process. In contrast when Prof. Salam suggested to a past Chairman of the Planning Commission that he should consult scientists in the planning of science based industries, the Chairman replied "Why should I consult the scientists? I do not consult my cook to show me how to run my household". Prof. Salam adds that he did not tell me "by what divine right he was heading the Planning Commission". It is essential to realise that in the conditions of today planning cannot be done in purely economic terms. After all, the modern world and its problems are a creation of modern S&T.

One needs not sound totally negative about development of S&T in Pakistan. From two universities at the time of partition, today there are 35 public sector universities in Pakistan. From an almost non-existing science base it has now about 10,000 research scientists. Pakistan's share of world research authorship and citations of Pakistan papers show some growth, at least the slope is not negative.

Most of the progress that Pakistan has made in S&T has its origins during the tenure of President Ayub Khan who made the first political commitment to develop science and education. He gathered around him some of Pakistan's prominent scientists and appointed in 1961 a young and brilliant theoretical physicist, Prof. Abdus Salam as his Science Advisor. During his period (1962-69) not only an infrastructure for science was created but a massive effort for manpower development was also undertaken. The Pakistan Atomic Energy Commission (PAEC) was revitalised with the late Dr. I. H. Usmani as its Chairman, (a bureaucrat with a Ph.D in Physics who had a passion for the development of science) with Prof. Salam as its active Member.

During the Ayub era, the Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan Institute of Nuclear S&T (PINSTECH) with a 5 MW Research Reactor, the Nuclear Power Plant near Karachi (KANUPP), Agriculture Research Centres at Faisalabad and Tandojam and Nuclear Medicine and Radiotherapy Centres at major hospitals, the National Science Council and the Pakistan Science Foundation were created. Also during this period the PAEC embarked on the programme of training more than 500 scientists in areas of experimental and theoretical physics, nuclear chemistry, health physics engineering and agriculture. These men by and large constituted Pakistan's major stock of trained manpower in the relevant disciplines.[2]

Quaid-i-Azam University in Islamabad was also created under Ayub Khan's patronage. He had visualised the importance of creating a postgraduate university concentrating on research and graduate programmes in S&T and the hard social sciences to ensure that the university is developed properly and gets international support and collaboration. He used his personal influence to get two crucial grants for the University. These

[2] The subsequent Pakistani leaders continued their support for nuclear technology.

were the Ford Foundation grant, which was effectively used for short term international contacts and the UNDP grant, which was mainly used for the development of experimental facilities and for long term visitors relevant to the fields to be developed. The results were encouraging and according to our peers, the Institute of Physics at the University was on the international map as an active centre of research in the highly competitive field of theoretical particle physics in which we could form a viable group in the very beginning. For the first time in the history of Pakistan, a graduate programme leading to Ph.D degree in Physics was started on a regular basis. The Ph.Ds produced were of the highest international standards. The above examples forcefully bring out the importance of political commitment at the highest level for a scientific enterprise to flourish.

Since the period 1962-1969 Pakistan has had several reviews of science policy without making much impact. The main reason is that those reviews were not performed by working scientists, but rather by people "with no personal experience in developing science, with no perception about the nature of science and its role in any country's development, and with no vision and no elan'.[3] Moreover, those policies lacked a built-in implementation mechanism. Many Research Councils, which were created from such policy reviews, failed to make any impact. Apart from budget constraints, there is a basic reason for their failure. They could not establish themselves as customers to prospective contractors in industry, utilities, government departments and defence. Unless a customer contractor relationship, with a built-in accountability process and research support, is not established, such Councils are not going to succeed. Contractual research is an alien word in Pakistani science.

Indigenisation and Self-Reliance

None of our governments has ever made it a national goal to acquire self-reliance even for defence technology. Rather, the

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[3] M.J., Moravcsik quoted by Abdus Salam in *Science & Education in Pakistan*, Third World Academy of Sciences, 1988.

attitude of our planners for most of the time has been that we need not develop or transfer a technology when we can import finished products. The result is that Pakistani markets are full of finished consumer goods, which is not indicative of our level of technological development. And we have paid scant heed to the scientific base of technology. Indigenisation is a slow process by its nature but it pays in the end. The establishment of indigenous scientific capacity for research and development is essential. It produces not only an awareness of significant developments of world S&T and their potentialities, but also enables a country to make autonomous technical decisions in negotiating, purchasing and assimilation of technology according to its economic and social needs.

Manpower

Development of S&T requires more than material infrastructure. It is development of manpower at different levels that fosters it. In Pakistan, inadequate attention has been given to this aspect of the development of science. Prof. Moravcsik who visited Pakistan several times in his letter to the then President of Pakistan after his last visit in 1987 wrote: "In surveying Pakistani scientific manpower, one is struck by its being overwhelmed by older people. In 1962[4], when I first came in contact with Pakistani science, there was a large group of bright young men in the sciences, many still in the process of being educated at an advanced level, but most already showing talent and achievement. Many of them contributed to science significantly in the following years. Members of that generation today are in their mid-forties or mid-fifties, some still productive, but the group, on the whole, is declining in its contribution to research, perhaps because of administrative preoccupations, perhaps just out of general tiredness."

The Ministry of S&T in 1985 reserved over 10 years 1,500 overseas scholarships for Ph.D in newly emerging fields to alleviate the problem of lack of development of manpower. This

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[4] This was the time when PAEC undertook the massive training programme as mentioned earlier.

commendable scheme, however, did not make a significant difference, as one would have liked. One of the reasons appears to be that such Ph.Ds could not get absorbed into the Pakistani science and education sectors due to lack of appropriate research centres.

Pakistan does not have an equivalent of the Indian Institute of Technology (IIT) with the possible exception of the Quaid-i-Azam University to take care of manpower development. Perhaps we can strengthen the science departments in the existing universities for indigenous Ph.D programmes or by setting science centres in some key areas. However, the science centres, are built around towering individuals to flourish and succeed. The International Centre for Theoretical Physics, Trieste, Italy (ICTP) was built around Prof. Abdus Salam, Tata Institute at Mumbai around Dr. Homi Bhabba. HEJ Research Institute of Chemistry in Karachi was built around Dr. Salimuzzaman Siddiqui and is one of Pakistan's designated Centre of Excellence by the Third World Academy of Sciences. It is headed by Prof. Atta-ur-Rahman and is spearheading research and post-graduate education in Chemistry. The same cannot be said about National Centre of Physics (NCP), which is still in an embryonic form and has yet to find a permanent status.

To promote high technology, we can create a National Centre for Information Technology, which assesses future scientific and technological trends and sets about bringing scientists and technologists together with economists, investors, industrialists and government funding agencies. There is another reason for creating such a centre. It can provide two ingredients that are essential for the development of technology: (i) recognition of its need and (ii) expertise to make it work.

The government of Pakistan has recently recognised the need for information technology. This technology is affordable as it does not require much capital investment like nuclear technology and has a world wide market, as shown by the example of India mentioned earlier. What is missing in this field is expertise, which we lack, particularly at the higher level. The proposed centre will provide the highest level of technical expertise and knowledge in the field of information technology. At present there is not a single institute in Pakistan, which is carrying out such an effective bland of research and teaching activities. To be sure, the Pakistani government as well as the private sector have established many IT institutions. But all of these work at the lower end of the spectrum for creating skilled manpower while the proposed centre will work at the upper end of this spectrum by carrying out high level R&D programmes. It would also provide a platform for communication among the government, private sector, the customer and more importantly the expatriate Pakistanis working in this field. It would provide intellectual backing to the Software Export Board. Without such a backing it will be difficult to compete globally. Ultimately, the Pakistani computer industry will have to create its own software instead of developing packaged products.

A consortium of industrialists should establish the above-proposed Centre in Pakistan, as ultimately they would be its beneficiaries. There has been no success so far. Whoever establishes this Centre, whether industrialists or the government, it should be at the same place as the Physics Centre located in the campus of the Quaid-i-Azam University (QAU). There will be other advantages of locating this centre at QAU. The Pakistan Institute of Development Economics is already at the Quaid-i-Azam University campus as well as the National Centres for Physics and Information Technology. Such clustering can bring together scientists, economists, investors, entrepreneurs, and government finance agencies to better prepare Pakistan for the 21st century. I have not mentioned Chemistry and Biology since an excellent HEJ Institute of Chemistry already exist in Karachi. A Centre for Advanced Molecular Biology, at the campus of the Punjab University, is joined by the National Institute of Biotechnology and Genetic Engineering at Faisalabad.

Internationalisation

Internationalisation of scientific endeavour is one of the important conditions for science to flourish in any country. This requires mobility for Pakistani scientists living and working in their own country. They should be able to travel freely to scientific institutions and meetings abroad, to migrate temporarily to anywhere in the world where their work will flourish and to collaborate with their colleagues at active centres of research abroad, while their positions are kept open at home. Some opportunities for international contacts are provided by The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, Another opportunity is provided by European Organisation for Nuclear Research (CERN).' With a rather small financial contribution, young Pakistani physicists can participate in research and development, which are at the very frontiers of not only physics, but also technology and computer software development. It requires a commitment of 2 million Swiss Francs (about 1.4 million US Dollars) over a period of 10 years. Out of this, half can be paid in kind so that a cash payment of nearly US$ 100,000 per year needed for travel and maintenance of physicists, computer software experts and engineers involved in the collaboration. Is it too much to expect from the 7th largest nation in the world, a meagre contribution of US $ 100,000 per year for ten years to enable its young scientists and engineers to contribute to man's stock of knowledge? Nevertheless, more of such international research-based collaborations are required.

Conclusion

The state of science, technology, and education in Pakistan, apart from a few bright spots here and there, is not much cause for celebration. In spite of this prognosis, there is no reason to be pessimistic. Growth of S&T at the highest level requires no more than one or two generations, as exemplified by the newly industrial countries of East Asia, South Korea and Singapore. All that is needed is a firm political commitment, patronage and dedication of scientists, technologists and educationists.

Equally essential is enlightened self-interest by the rich, instead of leaving the money to their children to let them squander it away. They should use it by investing their savings in high technology and education. In this way, they will be fulfilling their obligation to the poor and society by building hospitals, investing in the education of the under privileged and by patronising science. Development of science and country could occur if our businessmen listen to the warning and advice of Adam Smith mentioned below. If they "Maximise the profit' without discharging their obligations to society, then the State will have to intervene. If the State does not intervene then the man in the street will intervene since he can suffer only up to a limit. In that case every one will lose".

If we take steps to create, master and utilise modern S&T for the betterment of our society, we can follow Jamal Nasir’s advise: "Raise your head in pride and self-esteem, my brothers". Otherwise, there is a warning in the words of A.N. Whitehead, "In the conditions of modern life, the rule is absolute: the race which does not value trained intelligence is doomed. Today we maintain ourselves, tomorrow science will have moved yet one more step and there will be no appeal from the judgement which will be pronounced on the uneducated".

5
Warped Science Agendas: A Way out of the Morass

Q. Isa Daudpota

This chapter describes how and why our science agenda has been distorted. Realisation of past failures is the first step to find a new path. Pakistan needs a policy of science and technology (S&T) and an action plan based on the real needs of the majority of its people. Only then can it galvanise its resources to find a solution to the larger developmental issues.

In the musty cabinets of the Ministry of S&T (MoST) lie piles of policy documents, bearing marks of time and apathy. These tombs of good intentions have over the years listed all the wonderful things that S&T can do for us, if only we had the political support and the money to make them happen. Now, both the support and the money are there. Considerable funds are being allocated for the development of S&T. Things are apparently moving, but we are still working within the old paradigm of using S&T to gain "prosperity" without asking pointedly: who are the principal beneficiaries of this exercise?

Defence and Science Policy

Even when funding was grossly insufficient, forces within the Establishment sought to push the national security agenda to the forefront. It soon became the main beneficiary of the S&T enterprise. Hardly any voices from the S&T community opposed this; in fact many of them were co-opted by the state machinery to work on defence problems. Resources flowed into building up military S&T enterprises and trained persons followed to populate them.

Seemingly innocuous institutes such as Pakistan Atomic Energy Commission (PAEC), which ostensibly was to produce power for us, "so cheap that it wouldn't be worth metering" were created at great cost. Since our donors, the US government, had already convinced their own people about the nuclear enterprise, it seemed unreasonable for us to think otherwise! In fact, with successive military governments, and civilian ones too, control of S&T was wholly left to the vested interests of the generals and of powerful leaders of institutions such as PAEC. The research laboratories of PAEC, set up for developing peaceful uses of the atom, were largely transformed and focused on the manufacture of atomic weapons.

Large institutions, lacking public scrutiny, usually developed programmes based on internal plans of their own scientific elite, and to satisfy the demands of more powerful external outside. Legitimacy, when needed, was gained by glamouring the atom bomb's power, and getting Pakistan's only Nobel laureate Salam, his students and admirers to support and participate in the enterprise. The few successful offshoots of the atomic enterprise such as the high yield cotton plant and the radiation clinics for medical treatment were used to justify the high allocation of funds to the nuclear field.

There is no definitive information to evaluate the loss suffered by setting up the Kahuta lab which not infrequently duplicated work done elsewhere. The lack of information is a reflection of the secrecy surrounding its work – PAEC has been not much different. Interestingly, though, many in PAEC believe that the massive funding for Kahuta Laboratories was not well accounted for, and therefore wasted. Many socially beneficial projects could have developed instead of its uranium purification plant, its work on rocketry and other weapon systems.

PAEC and Kahuta Laboratories are places that started some decades ago. While they are still there to haunt us, the S&T scene has taken a turn for the better with the appointment of an energetic and knowledgeable minister for S&T. Not a day goes by without hearing about new projects being launched, particularly in information technology (IT). There are grants for doing research in our public labs and money has flowed to universities for enhancement of IT infrastructure. Despite the excitement that this new funding has generated, there are serious questions about the sustainability of the effort. This is because the scientific elite has forgotten to ask the right questions -- about who will benefit directly from the flurry of activity driven by increased funding. Before we discuss the questions, let us first look at some useful plans and ideas that have come about due to this government's doings.

Recommendations of National Commission on S&T

National Commission on S&T (NCST) is Pakistan's pivotal body for S&T. In its December 2000 meeting, proposed the following significant reforms:

(a) each R&D organisation will have a balanced representation on their boards from the public and private sectors;
(b) frequent government interventions in R&D policies will end;
(c) laws for regulating such organisations should be reformed to improve functioning;
(d) heads of organisations will be appointed on merit and they will be given the powers to 'hire and fire';
(e) inter-institutional transfer of staff will be facilitated;
(f) all organisations should submit business plans;
(g) regular monitoring and evaluation of institutions and projects;
(h) encourage fund development within organisations with earnings from sale of products and processes to be retained by the organisations.

This is an impressive wish list. But although the cabinet has approved these items, putting them into action will require courage and perseverance. Some key heads of S&T organisations remain sceptical of such reforms being implemented in spirit.

There are other overarching issues of S&T that determine the direction of the S&T enterprise. These are outlined in the following five important points:

a) We need a high level of literacy and quality education at all levels.
b) Universities and research centres require up-gradation.
c) Applied research and technology development is essential.
d) Policies of government should encourage entrepreneurs.
e) Most important factor: Creative people should be involved at all levels.

These make good sense and are familiar to most S&T workers, most of all Prof. Atta-ur-Rahman, from whose paper I have taken these points - written shortly after he assumed the hot seat in the Ministry of S&T.

S&T Policy and People's Needs

They do not, however, make explicit the social and developmental aspects of S&T – areas which have a direct impact on the majority of the people. Such 'trickle-down' development policies have repeatedly failed in Pakistan and the rest of the developing world. What is needed instead is an S&T programme that directly affects the lives of the peasants who live in villages and make up 70% of the population. However, current policies mainly aim at "fulfilling middle class dreams of a second-rate America of supermarkets and science-cities".

A long-lasting and fair agenda for S&T can only be build if the real needs of the majority of the people are given high priority. This can arise from an honest dialogue (a genuine two-way flow of knowledge) between S&T workers and people in need. Such a transformation may, however, raise the fear among some S&T workers that this would lead to "less sophisticated" science, one that would not allow them to publish their works in the prestigious journals of the West and thereby stop the accolades that we seek from outside.

Imagine the gratitude of the 140 million Pakistanis for our scientists and technologists who can solve, for example, the problem of food and water security, of providing clean water and energy for those whose lives remain stunted for lack of basic amenities. This may not be "high science" but it is essential science. Yes, science today is an international enterprise, but surely we must choose our own problems – their solutions should lead to innovative ideas, exciting science and useful technologies.

There are other advantages to this approach to S&T. Problems arising from such projects can lead to advances in basic sciences. Take the example of the phenomena of "diffusion" which is relevant to water seepage and salinity and of immediate interest to Pakistan's agriculturists. It can be studied at various levels and in different contexts. In the Silicon Valley, engineers look at its properties to make better silicon chips. So it is quite possible that mathematical techniques developed in an agricultural setting can be shared with those working in electronics.

All this does not suggest that basic sciences and technologies should be neglected. Instead, support for such work needs to be formalised, and about 10% of the total research and development budget must be allocated to it. Such funding should go to our brightest minds -- persons who would otherwise leave the country for lucrative research positions. At present the financial allocation for such "cutting-edge" research is ad-hoc and very limited.

Consumerism, degradation of the environment and the exponential population growth are problems that are fast undermining the quality of our lives. Active S&T programmes based on inter-disciplinary teams should be formed to tackle these vital issues. Due to the shortage of trained environmentalists, national and foreign training of a large number of dedicated persons in this area at the postgraduate degree level is urgently needed.

It is important to inform the public about how science can transform their lives. Scientists and engineers need to communicate what they know to others in their communities and through the media. The national media, particularly TV, should broadcast lively S&T and educational programmes at prime time to ensure wide coverage. In addition, curriculum reform needs to make all aspects of learning relevant to the life of the learner.

It is useful to look at Brazil where the S&T minister started a programme of generating fuel from sugar cane waste. This large project transformed major parts of the overall S&T effort. People took pride in using a waste product to produce valuable fuel. The other example that comes to mind is the learning experience of the Grameen Bank. Starting off a small-loans bank to the poor, it has now moved into telecommunication after gaining the confidence of those who most need a helping hand the most. Establishing a rapport with the public is essential for progress in S&T, as in other fields.

A large scale effort by our Ministry of Science and Technology is needed in two vital areas: clean water technology and solar thermal power generation. I believe that Prof. Atta-ur-Rahman has already moved toward getting this suggestion implemented. Many other such programmes can benefit from channelling adequate resources and the best brains into solving them.

Sustainable progress can happen if our policies are directed to the needs of the common people of this country. It can only be done with the help of our professionals putting into action an outward-looking S&T policy, which gains strength from solving our national problems first.

6
Impediments in the Development of S&T: Cultural and Social Structure

Tariq Rahman

While doing research on higher education in India a research scholar Edward Shils wrote:

> "I have not encountered one Indian academic who entered on his career under the pressure or the preferences of his elders. Parents encourage their offspring to enter government service, medicine, engineering and law but not university and college teaching."

Having carried out no scientific survey about this issue, I do not know whether this is true about Pakistan or not. But I rather suspect it is true. I know of no academics who want their sons to become academics. I personally would—but in the United States or Europe.

An academic needs not be a scientist, of course, but if we want to understand the phenomenon why the pursuit of knowledge is less important than other pursuits then we must understand people's desire to join academia. In any case, pure science is still valued more by universities than any other patron of science. Business and the state, while funding a lot on scientific research, do so for their own ends. In the case of business the end is to maximise profits. In the case of the state, generally the defence establishment, it is to obtain better and better weapons or defensive systems. Thus, if the university does not patronise science, basic science will not develop.

Let us now look at the cultural and social structure as impediments in the development of S&T.

The Non-Questioning Culture

A culture based on authoritarian values is necessarily non-questioning. Indeed, pre-modern cultures were all of the non-questioning type. Consensus was valued as it developed group cohesion. All love was focussed on the in-group and hatred on the out-group. The out-group was mistrusted and held in fear or contempt. If it was manifestly powerful then it was uncritically adored and romanticised. It was never treated as being equal and human: it was either demonised or deified.

This process required the transmission of group identity and that was the purpose of all socialisation including formal education. Since the educational process was supposed to transmit the group lore and values, it could not be questioned. Hence the emphasis was on rote learning rather than analytical skills. Among South Asian Muslims the Arabic alphabet and rudimentary Persian texts were memorised. Then the *Sarf* and n*ahw* in Arabic were also memorised. One read books and commentaries on books but one did not learn to question the books or what they taught. This, indeed, was sacrilege. At the highest level, of course, some *ulama* did develop the skill to apply their knowledge to new issues but they were the rare exceptions. This culture persists to this day. The examination system merely reproduces knowledge, as the idea of both students and teachers is to reproduce something to get marks and not to treat knowledge as a problem-solving skill.

In a number of issues ideology also discourages questioning. For instance, questions about the beginning of life and the solar system are often treated as taboo areas that must not be subjected to fresh questioning. This is because literal explanations of religious texts are held to be true religion instead of that quest of spirit, that hankering for ultimate human values, which are true hallmarks of spiritual life.

The Power-Orientation of the Culture

One cannot question in a hierarchical, power-oriented culture because the real ideology of such cultures, despite other names, which might be used for it, is power. The father, the husband, the village elders, the clan elders, the feudal lord, the government official, the boss, the government—all believe that their power should remain unchallenged and unquestioned. This creates a habit of passive acquiescence in most people. They simply accept everything, including the rationales given about the way life functions, and seldom think of questioning them.

Another thing which power-orientation has done to Pakistan is that it has made people value power in all its forms. People know that they will not get things done or even get their rights in the normal course of events. So they want someone powerful to become their patron. Thus parents want their children to join the state in some capacity or the other. The British in India created an internal brain drain away from the academic and scientific professions and put into the state's bureaucracy. Thus, the ICS (or the CSP in the context of Pakistan) became the graveyard of academic ability. One does not know how many Dr. Salams spent their lives seeing files but one does know that many did.

As money is also a kind of power, the brain drain continues. Brilliant young people tend to join banks, foreign bureaucratic organisations (UNO, IMF etc), NGOs and the industry but they are not attracted to pure academics. The new private universities—the one-subject degree mills one sees sprouting everywhere—also teach job-oriented subjects (i.e. subjects which tend to empower students). They do not teach pure science. However, they do teach technology. But technology does not really take off without the scientific base and our power-oriented culture does not value this at all. Thus, while the state gives perks and power to its functionaries; civil, military and private entrepreneurs give them fabulous salaries. The public universities, on the other hand, cannot compete with them to offer anything substantial to pure scientists either in terms of salaries or perks and material benefits. Therefore, disparity leads to all sorts of problems for which only the faulty educational structure and ill-devised policy can be held responsible.

Non-acceptance of Pleasure

Another point, and one which is almost never touched upon, is that ours is a puritanical, non-pleasure loving culture—officially at least. While it is commendable to say that one is studying or doing research for the nation or for one's community or to produce wealth and development in the world, it is taboo to say that one is working because it gives one pleasure. The biographies of great scientists like Einstein verify the fact that they enjoyed the process of discovery for its own sake. They found tremendous gratification in discovering new things irrespective of whether they were useful or not. Yet, the moment scientists confess this, people accuse them of self-indulgence. Capitalists vow not to pay them for having their fun. Bureaucrats will not hear of a project, which is not clothed in the language of 'national interest'. Administrators, especially if they are non-academics, would like to put more teaching loads or compulsory research upon them. Indeed, the whole world is up in arms if scientists use the language of pleasure rather than the language of duty.

While true elsewhere in the world also, this is especially true in Pakistan where people not only pay less to academic scientists to begin with; but are now discussing how to curtail their autonomy and leisure too. Indeed, the new universities coming up these days proudly proclaim that their 'teachers' (this is the word they use for academic scientists) do not have holidays and come to office daily. When asked whether they have leisure to do research they are rather disdainful towards the whole notion of leisure. Leisure and pleasure are tabooed words. But, without them, no great scientific work has ever been done.

The Social Status of Teachers

Almost no culture in the world gives a high social status to teachers. However, in western culture, scientists, if members of universities, are called academics. Elsewhere they are called scientists. Both scientists and academics do have a high social status. Thus, although business pays better than the academy in the west too, being a member of a university means that one is intelligent, and has a fairly good financial status. Thus, intellectuals, whether of the pure scientific or other types, are drawn to the universities. In Pakistan, unfortunately, the low social status of teachers rubs off on academic scientists too. They are neither seen as scientists nor are they called either 'scientists' or 'academics'. They are called 'teachers' and see themselves basically as teachers - i.e. disseminators of knowledge produced by others. The criteria for promotion in the universities are abysmally low and laboratories and libraries are hopelessly inadequate. Scientists employed by the state function like bureaucrats and are often dominated by professional generalist bureaucrats and, in some cases, military officers. They generally cannot even publish papers and fail to make a mark in the world. This means that those of our scientists who make a mark in the world do so despite, and not because of, the institutions which are meant to support them. It also means that they are the exception rather than the rule.

Conclusion

To sum up, we must educate our society. That is, the power structure must be changed so that patrons are not needed; academics (in all fields) must be better paid than other state and private employees; our universities must be improved. Otherwise we shall never create the necessary changes in our cultural norms and values to attract sufficiently large numbers of brilliant people to become scientists—especially academic scientists. Until this does not happen, S&T will not develop in Pakistan.

7
The Ideological Predicament of Contemporary Muslim Scientists[1]

Inayatullah

Introduction

The issue of relation of religion and science that somewhat has been settled for global community of scientists is still a problem for Muslim scientists who have given at least six responses to the issue. These responses reflect confusion among Muslim scientists and intellectuals concerning relations between science and religion. The confusion and the responses emerging from it are not just an intellectual problem that can be resolved by logic and reasoning. They are created and sustained by several factors including the political and socio-cultural environments in which Muslim scientists operate. Ultimately, only a deep transformation of Muslim societies can remove such confusion and release the suppressed creativity of their scientists.

Science is both a methodology of knowing reality and a normative culture. Essential elements of this methodology are observation of facts without pre-conceptions and bias, searching causal connections between these facts and subjecting them to a rigorous process of testing, verification and replication to establish universally valid laws. It accepts knowledge gained through subjective individual experiences as a source of valid knowledge, once externally validated.

Normative Culture of Science

The generally accepted elements of the normative culture of

[1] This paper has used some data and evidence supporting its thesis from author's paper "Cultural Pluralism and Development of Science in Muslim Societies," *Periodica Islamica,* Vol. 6, No. 4, 1996, pp. 3-22.

science are[2]:

a) adding new knowledge to the already existing stock of knowledge and relying exclusively on logic and evidence for this purpose;
b) continuously questioning the validity of received knowledge; refusing to claim validity for one's findings by quoting established authorities in one's field;
c) accepting with humility the tentativeness of one's findings and abjuring claim for absolute and final truth;
d) pursuing science in harmony with needs and demands of its development energised by curiosity and inquisitiveness, without obsession with one's material and symbolic needs and free from pressures from state, society and culture;
e) commitment to produce knowledge with awareness that it does not harm the survival and welfare of humankind.[3]

Paradoxes in Scientific Methodology and Culture of Science

Scientific methodology and the culture of science are highly interdependent. If practitioners of methodology have not absorbed the norms of the culture of science, knowledge of methodology by itself cannot foster scientific creativity.

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[2] Normative culture of a group, community and society consists of a cluster of ideals, `oughts` and prescriptions. The members of organisations are expected to act according to the norms of this culture but gap between norms and actual conduct is rarely bridged. For instance it is an `ought` for a scientist to add new knowledge but not every scientist actually does so.

[3] In the absence of common code of conduct among scientists specifying norms of culture of science it is difficult to identify an agreed set of its norms. Therefore, this listing is only tentative and subject to addition or subtraction. It appears that most scientists will agree with the first six norms but some may have reservations about the last two. For instance the scientists committed to value neutral stance of positivism would not accept the norm prescribing that scientific knowledge should be produced for the welfare of human race. For discussion on ethics of science, see: Noelle Lenoir, "The Ethics of Science: Between Humanism and Modernity", *World Science Report* 1993, UNESCO, 1996.

Despite general agreement in the global scientific community on the essentials of scientific methodology and certain norms of the culture of science, this culture is inadequately internalised both at the level of individual scientists and the scientific community as a whole. Only a small number of bold souls question the dominant paradigm and prevailing consensus. While most scientists claim not to accept reliance on authority, few question pre-eminent authorities in their fields, particularly those, whose works sustain the dominant paradigm. Similarly, while generally, scientists imagine themselves as a fraternity in search of truth, their community is marred by factionalism and mutual antagonism, peers do not always evaluate a colleague's work purely on merit and quality. Personal factors such as rivalry and jealousy affect their judgements. Scientists are also often less objective in evaluating the significance of their own work; get emotionally attached to it tenaciously defending it, even in the face of evidence to the contrary giving the impression that they have discovered the final truth.[4]

Most scientists do science as a routine professional chore; without inspiration from curiosity, internal needs and demands of development of their disciplines. Like most other professionals they produce science for earning material and symbolic rewards, for advancing "national causes" and without evaluating the impact of their work on survival and welfare of human race. The question why there are sharp contradictions between normative culture of science and behaviour of most scientists cannot be brushed aside by saying that they occur in all fields of life. Such attitude would block further enquiry and deeper understanding of these contradictions.

A few tentative explanations are offered here for these contradictions. Firstly, the biological and psychological needs of humans for self-preservation and self-enhancement often come in conflict with the norms of culture of science as such needs require compliance with just or unjust demands of the state and

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[4] Attitude of Einstein towards certain parts of quantum mechanics is one illustration.

society. When such demands are pressed by authoritarian states and conservative societies, they leave little choice for scientists to make decisions in the light of the culture of science. Secondly, the room for choice is further reduced if these states and societies are facing continuous crises of legitimacy and stability. In such a situation they prohibit in the name of national survival, unity and ideological purity questioning of those beliefs and perceptions which sustain and consolidate status quo. They use material and symbolic rewards and punishment to ensure conformity and prevent heresy. The doubters are branded traitors and apostates. If they are spared of physical death, such branding combined with excommunication and social isolation ensures psychological death of dissenters.

Predicament of Muslim Scientists

Scientists in general are pressurised from the state and society into conformity, consequently, producing intellectual confusion. However, it appears that such pressure is greater on Muslim scientists which further compounds their confusion. This confusion among the Muslim scientists could be a significant factor, besides other factors, in maintaining their acknowledged low level of creativity in science.[5] To understand this confusion

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[5] For description of poor state of science in the Muslim societies, see Pervez Amirali Hoodbhoy, *Muslims and Science: The Religious Orthodoxy and Struggle for Rationality*, Lahore, 1991, pp. 32-56; and Papers presented in International Conference on Science in Islamic Polity in the Twenty-first Century held from March 26-30, 1995 organised by OIC Committee on Scientific and Technical Co-operation (COMSTECH) hereafter to be cited as *Conference Papers.* See in particular Shafiq Ahmad Khan, M. M. Qurashi and Nelofar Arshad, "R&D Manpower in Some Selected Muslim Countries with Special Reference to Industrial Development," pp. 223-237 and H. A. Khan, N. M. Butt & I. H. Qureshi, "Some Important Steps for the Renaissance of Sciences in the Muslim World," pp. 446-458. The data put forth by Khan, Qurashi and Arshad from 11 Muslim countries suggests that manpower committed to S&T in these countries is about 33% lower than a standard requirement in relation to population. The total stock of R&D manpower in these countries was only around 138,009 compared to 949,200 of USA and 680,800 of Japan (p. 224). See also papers of Riazuddin and Anis Alam in the present volume.

one needs to bring out certain differences between the way science and Islam perceive nature and seek to gain knowledge from it. Science assumes that nature functions in accordance with certain unchangeable laws, which it seeks to discover. On the other hand, most Muslim theologians believe that the creator of universe who has made these laws can override them at will. Science accepts valid only the knowledge that can be externally validated. Knowledge of Islam is based on the authority of the Prophet who had special access to the divine source of knowledge. Muslim theologians accept the validity of this knowledge without seeking its external validation through scientific methods.

Science and Islam also differ with respect to the goals for which .knowledge is to be sought. Science starts with doubt and moves toward its reduction. Whatever certainty it achieves at a particular time is considered only tentative. Future scientists are expected to question it. Furthermore normative culture of science allows unlimited freedom of thought and encourages doubting and questioning every verity.[6] Islam does not permit such a freedom to its believers for preserving its basic theological premises. In sharp contrast with science, pursuit of religious knowledge begins with certainty and continues in order to add more certainty to it. Besides, the purpose of gaining religious knowledge is to give moral dimension to personal and social life of believers and not for developing technical means for gaining power over nature and humans. The Quran calls to human race particularly to its followers to reflect on the universe, history, society and self, is directed towards strengthening their belief in its message and to draw moral conclusions from it in order to fortify the new moral order which it seeks to create. Such reflection is not meant to doubt or question its basic principles, which if indulged, are to be penalised.

The above described confusion among Muslim scientists (and one may add intellectuals) is not just a theoretical and intellectual problem that can be removed by use of logic and reasoning as it emerges from larger political and socio-cultural

[6] In practice such freedom is circumscribed by scientists' personal and emotional commitment to existing theories and paradigms.

context of Muslim societies. This context further reinforces the confusion as discussed below.

Most of the contemporary Muslim states are run by authoritarian rulers, traditional or modern, who hold different attitudes towards culture of science and its offspring technology. They are afraid of the diffusion of the culture of science in their societies apprehending that this would undermine the system of knowledge that legitimises their power. But they favour developing or importing turnkey technology, particularly military technology, and finished consumer goods as this helps them achieve their goals of national security, international status, and increase in superficial affluence and personal comforts. This discriminatory attitude sets the direction and goals of the development of science. Science is neglected but technology of certain types is fostered. The rulers also define a narrow and instrumental role for scientists. Most of them accept this definition due to their complete dependence on the state for material resources needed for doing science. Under authoritarian rule, Muslim scientists are not free to set their own agenda for the development of science. Besides the authoritarian nature of Muslim states, resistance to the culture of science also comes from the power of the *ulema* in Muslim societies. Claiming exclusive rights to interpret religion, the *ulema* often regard the culture of science with its emphasis on scepticism, empirical evidence and negation of authority, a threat to their faith and subversive of their authority. Indeed the contemporary *ulema* have dropped their traditional rejection of technology but this has not changed their negative attitude towards the culture of science and some generally accepted scientific theories. The last three decades of the twentieth century have witnessed the rise of interest among the Muslims in reconstructing their societies and political systems within the framework of their religious and cultural heritage.[7] This interest, particularly visible in the emerging intelligentsia, nascent middle class and the *ulema*, has

[7] For an excellent description and analysis of Muslim consciousness in four Muslim countries see Riaz Hassan, *Faithlines: Muslim Conceptions of Islam and Society,* Karachi, Oxford University Press, 2002.

given rise to Muslim revivalist movements, which in turn nurture and sustain it through their literature, organisation, and political activity. In some Muslim countries these movements have appointed themselves as watchdog of what they perceive as intellectual heresy. Their student wings in academic institutions monitor and censure any intellectual deviance from the prescriptions of orthodoxy. The rise of revivalist movement has generally added to the influence and power of *ulema* in shaping the attitude of Muslims towards the culture of science. When the power of authoritarian rulers, conservative *ulema* and revivalist movements fuse together as happened during Zia's rule in Pakistan, it adds new and stronger barriers to the spread of the culture of sciences. Absence of an autonomous community of Muslim scientists both at national and international level is another obstacle to the diffusion and full absorption of culture of science among Muslim scientists. Having themselves absorbed the religious culture of their societies and facing pressure from the state, *ulema*, revivalist movements and larger society to adhere to it, the weakly organised Muslim scientists are unable to act collectively to spread the culture of science and protect their members from charges of heterodoxy. Lack of such organisation also prevents them from setting the direction of the development of science, hence, letting the state determine the science policy with serious negative consequence for development of science and its culture.

The traditional scholars of the earlier periods of Islam probably did not experience the above discussed confusion with the same intensity as contemporary Muslim scholars do. Their belief that Quran is a guide for better life herein and hereafter and not a book of science prevented such confusion. In any case they had no doubts that secular knowledge was inferior to divine knowledge.[8] Furthermore, the prestige and power of science was not well-established at that time. Consequently, even scientifically inclined Ibn-e-Khaldun, known for his major contributions to the philosophy of history and development of sociology could say that

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[8] Muhammad Khalid Masud, "Reasons for Declining Scientific Activity and Creativity in the Muslim World," *Conference Papers*, pp. 171-177.

"excessive indulgence in subsidiary sciences is waste of time and life and a meaningless pursuit of irrelevance".[9]

Contemporary Muslim scientists and scholars cannot resolve their confusion as easily as their predecessors did due to their awareness of the high intellectual prestige of science and the power it places at the disposal of its producers. They know how the development of science in western countries has enhanced their power and helped them shape the global power structure in their favour, turning Muslim countries into client states. In this new situation they cannot avoid the issue of relation between science and religion which they have attempted to resolve in a number of ways. For analytical purposes their responses are divided into six categories listed below.[10]

Attitudes of Muslim Scientists towards Science and Religion

No.	Type	Attitude towards Science	Attitude towards Religion
1	Pure Scientists	+	-
2	Technocrats	+	+ -
3	Romanticists	+	+
4	Bucaillian Islamists	+	+
5	Modern Islamists	+ -	+
6	Post modernists	+ -	+ -

Note: (+ = Positive; - = Negative; + - = Ambivalent)

1. The Pure Muslim Scientists

The pure Muslim scientists, like pure scientists all over the world, hold that the culture of science and religion are

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[9] Ibn Khaldun, *Muqaddima*, 1900, Cairo, p. 536, quoted in Masud, "Reasons for…," p. 172.

[10] None of these categories are neat separate boxes. At concrete level probably no Muslim scientist will completely fit into any one particular category as he/ she may have more than one response to the issue. Their dominant orientation determines their category.

incompatible. They believe that true knowledge about nature, self and society can be gained only through scientific methodology. They dogmatically contend that all knowledge based on other than their method is false. For them all knowledge is either scientific or unscientific. Constrained by their belief in tentative nature of scientific knowledge, some pure scientists accept the inadequacy of science at the present level of its development in pronouncing judgements on issues concerning ultimate reality and moral values. But this belief rarely shakes their conviction that as science develops further, this inadequacy would be overcome and eventually science will eliminate all other claimants of true knowledge including religion. Some pure Muslim scientists also regard religion as an obstacle to development of science and society. Given the overall cultural constraints of Muslim societies very few among Muslim scientists would publicly accept the label of a pure scientist.

2. Technocrats

Technocrat scientists use scientific methodology to study a limited range of technical problems and are not seriously concerned with the implications of their findings on their personal religious beliefs or larger philosophical issues. They pursue their professional work in any cultural and value context and serve any organisation or state regardless of their moral goals. The fact that most Muslim scientists are employees of state and posture of value neutrality helps them survive and flourish in this environment, where they accept being a technocrat without much hesitation. Some may even be proud of being value neutral.

3. Romanticists

Romanticists are strong believers in their faith and its superiority over other religions. At the same time they are highly impressed by the achievements of modern science. Unlike pure scientists they do not feel that their faith and science are intellectually incompatible. What distinguishes them from other categories of Muslim scientists is their interest in proving that modern science developed in the West because of teaching of Islam. Hence, implying that it would not have emerged without the contributions of their ancestors, the Muslim scientists of Middle Ages,[11] and that Muslim scientists of that period were precursors of some major theories of modern science.[12] They invest considerable energies in proving these two propositions.

Such interest can be productive if it is centred on writing a history of Muslim science in a detached and objective way. But writings of Romanticists leave an inescapable impression that their interest does not spring from objectivity but from their desire to prove the greatness and superiority of their ancestors over other scientists.

Two examples are cited here to illustrate this point. A well-known Pakistani historian, N. A. Baloch, has sought to connect Darwin's theory of evolution with the Quran. He writes, "The Quranic commandment to go around the earth and observe how the creation originated was for all human beings and for all times. As such, if Charles Darwin took it several centuries after the Muslim pioneers and travelled extensively to discover the origin of species, he was still within the pale of Quranic light". To establish that Darwin had read Quran he writes that Darwin, "… had felt the need of studying Arabic and took trouble to find the teacher who instructed him in Arabic".[13] Such a "proof" is mere speculation in the absence of direct statement from Darwin

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[11] Zafar Ishaq Ansari, "Scientific Exegesis of the Qur'an," *Journal of Qur'anic Studies*, Vol. III, No. 1, 2001, p. 92.

[12] Ziauddin Sardar, "Islamic Science: The Way Ahead," Public Lecture, International Conference on Science in Islamic Polity in the Twenty-first Century, March 26-30, 1995, OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, 1995. He calls this tendency "percurisitus." For writings of Muslim scholars that advance similar claims see Ahmed Yuksel Ozmere, "Reasons of Decline of Scientific Activity in the Ottoman Empire," *Conference Papers,* p.184 and N. A., Baloch, "Development of Scientific Knowledge Under the Creative Impulse of the Qur'an," *Conference Papers,* pp. 73-78. For views of more scholars belonging to this category and for his critique of them see Ansari, "Scientific Exegesis …," pp. 93-99.

[13] "Development of Scientific Knowledge …," p. 77.

to the effect that he learned to observe nature guided by Quran or that he found the concept of evolution in it. While making this statement Baloch does not take into account that most of the earlier and contemporary theologians have rejected Darwin's theory and do not agree that it is found in Quran.

Another example is what Zia Sardar in his several writing has called "percursitus". It is from an article by well-known Pakistani educationist and scientist, the late Professor Raziuddin Siddiqi, who claimed that the Muslims knew about the idea of evolution before Darwin.[14] For proof he relies on the poetry of Maulana Rumi instead of the Quran. He is careful, however, not to claim that Darwin was inspired by the relevant verses of Rumi. Unquestionably, the idea is found in the poetry of Rumi. But an idea by itself is not a scientific theory, for which one has to provide necessary proof. In any case, it is not certain that any Muslim scientist took the idea seriously and tried to develop it into a scientific theory.

4. Bucaillian Islamists[15]

Like romanticists, Bucaillian Islamists also have positive attitude towards both science and religion and reject the idea of incompatibility between the two. They contend that Quran is simultaneously a book for guidance of humankind as well as a book of science. They support this contention with the argument that Quran has foretold the discoveries of modern sciences such as "relativity, quantum mechanics, big bang theory to entire field of embryology and much of modern geology…".[16] By making

[14] M. Razi-ud-din Siddiqui, "The Contribution of Muslims to Scientific Thought," in *Conference Papers*, pp.629-636.

[15] "Islamic Science …," pp. 34-35. Sardar has coined the term "Bucailleianism" for a school of thought that shares the thesis of Maurice Bucaille, author of *The Bible The Qur'an and Science,* 1976. This school did not emerge with the publication of this book as shown by Ansari "Scientific Exegesis …," pp. 98-99 but its publication strengthened and popularised it.

[16] "Islamic Science …." For papers of some scholars in Bucailleist tradition see Mohammad Jamil A. Al-Habbal and Makdal R. A. Al-Juwarey, "Scientific Themes in the Holy Qur'an," pp. 135-150;

this claim they unwittingly reveal that science possesses higher level of validity and that Quran needs confirmation from it.[17]

A close examination of this claim raises several questions. First the Prophet himself, his companions and early Muslim exegists did not give the Quranic verses the meanings which Bucaillian Islamists give them now after having access to modern theories of science. Second, theories of science are tentative and subject to revision. No scientists would claim finality for them. The theories, which appear to be consistent now with some Quranic verses, as interpreted by Bucaillian Islamists, may be refuted and modified in future and new theories may emerge, which may not be consistent with interpretation of Bucaillian Islamists of these verses.

This gives rise to a question. If the ideas concerning these theories did exist in Quran then why had earlier Muslim scholars not developed them or anticipated their emergence? The reason seems to be obvious. As stated by Ansari, most of the early Muslim scholars did not consider Quran a book of science.[18] Very likely they were also averse to its being thus understood. They regarded it a book essentially for religious guidance of humankind. Early Muslim scholars were not facing the challenge of reconciling Quran and science in the absence of a well-developed science at that time. Buccaillism appears to be a response of Muslim scholars living in an age in which achievements of science and its intellectual prestige have become well established. The only scientific way the Bucaillian Islamists can prove their thesis now is to derive certain predictions from Quran and watch if future developments in science will confirm them. Searching for Quranic verses and interpreting them in a way to confirm a theory of science after it

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Saeedullah Qazi, "Qur'an on Science and Technology," pp.151-162 and Baloch, "Development of Scientific Knowledge … ," pp. 73-78 in *Conference Papers*.

[17] The claim may be a psychological response of scholars who over-impressed with achievements of science want to bolster their belief in Quran with its help.

[18] "Scientific Exegesis …," pp. 92-93.

has been tentatively established is neither a service to the Quran nor to such a theory.

A second claim of Bucaillian Islamists shared by Romanticists and a considerable number of other Muslim scientists and intellectuals is that Quranic verses inviting the believers to reflect on nature, universe, society, man, and history to motivate them to pursue science. Among the proliferating number of such (Muslim) scholars and scientists is the Nobel laureate late Abdus Salam who contended that his religious beliefs inspired his work.[19] Their third claim is that achievements of earlier Muslim scientists were under the influence of Islam in general and these verses in particular.[20] Both these propositions need to be empirically tested. This can be done in three ways: firstly by establishing that the work of earlier Muslim scientists was *exclusively* inspired by these verses unaffected by other factors. Secondly, that whenever Muslims seriously reflected on signs of God following these verses, science flourished concomitantly in their societies. Finally that the Muslim scientists with greater religious zeal are also more creative in science than those who lack it.

Quran indeed invites humans particularly Muslim to reflect on signs of God which could inspire quest for knowledge among them. However, the main issue in this regard is the type of knowledge. The Quran's invitation to reflect on universe, nature, society, self and history is to establish the unity of God - the

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[19] Pervez Hoodbhoy, "Encounters with Salam" *Periodica Islamica*, 6(4), pp.25-26. Some other scholars who make similar claims include Baloch, "Development of Scientific Knowledge …" , pp. 73-78, Siddiqui, "The Contribution of Muslims ….," pp. 629-636 and Muhammad Saud, *Islam and Evolution of Science,* Islamabad, Islamic Research Institute, 1988.

[20] Some Muslim scholars have added up such Quranic verses. The total differs with different authors but it is often more than 700. The thesis of religious motivations playing a role in promoting science is not a new one. Max Weber attributed development of science in the West to Protestant ethics and development of capitalism. The thesis though still a controversial one has some empirical support. See Robert K. Merton, "The Puritan Spur to Science," in Norman W. Storer (ed.), *The Sociology of Science,* Chicago, 1974, pp. 228-253.

central theme of Quranic teachings - and warn those disregarding the divine message that they will suffer for it as other people in history did. Such reflections do not seem to be directed towards discovering cause and affect relations and laws in universe, nature and society.[21] If Quranic stress on reflection was meant to discover such relations then it would have prospered most during the first 40 years of Islam, as Quran was best understood then. Apparently this did not happen. Instead what flourished most in that period was knowledge of Quran itself, its memorisation, compilation, interpretation and search for authentic Ahadis.

In proving their thesis Bucaillian Islamists reveal several weaknesses. They misinterpret Quranic verses.[22] Furthermore according to Ansari they show "… an immature haste in showing correspondences between the Quran and science. They tend to be carried away too quickly and too far by this zeal at the cost of scholastic circumspection and intellectual maturity. They seem to jump at conclusions and make inferences that seem to be actuated more by the desire to prove a theory than by the urge to know the truth. The current Islamic discourse is full of instances of haste and lack of intellectual vigour".[23]

Modern Islamists differ from earlier four categories in several respects. They have some knowledge of sociology and philosophy of science and its shifting paradigms. Unlike Romanticists and Bucaillian Islamists they are not overawed by the achievements of science. They understand its limitations and

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[21] Ansari's comments on this issue are: "The verses about natural phenomena, especially the 'sign' verses are, as far as we have been able to ascertain, aimed at drawing man's attention to these micro facts in order that he might be enabled to arrive at the truths that are bigger and more important than natural phenomena. To look at these verses in disregard of the context is to consider them independent of the aims they were required to fulfil, and to relegate to the background the basic concerns to which the Qur'an is addressed is likely to distort those verses and divest them of their true meaning and significance. See "Scientific Exegesis …," pp.101-102.

[22] "Scientific Exegesis …," pp.100-101.

[23] Ansari "Scientific Exegesis …," pp. 100-102.

are critical of the positions taken by Romanticist and Bucaillian Islamists. Their central thesis as propounded by two prominent Modernist Islamists - Ziauddin Sardar and Hossein Nasr[24] - is that science developed within the fold of western civilisation is dehumanised as it is unconcerned with the ethical purpose for which the scientific knowledge needs to be acquired and used.[25]

The criticism is indeed valid. Science is a social product and its social context determines both its production and use. Those who control allocation of funds for development of S&T also determine the direction of science and the purpose for which it is to be used. They fund S&T that enhances their power over others be they individuals, groups, nations or civilisations. In doing so they are unmindful of the consequences that such science is creating for collective survival of human race and its welfare and the intractable problems it is producing which it will be unable to solve.

This criticism equally applies to production of S&T within the context of different civilisations, different socio-economic and political systems, capitalistic or socialist. Take the example of nuclear weapons that have the capacity to annihilate human race. They have been produced in the womb of Judeo-Christian, Confucionist, Hindu and Muslim civilisations regardless of their religious and secular orientation.

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[24] "Islamic Science …" and Seyyed Hossein Nasr, "The Islamic Worldview and Modern Science," Keynote address to the International Conference on Science in Islamic Polity in the Twenty-first Century, March 26-30, 1995, OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, while sharing most of the critique of what they call Western science and emphasising the need to place science in Islamic cultural context, their attitude towards classical science and interpretation of core values differ. Sardar does not romanticise the traditional Islamic science while Nasr does. Sardar envisions an Islamic society, which can coexist within the context of contemporary cultural values while Nasr seems to be essentially a revivalist.

[25] "Islamic Science …," pp.1-60 and Nasr, "The Islamic Worldview …," p.6.

Islamic Modernist's prescription for changing the malevolent aspects of contemporary science and putting it at the service of human race is that it should be Islamised by developing it within the framework of Islamic culture and its values.[26] The thesis can be tested in two ways: by checking the attitudes of contemporary Muslim rulers, the Muslim revivalist movements, and Muslim scientists towards the production and use of S&T, by enquiring if the Muslim civilisation, which the Modernist Islamicists are expecting to emerge, would humanise contemporary science.

The attitudes of Muslim rulers, Muslim revivalist movements and most Muslim scientists suggest that they want to develop science and/ or acquire technology for the same goals for which western countries have developed them i.e. for security and deterrence, for national power and glory, for economic development and for raising their international status. However, compared to western countries Muslim countries have much lower interest in developing S&T that can help solve national and global issues of poverty, degradation of environment and rampant conflicts.

The point can be illustrated with their attitude towards acquiring nuclear technology and manufacturing atomic weapons – the "ultimate evil" in the words of International Court and a serious threat to human survival. The Islamic Republic of Pakistan has already developed nuclear weapons. Two other Islamic republics - Iran and Libya - seem to be determined to acquire them. The well-organised revivalist party in Pakistan, Jamat-e-Islami, is the most vocal defender of Pakistan's right to possess nuclear weapons.[27] The attitudes of Pakistani Muslim scientists who participated in development of nuclear weapons are also similar to American, British, Russians, Chinese and Indian scientists. No Pakistani nuclear scientist so far has expressed moral reservation or regrets for participating in production of

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[26] "Islamic Science …," pp. 35-41.

[27] Jamaat leader Qazi Hussain Ahmad believes that the use of nuclear weapons is un-Islamic but not its production as it provides deterrence. He has repeatedly made such statements at different places.

these weapons. In fact some of them go out of the way to claim and contest the paternity of the bomb. There are no "Rotblats" among Pakistani nuclear scientists.[28]

The proposition advanced by Modernist-Islamists that science is produced in the cultural context of an ideal Islamic society will be more ethically sensitive than that the present science can be tested only after a fully developed Islamic civilisation replaces the present civilisation. At present it cannot be more than a hope.

A second critique of contemporary science by Modern-Islamicist is that increasing specialisation in the West has fragmented knowledge about nature, man and society that makes the grasp of total reality impossible and solution of human problem through fragmented knowledge difficult.[29] Indeed this is a valid criticism of modern knowledge. Scientific methodology applied to the study of nature, individual and collective human behaviour has not yet produced a unified and integrated theory. However, it may be noted that natural sciences are in search of such theory and to a certain extent have succeeded in this task. However, the challenge of development of unified theory of human behaviour remains unmet though some elementary achievements have been made. Whether Muslim counterparts of western scientists with a low level of development of science in their countries, and working in political, cultural and social environments un-conducive to development of science, can go beyond mere noticing this weakness of modern knowledge and meet the challenge of unifying knowledge better than their western counterparts, is yet to be seen.

A third critique of science by Modernist-Islamists is that western science is violent toward nature including animals while other

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[28] The scientist who worked in the Manhattan project that produced first atomic bomb. He resigned from the project and regretted his participation in it.

[29] Masudul Alam Choudhury, "Socio-Scientific Post-Modernity and Islam," *Conference Papers*, pp. 46-72.

civilisations, particularly Chinese, have a benevolent attitude towards nature.[30] Implicit in this contention is that a science developed in Islamic framework would be benign towards nature. Indeed, contemporary S&T have been used to exploit nature. But this may be due to the emergence of capitalism in the fold of western civilisation and less due to any direct impact of the western civilisation on science. Capitalism legitimises greed and accumulation of wealth for its own sake, which has driven western man to ravage nature regardless of its long term consequences for human survival.

The ethos of a civilisation should not be determined by its ideal prescriptions alone but by the extent to which they influence actual behaviour of its carriers. For instance, in pursuit of economic development contemporary Chinese society inheriting Confucianism is as malevolent toward nature as the western societies are. One should also note that recent concern for protection of nature and environment has developed more in the west than the countries that have inherited other civilisations including the Islamic.

In understanding the attitude of Modernist Islamists toward science one may note that most of them are not scientists but philosophers, sociologists and historians of science. Some of them are expatriates living in the West. As expatriates they experience a greater crisis of cultural identity than their fellow Muslims living in their own countries do. Their host countries are not very accommodative towards preservation of their cultural heritage and extremist groups there demand their total assimilation. Consequently, some of them respond to their crisis by forcefully asserting the superiority of their traditional intellectual heritage and by pointing out the inferiority of knowledge system of the host civilisation. In this zeal they excessively exaggerate the flaws of "western" science.

6. Post-modernist

Post Modernists among Muslims scientists maintain that all views of reality are socially constructed. Therefore there is no

[30] "Islamic Science …," p. 20.

objective universal reality outside its social context. The claim of science to such objective reality is unsustainable. By contextualising and relativising science they also undermine the claim of religion to absolute universal truth. With this, post-modernism has unleashed an intellectual chaos and the outcome of this chaos is uncertain. From it may emerge epistemological diversity, higher degree of tolerance for various views of reality and mutual accommodation between science and religion, leading to a universal and higher objectivity unconditioned and independent of its social context. Alternatively, it could further fragment and relativise knowledge on national and cultural lines without building a bridge of communication between them.[31] As post-modernism strikes at the claim of universal and absolute truth of Islam one can guess that very few Muslim scientists would accept its creed.

Conclusions

Intellectual confusion about relations between science and Islam, re-inforced by the socio-cultural and political system of Muslim societies, has blurred the mental clarity among Muslim scientists necessary for creative scientific work. This confusion has generated among them certain evasive and escapist responses that may possibly have weakened curiosity, passion and capacity for developing new and creative scientific insights. Such responses may have also prevented Muslim scientists from objectively and courageously confronting the existing reality that their societies are poor in science measured against several indicators of development of science. They may have also made it difficult for them to identify the causes of scientific backwardness of their societies and develop effective strategies for overcoming it.

The drive of Muslims intellectuals and scientists for a secure identity, cultural assertion, the desire to break the domination of

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[31] For a brief discussion of post-modernism and its impact on religion, science and society see Sohail Inayatullah, "Islamic Responses to Emerging Scientific Technological and Epistemological Transformations," *Islamic Thought and Scientific Creativity*, Vol. 6. No. 2, June 1995, pp. 52-53 & 63.

other societies on knowledge and culture can lead them to two different paths. First is the path of glorification of the achievements of their ancestors, of deriving science from religion, by using the crutches of science to fortify their faith and consume their energies in Islamising science. In choosing this path they should enquire how much of this choice is determined by constraints imposed on them by their inherited faith, by their state and its rulers and their emotional need to resolve their identity crisis. They also need to examine if this path will enable them to be creative in developing a science that helps their societies realise their potentialities, enhance their collective well being, and reconcile the needs of separate security with global security and survival of human race.

The other path open to them is to enthusiastically embrace scientific methodology, imbibe the spirit of the culture of science, own the achievements of science as a collective heritage of human race to which at some stage Muslims also contributed, identify and work to create conditions in their societies in which a non-parochial and universal science flourishes. Only a high level of creativity in benign and humanised science among scientists, be they Muslim or non-Muslim, would correct the weaknesses of science developed in western cultural context and not just their culture-based critique.

8
The Impact of Islam on Science[1]

Asghar Qadir

Introduction

The traditional view, that the natural sciences are totally divorced from the social milieu in which they are formulated, has long been discarded. However, the awareness of this change has largely been limited to the philosophers of science. As such, it has not been considered relevant to question whether religion may have had some influence on science. As pointed out in my companion article in this book, there has been an intimate connection between the two for most of the history of science. It is only with Newton that attempts were made to maintain a total separation between them. In this article I try to trace the influence of Islam on the development of science and explain why Islam should have been expected to have that influence. Let me state at the outset that I am not maintaining that "Islam contains all of science", or even that "Islam necessitates the development of science". In fact, there has always been one section of Islamic thought that is inimical to the development of science. However, I believe that it could have been expected that the other view would dominate in the earlier phase of development of the religion and the more reactionary view would dominate the next phase. Be it noted that there will not only be two phases. I further expect that Islam, like Christianity, will adapt to accommodate the requirements of science if it is given the time.

The Influence of Islam on Science

I now return to a discussion of the influence of Islam on science in the light of our current philosophy of science. From the

[1] This article formed part of a talk presented under German Academic Exchange Programme (DAAD). I would like to thank Dr. Falk Triebsch for permission to print it here.

Aristotelian, to the Muslim, to the Newtonian, to the modern philosophies of science may be viewed as swings of the pendulum. In some ways the Muslim philosophy is much closer to the modern philosophy of science than the Newtonian philosophy. The Muslims took an empirical approach to science rather than refer to some self-evident truths (as did the Greeks) or laws of nature waiting to be discovered (as taken by Newtonian science). This is the modern view as well. As Einstein put it "scientific theories are free creations of the human mind" which are constrained only to fit with observation. In principle there could be two equally valid sets of laws based on different descriptions of nature. The choice of how to describe nature is arbitrary and based only on providing a convenient description for one's purpose. Further, there is a strong inter-relationship between the types of questions asked, the way one is going to find the answers and the theory based on the resultant findings. This philosophy, which many saw as the consequence of relativity as formulated by Einstein, is mainly the consequence of quantum theory as formulated by Neils Bohr. Both theories do include the inter-relationship of the "stage" and the "actors".

To what extent is the similarity between the Muslim and the modern philosophies of science accidental? Or is there a causal connection between them? To address this question we need to see why the Muslim philosophy of science came out the way it did. Islam enjoins on the believers that they look at the Universe to appreciate the wonders of creation. As such, observation is given great weight in Islam. This is not said merely by some commentators or philosophers of Islam, but is stated in the *Quran* - the book that Muslims believe - is the word of God as stated through the agency of his messenger, the prophet Mohammad. *It is a religious duty!* This certainly explains why the Greek approach of looking for self-evident truths should be overturned by the Muslims. But is this all or is there some further reason why observation and experiment should take precedence over pure thought? In fact, as one might expect, there are social and economic reasons as well.

One of the main reasons why this philosophy should have developed among the Muslims was the abolition of slavery in Islam. For example, one of the great Muslim saints, Bilal, was a slave who was freed by the Prophet. As such, requiring menial work of others was frowned upon and people had to do their work for themselves. Consequently, the Greek ideal of the "patrician" philosopher-scientists, who got others to do their work for them, was changed. The taboo against working with one's hands was broken. If direct observation did not provide the desired information, there was no reason why conditions should not be created in which observations would provide it --- i.e. conduct experiments. I would argue that this is why it was natural for observational and experimental science to develop and flourish among the Muslims.

It could have been argued that slavery was equally forbidden in Christianity. As such, one might have expected science to develop along experimental lines among the Christians. However, this argument does not hold, as there is one glaring difference between the two religions, which is crucial for the development of science along the lines followed by the Muslims. Christianity encourages hermitage. The ultimate in piety is to live a monastic life far from the rest of humanity. Not so in Islam. Hermitage and celibacy are discouraged. Muslims are required to live as part of, and contribute to, society[2]. Science cannot be expected to issue from hermits as it needs many people working together. Further, science was developed with a view to its utility for the Muslim community (the *ummah* as it is called). There was, then, a strong emphasis on the technological applications of science. This, again, encourages experiment so as to optimise the use of science for society. Additionally, Christianity extols suffering and misery[3] as a

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[2] To the best of my observation, this is true for all religions of genuinely Semitic origin and the opposite for all religions of Aryan origin. It may well be that the original form of Christianity has been tampered with and modified by the Romans. But this is not relevant to my thesis here.

[3] Again, this may be the result of tampering by the Romans to help them control their slaves, but is again not relevant to my thesis here.

means to obtaining rewards hereafter. This is not conducive to developing technological means of alleviating misery. To the contrary, Islam gives no credit to suffering needlessly. Where possible suffering is to be avoided and what God has provided for the use of humans is to be availed to the maximum. It is regarded as impious to do otherwise.

There was also an indirect impact of Islam on science. This is the economic reason. Trade was encouraged in Islam as a desirable alternative to living off the work of one's forebears. This, in turn, encouraged exploration, which gave rise to a technology related to travel. It also led to exposure to new ideas and beliefs in different societies that the Muslims came in contact with, which in turn led to a breaking of preconceived dogmas as regarded the working of nature. The break from preconceptions meant that Al-Haytham could put the Sun at the centre of the Universe for no better reason than that it was the most convenient description. The Greeks could only do so because the Sun was their deity. When Asghar Al-Zarkali found that a better fit to observation was obtained by using elliptic orbits for the planets in place of Al-Haytham's circular orbits, he did not need to break any preconceived notions. For the Greeks this would have been unthinkable.

It must be admitted that this was not the only attitude to science and its development. Despite the fact that there is explicit prohibition against a clergy in Islam, a clergy *did* develop. This section of society, as could be expected, was strongly set against any new ideas, and hence against science which was seen as weakening the faith of the Muslims. Inevitably, the clergy repeatedly declared many of the most eminent scientists to be heretics. Quite often the rulers (*Khaliphahs* or *Caliphs*) patronised the sciences and the scientists, but very often they sought support from the clergy and, in turn, supported them. This gradually led to a decline in the science and culture generated from the Muslim civilisation. It may be mentioned that such a decline could have been predicted by applying the analysis of one of our social scientists, Ibn-e-Khaldun. He had contended that the Quran should not be taught to young children, as it would dull their creative capabilities to be confronted with a book that was to be accepted as complete, perfect and unalterable. This led to charges of heresy. He went on to investigate the rise and fall of civilisations and concluded that they all followed a pattern. The Islamic civilisation had entered the stage of decline and collapse. It has often been claimed that Ibn-e-Khaldun had opposed scientific knowledge and argued that only religious knowledge is relevant. I think that this is due to misinterpreting his argument. He was very much a social scientist and thought that only that knowledge which is relevant for people is worth pursuing. As such, I would take his point as a precursor of the modern battle between the natural and social sciences, rather than as an attack on science per se. In the sixteenth century the last of the candles burning in the Islamic world had dimmed and been extinguished. There was no further impact of Islam on science.

The Two Islamic Views of Science and the Modern View Compared

In the companion article we have seen how the view of science has been changing over the ages. Though there is no exact definition of science that is agreed-upon, there is a general consensus on most aspects of it. Another way to put it is that people would agree, by and large, on what is or is not science. The disagreements are negligible compared with the agreement. In one way of looking at it, the philosophy of science has been going through the swings of a pendulum. One extreme is that there is one true theory, which can be apprehended by sufficiently profound thought and insight. The other is that theories are only convenient ways of compressing a lot of data. There are views of all shades between them. The majority view of the Muslim scientists (who made significant contributions) and the modern view of science are closer to each other than they are to the Greek or the (Newtonian) classical views from this point of view.[4]

[4] Let me stress that I am *not* claiming that Muslim science was "more advanced" than Newtonian science. I am only pointing out that in this one aspect it was closer to the modern view.

There was another Muslim view of science, which has not been mentioned here, that was very important and was dominant in the later Muslim times. This was the view of the *mutakalamun*. They believed that all knowledge that was relevant and valid was already given in the *Quran*. Thus all the science that was done by the other scientists was either irrelevant or incorrect. This suited the self-styled clergy that had developed, and this group became the dominant force in the Muslim world. Many of us would regard them as responsible for the death of science among the Muslims of the time and for its dearth in the modern Islamic community. There can be no doubt that this was a very negative impact that Islam had on science. Many would cite *it* as the impact of Islam on science. This is at most half the truth. I would argue that this is not the impact of *Islam* on science, but rather of its moribund phase. Religions evolve over time. Any dogma, which may start off as reasonable, must go out of phase with the developing world in due course. When that dogma is a religious faith there is no room for revision, and its adherents will fight tooth and nail to defend the dogma in its pristine form. The majority might pay it lip service but would not take it too seriously. When a revival movement starts, and start it must, it is viewed as heresy by the orthodox and witch-hunts begin. Even though Islam has *ijtehad* (revision in the light of developments) built into it, the clergy ignore it.

The fifteenth century of Christianity saw witch-hunts arise as a reaction to new ideas brought in from the Muslim world. It saw the revival movement of the Protestants. We should not be very surprised when we see much the same scenario unfolding in the fifteenth century of Islam. Some renaissance scientists argued that physics based science is inherently Pagan and alchemical science is Christian. They even adopted Greek names, Paracelsus and Heracles, so as to be identified with the Christians and not the Pagans.

The modern view of science combines the Muslim and Greek views. Even the Muslim scientists developed theories to present all the facts in a manageable form. Current attempts go much further. The modern view rejects the certainty and definiteness of Newtonian science and replaces it with a relativity of the truth, depending on the observer, quantum uncertainty and the role of chance in physical laws, an inherent lack of completeness, dependence of the laws on the type of description one chooses, tentativeness about the truth of a theory and lack of uniqueness of laws and description of nature. In the popular mind all these changes were associated with Einstein (though he was one of the major critics of many of the more radical aspects of this revolution in thought). This is most clearly seen in the addendum to Newton's epitaph:

> But not for long. The Devil howling "Ho!
> Let Einstein be!" restored the status quo.

In fact the laws of nature are not returned to hiding in the night, but have been further clarified. All that has happened is that science has shed its dogma. This fact has not really seeped into the "common man's" mind. People still see science as dogmatic and scientists as rigid in their views. They still see mathematics as consisting of incontrovertible truths. As people say "In Mathematics a thing is either true or false. Right?" Wrong, I am afraid. It may well be neither true nor false but our choice whether we take it to be true or not.

The more enlightened view among the Muslims was based on a philosophy very closely related to the modern view. However, it would be wrong to take that to mean that they are basically the same, or that modern science was already there in embryonic form among the Muslims. In substance modern science is much closer to Newtonian science. It is only the philosophies that are similar --- and even they are only similar, they are not by any means identical, leave alone the same.

Discussion and Conclusion

There are many points that have not been discussed and need further discussion. I will indicate some of them. Perhaps the most glaring is the neglect of all mention of Thomas Kuhn in an area that many may identify totally with him. He is probably the first of the modern philosophers of science to bring out the fact that science does not exist in isolation from society, but rather takes its character from there. I did not mention his contributions because they were not germane to my task, of assessing the impact of Islam on science. It is not that I am unaware of Kuhn, or that I want to detract from the credit that is his due.

To the best of my meagre knowledge in this matter, nobody before me has really investigated the topic I am talking about. Consequently, there are many ramifications that need to be explored more fully. I have merely sketched the bare outlines. One of these is the Islamic theory of knowledge. It recognises two sources: deduction; inference, observation, experiment; and intuitive knowledge coming straight from God, or in other words faith. The former are what I stressed and the latter is the base for the mutakalamun, whom I mentioned earlier. The social impact of the change from the earlier view of knowledge to the intuitionist view would be worth exploring.

The Newtonian view did not allow for the social sciences. It is worth investigating to what extent they are indeed sciences. In the Aristotelian view they *were* the sciences. It was the *science* of rhetoric, of poesy, of aesthetics, etc. (Inevitably, as they derived from Aristotle's self-evident truths.) In fact, the status of the natural sciences was suspect, but acknowledged since some justification had been provided for them. Since there are no "immutable laws" to be discovered for the social sciences, the Newtonian philosophy does *not* accommodate them. However, the modern view of science does, since one can formulate testable theories for them. Their place in the Islamic view of science needs to be explored further.[5]

It may seem odd not to go into some detail about the insights obtained from quantum theory and relativity; especially in view of my preoccupation with these topics. However, the purpose of this article is not to delve into modern science but to deal with its philosophy. There is a lot more to be said about the philosophy of science driven by quantum theory and relativity. I

[5] As I mentioned earlier, Ibn-e-Khaldun had discussed various aspects of the social sciences as sciences.

have left even that out, except for some glancing references to it. The reason for this omission is that I have concentrated on the impact of Islam on science. It cannot be said that these areas fall within the arena of that discussion. Nevertheless, there is some part of it to be discussed in the context of Islam as I shall go on to explain.

The essential question is whether things exist in themselves or only in the context of being observed (or even as answers to questions asked). This matter was discussed by religious scholars over the ages. For example, Bishop Berkeley had held that things could only exist if they are observed and not otherwise. He then assigned God the role of the Universal Observer. This point is brought out by the following limerick:

> There was a young man who said "God
> Must think it exceedingly odd
> That this tree
> Continues to be
> When there's no one about in the quad."

and its addendum:

> "Dear Sir, your astonishment's odd
> Since I'm *always* about in the quad.
> And that's why this tree
> Continues to be"
> Since it's seen by Yours faithfully, God."

This is echoed in Bohr's Copenhagen interpretation of quantum mechanics, especially as formulated by John Wheeler: "No phenomenon is a phenomenon unless it is an observed phenomenon". On my pointing out the problem of defining "observation", Wheeler modified it to "No phenomenon is a phenomenon unless it is a *registered* phenomenon". On the other hand, Einstein and his followers believed in the existence of a physical reality independent of the observer. Some of the Muslim philosophers had entered into this debate as well, assigning God the role of the Observer. It would be worth exploring this matter in the context of the Islamic philosophy in more detail.

The effect of the observer in modifying the observed arises in both quantum theory and relativity. The discussion of observer participation in the phenomenon being investigated is reminiscent of the modern anthropological approach. One starts by admitting that there will be a bias introduced by the scientist. Instead of trying to achieve an unattainable objectivity, one works with an admitted subjectivity that can be taken into account. This is part of the modern view of science. As a test of the claim that the modern and Islamic philosophies of science are similar, it would be pertinent to ask about the extent to which this view is contained in, or at least consistent with, the latter.

A related question, though not directly relevant for the topic I am talking about, is the question of the meaning of "scientific laws" applied to conscious beings. The point is that stating a law about the behaviour of an electron will not change the way the electron behaves. It is only the process of measuring any property of the electron that can change its behaviour. This is not true for the social sciences, where the statement of laws *has* changed the behaviour of the beings for whom the law is stated. Thus, when Adam Smith stated how a "rational man" will behave, it determined the behaviour of future generations. The law did not *describe* the behaviour but *generated* it. Similarly, the statement of Marx's economic theory (and its misinterpretation) led to the communist revolutions in Russia and China, it did not predict them. How far is this fact consistent with the Islamic philosophy of science?

9
Islam and Science

Khwaja Masud

In Islam as prophecy reaches perfection, it stands abolished. Henceforth, man is thrown on his own resources for full consciousness. From this follows the necessity for the abolition of priesthood as the repository and interpreter of divine knowledge. This, in short, is the concept of the finality of prophethood, as explained by Iqbal in his six lectures in *Reconstruction of Religious Thought in Islam*, which implies that all personal authority, claiming a supernatural origin has come to an end in the history of man.

According to Iqbal, "The Prophet of Islam seems to stand between the ancient and the modern world. Insofar as the spirit of his revelation is concerned, he belongs to the modern world. In emphasising nature and history as the sources of knowledge, the Quran ushers in the modern world whose weapons of discovery are observation, experimentation and generalisation.

Though the Greeks scaled the sublimest heights of speculative thought, their too much dependence on deduction and their aversion to experimentation also closed the door on any scientific advancement.

During the mediaeval age named by the Europeans as the Dark Age, it was scholasticism that held its grip on the mind of Europe. Scholasticism suffers from blind faith, argument, from authority, indifference to facts and undue emphasis on verbal subtleties and reasoning in matters which observation alone can decide.

Induction, according to Iqbal, was a great gift of Islam to humanity. "Neither Roger Bacon nor his later namesake has any title to be credited with having introduced the experimental method," says Briffault adding "t (T)he experimental method of the Arabs was by Bacon's time widespread and eagerly cultivated throughout Europe". On the other hand, it was Nazzam who first formulated the principle of doubt as the beginning of all knowledge; anticipating Desecrates by 400 years, who started off on his philosophical odyssey by the dictum, "In order to reach the truth, it is necessary in one's life, to put everything in doubt". It was he who uttered the epoch-making dictum, "I think, therefore I am".

Modern science has flourished in an atmosphere marked by scepticism. It puts to doubt all dogmas. It does not take anything for granted. The beliefs of a scientist are tentative and not final. They are not based on authority. They are based on evidence. Modern science is iconoclastic in dealing with convictions based on tradition or authority.

Modern science is not antagonistic to the Quranic spirit which is also iconoclastic. As opposed to scholasticism that believed in order to understand, modern science understands in order to believe. The Quran emphasises rationalism over and over again. It appeals for *tadabbur, tafakur and taaqul* and abhors obscurantism, dogmatism, irrationalism and intolerance.

According to Iqbal, "For purposes of knowledge, the Muslim culture fixes its gaze on the concrete and the finite". Knowledge must begin with the concrete. This, indeed, is the spirit of modern science. By giving examples of Ibn-i-Khaldun's view of history as evolutionary movement, and Musa-al-Khwarizmi's shift from arithmetic to algebra, Iqbal concludes that "all lines of Muslim thought converges on a dynamic concept of the universe".

Thus Islam rejects a static view of the universe and regards it as ever-changing and evolving. According to the Quran, change is one of the greatest signs of God. "Verily, in the alternations of night and of day and in all that God has created in the heavens and in the earth are signs to those who fears Him." (X, 6)

"Every day does some new work employ Him." Is it not an argument for a changing and evolving universe? The principle laid down by Islam to keep pace with the changing world is *ijtihad* that is, man's exertion with a view of forming an independent judgement. "God particularly dislikes those who are unwilling to subject their ideas to re-examination." (VIII: 23, X: 1000)

Science demands immense patience in observation and great boldness in framing hypotheses. The test of scientific truth, is patient collection of facts combined with bold guessing as to the law binding facts together. Science demands an independent, inquisitive spirit, a pioneering zeal and an enterprising elan.

Science advances when there is unity between theory and practice. Any dichotomy between theory and practice spells disaster for scientific progress.

Why is it that for the last 500 years, the Muslim world has been so deficient in producing scientists and philosophers? Why is it even now when it commands such immense resources, it lags so far behind in S&T?

The reason is that Muslim world has fallen victim to irrationalism, traditionalism, dogmatism and obscurantism. We dread the new, the novel and the original. We love clichés. We are only good at repeating time-worn, moth-eaten views. We revel in interpretations, but flinch from creativity. We bask in the glory of the past. We do not have the courage to face harsh reality. We are in the stranglehold of nemesis of mimesis. As Iqbal puts it, "We do not change ourselves, instead we change the Quran". Intellectual stagnation and moral degeneration are our dismal lot.

Science needs a Weltanshauung whose keynote is enlightenment with rationalism, humanism, tolerance and pluralism as its driving forces.

As Iqbal puts it, “The truth is that all search for knowledge is a form of prayer. The scientific observer of nature is a kind of mystic seeker in an act of prayer. Although at present he follows only the footprints of the musk deer, and thus modesty limits the method of its quest, his thirst for knowledge is eventually sure to lead him to the point where the scent of the musk is a better guide than the footprints of the deer. This alone will add to his power over nature and give him the vision of the total infinite which philosophy seeks but cannot find”.

Islam is not a closed system with set answers to all the problems of mankind, rather it is a faith in which God provides mankind anew every morning the riches whereby it may answer these problems through the application of the principles given in the Quran. Islam overflows all definitions, because it is open at one end to the immeasurable greatness of the divine and it reaches at the other hand to the immeasurable diversity of the human. With the powerful instrument of *ijtihad*, the world of Islam must brace itself for the renaissance and reformation about which Iqbal dreamt and Jinnah struggled.

10
Religion and Science: Exaggerating the Conflict

Tarik Jan

Science and religion? Why combine the two when both have different origins. Science is a human endeavour to improve the material condition of humanity while religion is a divine response to improve the human situation.

Nevertheless, the two have certain common grounds. Science presumes that the material reality is governed by laws, which one can determine as well as understand. A natural corollary to this is a scientist's belief that there is order in the universe. Religion, especially the revealed ones, holds that everything has been created according to weight, measure, and number, that things are bonded and subdued to humanity's benefit. Besides, such a claim implies that science is Allah-given, for a scientist discovers pre-existing natural laws and does not invent them. Religion further claims that it has helped science in its origination and growth. This may sound weird but humanity's march toward civilisation would not have been possible unless it had come out from under the shadow of polytheism, which anthropomorphised every natural force into a god. Likewise, for any science to grow; it is important that nature is desacralised separate from God who created it and who is immanent but not part of it. The polytheistic concept that God lives in His creation, or that the universe is an extension of the creator in the anthropomorphic sense, has to be killed so that nature is reduced to an observable phenomena, which can be harnessed to humanity's benefit. The revealed religion like Islam precisely did the same.[1]

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[1] For this see Tarik Jan, *The Life and Times of Muhammad Rasul Allah – Universalising the Abrahamic Religion*, Islamabad, Institute of Policy Studies, Vol. 1, Second Revised Edition, p.199.

The two also show commonality in their moral posturing. According to physicist C.A. Coulson, science and religion share the same moral attitudes, for example, humility, co-operation, universality, and integrity.[2] The process philosophy, as developed by Alfred Whitehead, speaks of a new systematic metaphysics that says, among others: the dogmas of religion are the attempts to formulate in precise terms the truths disclosed in the religious experience of mankind. In exactly the same way the dogmas of physical sciences are the attempts to formulate in precise terms the truth disclosed in the sense perception of mankind.[3]

If that is the case, why talk of strife between religion and science? Reason could be many, but one thing is for sure that the presumed conflict is political. Disturbed by the existing harmony between religion and science, a certain segment of our society is desperately engaged in the exercise of transplanting the idea of strife on our social scene so that they can obtain their agenda of secularising the society.

True, science calls for an open mind and an unremitting search for facts. One can also celebrate science culture, whatever it may mean, as free from trammels. And one can also romanticise science as an end by itself pursued for its own sake. But whether one can have these three aspects is an impossible proposition primarily because it bypasses the scientist's humanity visualising him as a person who is free from any contamination but science, which may not be true. Every act of our perception and cognition is mediated. Even the apparently simple observation of the objective world is not a mirror-like knowledge, "for the object it experiences has already been

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[2] C.A. Coulson, *Science and Christian Belief,* Chapell Hill, University of North Carolina Press, 1955, p. 117.

[3] Alfred A. Whitehead, *Religion in the Making,* New York, The Macmillan Company and Cambridge University Press, 1926, p. 57.

structured by the subject's own internal organisation". That is why, as Kant said, all human knowledge is interpretative.[4]

At the same time, it ignores the fact that a scientist is part of societal and state structures that determine his being and priorities. For example, the much-celebrated computer was largely born of military necessity and so was the Galileo telescope, who by selling it to the military made money out of it.

The Three Models

From the western scientific literature three models of relationship between religion and science can be developed:

a) Conflict model patterned after Draper and White's views suggests of an ongoing conflict between religion and science.
b) The divergence theory suggests two different realms of religion and science though essentially complementary.
c) The confluence model holds that religious beliefs gave spurt to science.

The historian Brooke thinks that the three models are "overstated," for "serious scholarship in the history of science has revealed extraordinary rich and complex a relationship between science and religion in the past that general theses are difficult to sustain".[5] Brooke makes a 422-page sustained argument of erudition and insights embellishing it with case studies.

The conflict model has become handy to a small section of our society because they find it useful dislodging religion from the public place. Their plea is that the Muslim people are backward owing to the retarding influence of religion on their mental growth, and that if they want to come out of poverty and backwardness they must question everything. In other words, they have reduced the choice for policy makers between

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[4] Richard Tarnas, *The Passion of the Western Mind,* New York, Ballantine Books, 1993, p. 417.

[5] John Hedley Brooke, *Science and Religion – Some Historical Perspectives,* New York, Cambridge University Press, 1993, p. 5.

progress (science) and backwardness (religion). Mischievous as it is, such a narrow band formulation is seriously flawed, as science alone by itself is incapable of parenting any wholesome model for societal development. Charles Darwin who is believed to have given a scientific base to the secular view on life by his evolutionary theory lamented his trust in science. "My error," he said ten years after the publication of the *Origin*, "has been a good lesson to me never to trust in science to the principle of exclusion".[6]

The Quran and Nature

Equally untrue is the secular contention that the Quranic verses (*ayahs)* have no other meanings other than as pointers to Allah's presence. Not that the secularists are willing to concede God - the Creationist's role in the universe but that it suits their cause if the Quranic verses are emptied of their deeper meanings. Ironic as it may be, when it comes to Islam and Muslim bashing, they become high on reason stressing its role in the human development. But when the same "irrational Muslim" wants to reflect on the Quranic content through intellection, observation, and experimentation, the secularists want him to make a passive reading of the Quran. Two reasons can be cited for their duplicitous posturing. One, the affirmation of the scientific approach in the Quran reinforces the Muslims' faith in their religion in these doubting times. Second, the more scientific findings cohere with the Quran, the more it helps Islam stand out as an ideal faith and consequently the truth. Both pose a problem to the secular view as these create a barrier to the spread of secularism.

Whether the Quran helps science or not is contingent on two aspects of it. What is its attitude toward intellection and empiricism? Second, does the Quran speak of reflection on the universal phenomena or the signs of Allah as the Quran calls it?

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[6] Nora Barlow (ed.), *The Autobiography of Charles Darwin 1809-1882*, Garden City, N.Y, Doubleday, 1963, p. 84.

Islam and Reason

Neither the Quran nor Sunnah take themselves as close-ended. Both are opposed to pedagogical planning, as its limits are narrow. Expressed differently, the two do not seek formal conditioning of the Muslims nor do they want them to face what is known as the chaos of polymathy, which may overcrowd the mind but fails to educate. At the same time, they disfavour what is known as structured mass organisation in the context of an eternal now with the public overlapping the individual life or a planning that limits itself to the finite horizons of the human intellect, for in their view, it not only dehumanised humanity but also put a premium on human growth. Humans must have space to realise freedom as autonomous selves. To both, Islam in its socio-economic and political aspects is a blueprint of basic structure and not the whole thing. Each generation has to work out the details according to its needs in the civilisational context, through the interplay of reason and the word of God. In their perception, the Muslim approach should aim at retaining Islamic dynamism and not at reprising the past. The prophetic scheme thus gives reason a pivotal role in accomplishing this task. While *wahy* (revelation) gives substance to life, the role of reason is to play itself in four main directions:

a) Allah-consciousness;
b) Selfhood or self-cognition ;
c) Social awareness;
d) Environmental knowledge.

True, revelation opened a window on the human self, creation, and the Creator, but the application of knowledge thus acquired was left to reason and reflection. To begin with *thud* (monotheism) itself is a prime rational concept when it says there could not be more than one God. Or when it holds that there is a beginning as well as an end. Or when it says that there is an absolute ontological dependence of the creation on the Creator. Or when it says that the creation and the Creator are unlike in their essence. Or when it stresses that revelatory guidance is coterminous with the existence of a compassionate God.

Likewise, humans were asked to find the principal Creator from the creation itself. “In the creation of the heavens and the earth and in the alternate motions of day and night, there are signs (to reflect upon) for the wise,” said the Quran. Further, “... in the cattle there is lesson for you. We give you to drink what is in there, from between the refuse and the blood, pure milk palatable to the drinkers”.

This was purely empirical in a world cultivated on untested assumptions. In other words, the Quran fostered observation and experimentation, *a posterior* as well as *a priori* methods -- from effect to cause and from cause to effect -- so that the sciences and contemplative thought could have a religious spurt.

Another aspect of this kind of rationalism was to strip past history of its sanctity and reduce it to a repository of human experiences, which may be made use of, should the contemporary situation give rise to a parallel.

In Islam, the Quran with its transcendence and the Prophet as its exemplar became the touchstone of human activity, and the past pruned to a mere reflection of a bygone era, a source of light may be, but not an object of worship. That this put an effective check on man’s conservative bent along with a halt to his liberal attitudes is too obvious to amplify upon.

Besides, it took away the high pedestal on which were perched the scholars, the rabbis, and the priests. When the revelation deprecated the Jews and the Christians for elevating their clergy to godhood, ‘Adiy ibn Hatim, a Christian convert to Islam asked the Prophet its precise import, he replied by raising a counter question: “Didn’t they give preference to their (priests) words to God’s word?”

Equally important is Islam’s view of time, which as opposed to the Arab notion of the infinite nature of *dahr*, took it as finite and responsive. Such an inference denied three dimensionality of time –- past, present, and future. “Labour in this world,” said the Prophet, "as though you were to live eternally, labour for the next world as though you were to die tomorrow". This situates the moral agent in the flow of time defining "the present as the privileged sphere of the ethos" and doing away with the infinite time of pre-Islamic peoples. The autonomy thus given to the human agency calls for a creative temporal moment in response to a problem that matures in the womb of time, and asking for a solvent. This could be in the form of maintaining the purity of the Islamic tradition in the face of the onslaught made by the formal rationality or by explicating the shariah and updating its content or by improving the civilisational context of the human situation through control and manipulation of the material resources.[7]

The Quran and its Invitation to Reflect on Nature

In understanding the text, whether revelational or non-revelational, there are layers of meanings which, depending on the reader's ability to understand, unfold themselves on his mental canvas. An average reader may negotiate the surface meaning while the reflective one may tangle himself with the deeper meanings. This is so because natural phenomena activate three kinds of responses in the observer: some are pepped up, for they feel its resonance in their souls; others are overwhelmed by their mysterious presence and end up in a state of awe. A few may even start thinking and thus lead to a process of discovery. A straightjacket formulation will be therefore flawed.

Allama Inayatullah al-Mashriqi recounts his encounter with Sir James Jeans (1877-1946) the famous mathematician and astronomer in Cambridge. Mashriqi was his student in the 1900s. Intrigued by Jeans' religiosity, one day he took courage to ask him what was it that reconciled a scientific mind like his with religion. Jeans replied that it was the wonder that lied behind the natural phenomena. To cap it he revealed the information that whenever he observed the material reality and

[7] For this entire section, see Tarik Jan, *The Life and Times of Muhammad Rasul Allah – Toward the Universal Islamic State*, Chapter "Making of a Community," Islamabad, Institute of Policy Studies, 2003, Vol. 2, under print.

reflected on it, he shivered within. Encouraged, Mashriqi read to him the following verse from Surah Fatir 27-28:

Did you not see how Allah sent down
water from the sky and brought forth
fruit of different hues?
In the mountains there are streaks of
various shades of red and white, and jet
black rocks. Men, beasts, and cattle have
their different colours, too.
From among His servants, it is the learned
who fear Allah.

With tears welling up in his eyes Jeans said: “For sure only the knowledgeable ones fear Him”.

So then what is the Quran? There can be no two opinions on the Quran that it is a book of guidance (*hidayah)* and not science per se. This, however, does not mean that it has nothing to do with seeking knowledge or science. Some scholars, like 19th-century al-Tahawi, expounded the Quran from the science viewpoint running into several volumes. There are more than 700 verses in the Quran containing references to the natural phenomena. Very few subjects have this repetitive scale. Could it be that by such repetition the Quran wanted to condition its readers’ mind to follow the nature’s path toward Allah – the Creator? The answer is certainly yes. Jean d’Alembert, the famous French physicist (1717-1783), almost echoed this theme when he said:

> The principal profit we should derive from cosmology is to raise ourselves through the general laws of nature to the knowledge of its Author, whose wisdom has established these laws. … Thus cosmology is the science of the universe inasmuch as the universe is a composite entity and yet simple because of the unity and harmony of its parts, and whose basic factors are

> combined, set into motion, and modified by that supreme intelligence.[8]

One may rationalise their opulent presence in the Quran as a pointer toward its creator and that will be justified but that will be a surface reading of the Quran as well as of the human mind for it limits itself to seeing the phenomena and nothing else. For example, is it psychologically or even physiologically possible to restrain the reader from reflection on the nature of the phenomena and the working laws inherent in them? Can we map the human brain as such – confined to seeing and not transmitting the seen to reflection? Or what happens to the retinal messages received in the human brain? Is the human mind a kind of a black hole – a burial ground of the dead?

To illustrate the point, let us take the following four verses:

- Who has made the earth a comforting place to live in …(al-Naml: 61).

- It is Allah who sustains the heavens and earth, lest they cease (to function); and if this should fail, there is none – not one can sustain them thereafter. Verily He is most forbearing, oft forgiving. (Fatir: 41).

- Allah swears by the shelters of the stars and that is indeed a mighty adjuration if you but knew. (al-Waqi'ah: 75).

- You see the mountains and think they are firm in their place while they are flying like clouds. This is because of Allah's creativity who has structured everything with wisdom. (al-Naml: 61).

Here in these verses five things are being said all conjoined together as if building up the Quranic cosmology.

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[8] See "Cosmologie," *Encyclopédie ou Dictionnaire raisonné des sciences…* , Paris, Chez Briasson, 1754, Vol. 4, p. 294.

Earth as a comforting place (*qararun*) free from disequilibrium; the reality of the mountains as clouds flying; holding the heavens and the earth from falling on each other; the movement of the sun and other celestial bodies; finally, the great expanse of the stars.

Each revealed fact was unknown to then knowledge scene. Since 632 B.C. when the Quranic revelation ended its descent, it kept on nudging its readers to probe the natural phenomena and find out reality. Today with advanced tools, our cosmological findings are unlocking the great scientific messages in these verses. For example, when the Quran described the mountains as the flying clouds and ascribed their apparent presence as not still but in motion to Allah's creativity, none of its first generation audience understood it. Today with the earth's rotation confirmed, describing mountains as clouds flying becomes understandable.[9] It may be of interest to note that for the developing notion of a revolving planet in 1510 C.E., Nicholous Copernicus was hailed as "the father of modern astronomy".[10]

Thus, this verse alone is enough to demolish the contention that when the Quran talks about the natural phenomenon, it invites belief in Allah's presence and nothing else. Because if it were so, alluding to the mountains as clouds flying, which the readers of the Quran could not even observe, would have failed to invoke that kind of religious feelings.

Likewise, describing earth as a "comforting place" despite its elliptical movement at the speed of 84,000 km an hour is a scientific statement of a far greater magnitude than could not be obviously understood by its surface reading.

We now know that the earth's rotational speed is proportional to its mass and so is its gravitational force. Any variation in them, say if its movement is reduced to a 150 miles an hour, the

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[9] For instance, if one stands in space at a convenient place and watches the earth rotate, the mountains should look like the flying clouds.

[10] Kenneth C. Davis, *Don't Much About the Universe,* New York, Harper Collins, 2001, p. 47.

impact on human life will be catastrophic: the day will have duration of 120 hours; we will lose all vegetation. Likewise, any variation in the gravitational force, which keeps us planted on the ground, would have flung us in the air and our houses blown into pieces.

The Quranic statement in which Allah swears by the stars and then says it is a "mighty adjuration" is an unusual one. In this statement there is no pointer to any visible natural phenomenon to create the kind of religious response that could have affirmed Allah's transcendence by mere sight. The statement is similar to one in which mountains are described as clouds flying – defying the sensory experience. How mighty is Allah's adjuration is knowable in the fact that "more than a million earths can fit inside the sun; every second five million tons of matter are converted into energy by nuclear reaction in the heart of the sun, sort of like million of hydrogen bombs all going off at once. The sun (age about 4.60 billion years) produces this energy at the rate of 92 billion one-megaton nuclear bombs going off every second. … In one second, the sun gives off more energy than all people have produced during their stay on earth. Yet earth receives only a tiny fraction – two billionth – of the sun's total energy".[11] Four years ago Solar and Heliospheric Observatory (Soho) – a 1.85 tons satellite – discovered tornadoes in the sun "as wide as Africa, with wind … speeds of 50,000 km per hour [that] can become ten times faster in gusts".[12]

How mighty Allah's creation is, can also be measured by the size of the galaxy known as the Milky Way. Recent estimates are talking about the presence of 200 billion stars that constitute the Milky Way. These are known facts. Add to these unknown stars and other galaxies and the human mind shrivels before them. The Milky Way alone, which includes the sun, earth, and the rest of the solar system, is between 100,000 and 130,000 light years in diameter. One light year is about 9.20 trillion km. Multiply it with 100,000 and one can have the awesome size of the Milky Way. The Andromedia Galaxy found by the Muslim

[11] *Don't Much About the Universe*, pp. 94-95.
[12] *Ibid*., p.100.

astronomer As-Sufi in 964 C.E. contains about 400 billion stars.[13]

That is being the Quranic approach, small wonder, Islam or Muslims cannot be accused of opposing science. For instance, look at the fact that almost 300-400 years before Copernicus, Abu Ishāq al-Bitrūji latinised as Alpetraguis came up with his shattering criticism of Ptolemy's cosmology of epicycles and eccentrics, which provided a new explanation to the paths and motions of the stars. In the words of Will Durant, it "paved the way for Copernicus…"[14] Unlike Galileo, al-Bitrūji was not punished. Or take the case of Giordano Bruno, a priest, who was burned because he propounded the idea of more than one universe not available in the Bible. In Islam, the Muslims knew it through the Quran that their God (*rabb)* is the master of all the planets (rabb al- 'alamiin) and their prophet is rahmatil al-'alamin, implying that there are several planets in addition to the earth.

What is far more amazing is the fact that the past Muslim society adhered to Islam more sincerely than today's lukewarm Muslims. If science could flourish in that kind of ambience it can even today. Likewise, when we talk about the past Muslim science, it cannot be described as superficial or taken slightly. Contrary to Greek science - which was largely observation and recording of secondary details - the Muslims conducted controlled experiments and maintained careful records. For instance, 500 years after Jabir ibn Hayyan (702-765), Roger Bacon brought his experimental methods to Europe. Their botanical, medicinal, and astrological works were used as textbooks for almost 700 years in Europe. They originated encyclopaedias, determined specific gravity of liquids and solids, and worked out astronomical coefficients as good as modern calculations. They also developed algebra and chemistry, analysed chemical constituents of plants and figured out their medicinal values, built sophisticated astrolabes and

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[13] *Ibid*., p. 198.

[14] Will Durant, *The Story of Civilisation – The Age of Faith,* New York, Simon and Schuster, 1950, p. 329.

powerful telescopes. Men like Khuzini proposed gravitation theory almost 500 years before Newton. Their philosophical works and commentaries of Plato and Aristotle helped shaped the western mind. Almost 700 years before David Hume, al-Ghazali reduced reason to causality and causality to mere sequence. People like al-Farabi anticipated Hobbes, Nietzsche, and Rousseau.

What was their source of motivation? It was certainly not commerce or money. Science was not as commercialised as it is today. Nor did the Muslim scientists have the benefit of Harvard, MIT and Oxford's education. They were the products of religious schools. By and large they were practising Muslims. Inspired by Islamic metaphysics and the sound epistemology built on it, they left an enduring legacy – a noble monument to their faith. A western scholar aptly describes the Muslim legacy as "half forgotten". To accuse Muslims of being "romanticists" - as if they allude to their past without reason - is to undermine history. In fact, Muslims are still not conversant with their past achievements. What comes to them is filtered and not sufficient. There are still thousands of manuscripts scattered all over the world waiting for tabulation and analyses. "When scholarship," said Durant, "has surveyed more thoroughly this half-forgotten legacy, we shall probably rank the tenth century in Eastern Islam as one of the golden ages in the history of the mind."[15]

Lately, a prominent American had the magnanimity of spirit to have said after the tragic September 11th incident:

> And this [Islamic] civilisation was driven more than anything else, by invention. Its architects designed buildings that defied gravity. Its mathematicians created algebra and algorithms that would enable the building of computers, and the creation of encryption. Its doctors examined the human body and found new cures for diseases. Its astronomers looked into the heavens, named the stars, and paved way for space exploration.

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[15] *The Story of Civilisation – The Age of Faith,* p. 257.

> …The technology industry would not exist without the contributions of Arab mathematicians.[16]

Equally meaningless is the taunt that if the Quran had the scientific references why did not the Muslims have science during the first forty years? Science needs some germination period as well as infrastructure. The first Muslim society was by and large illiterate, poor, and battling for survival. Once the Muslims overcame their inadequacies science was not far away. For the secularists it may be a puzzle – an unbelievable feat in what they perceive to be a dogma-ridden milieu and yet science created by it receives global applause. What they forget is that worldviews and metaphysical beliefs especially when grounded in the prophetic knowledge are not hurdles but signposts on the road to acquiring knowledge about reality and improving humanity's fortune. Kuhn is right when he says that worldviews and metaphysical beliefs are elemental in any paradigm constitutive of science.

The Galileo Case – the Fight Between Old and New Cosmologies

Galileo's is the most celebrated case in the science history of the West cited frequently to prove the point that religion frustrated scientific pursuits. As it happens with the mind that seeks authentication of its biases, many facts have been glossed over to arrive at a preferred conclusion. So, what was it that Galileo stood for? The heliocentric theory that he supported had two aspects: mathematical that helped measure the angular positions of the planets; and cosmological that talked of a much larger universe as opposed to the traditional cosmology. Far more shattering was his demonstration of the earth's rotation around the sun rather than the sun revolving around the earth. And third, that the earth had an elliptical surface rather than spherical.

True that it challenged the established cosmology, the opposition was sectional and not uniform. Even in the religious

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[16] See at <http:/www.hp.com/hpinfo/execteam/speeches/fiorina/ Minnesota o1.htm> for the entire text.

circles, Galileo had his support. Cardinal Bellarmine, the chief theologian, thought the Church should accept its failure to understand the scripture rather than "declare an opinion to be fake which is proved to be true,"[17] though later under pressure from religious as well as non-religious sources he made the decision that Copernicanism was "false and erroneous". The Church also suggested as a compromise that the Copernicus view of reality be treated as a mathematical construct rather as a true picture of reality. Galileo agreed but later refused. It is equally important to note that between 1543 and 1600 C.E., there were at least ten Copernicans involving seven Protestants and three Catholics who strongly pleaded for the earth's rotation. Catholic Diego de Zueriga even quoted the Bible (Job 6:6) in support of the earth's movement.

The matter was though not simple; it posed a problem: should the Copernican system be read as the possible picture of reality? What if subsequently it turns out to be false? "The latter," suggests Brooke, "could be a more radical position than to accept it as potentially true".[18]

Brooke also cites the case of the Lutheran University of Witterberg where parts of the Copernican system were accepted as improved tools for predicting the angular position. ... "The Lutheran circles … played down the cosmological aspects of De revolutionibus".[19] Ironically, uniform opposition to Galileo or for that matter to Copernican system came from the academic philosophers who obsessed with Aristotelian cosmology or world picture pressurised the Church for Galileo's prosecution. In other words, as Brooke concludes, the opposition to Galileo was more of a nature of a conflict between the old and the new cosmologies. The old Aristotelian cosmology was not biblical, though it found place in it, proving the Quranic charge that the Bible was falsified by interpolations.

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[17] *The Passion of the Western Mind,* p. 260.

[18] *Science and Religion – Some Historical Perspectives,* p. 90.

[19] *Ibid.,* p. 90.

To deny, however, that the Copernican system received no opposition would be inaccurate, but it will be equally falsifying history if the whole Galilean situation is construed as religious opposition to science. For example, Copernican was scorned by Italy but it found its principal supporters in the New England clergy. In England, John Wilkins said almost the same things (*Discourse Concerning a New Planet*, 1640) but was not censored. His case is all the more interesting because he was a bishop.

Even in Italy, the seat of papal authority, Galileo's case was an aberration; the environment in general was friendly to knowledge. "One can lose a sense of perspective if the condemnation of Galileo is taken to epitomise the attitude of scholastic and Catholic authorities toward the natural sciences. Relatively few scientific works were placed on the index."[20] Likewise, Descartes could publish his work in Holland but not in France.

Again ironic as it may sound, established religious institutions played a contributing role toward the growth of science. The scholars in the West were products of the church sponsored educational institutions and the first to have challenged the ancient texts under the impact of Muslim scholarship. Their criticism of Aristotle, which broke the unscientific hold of the Aristotalian thought, was mainly borrowed from al-Ghazali, Farabi and others.

As early as fourteenth century bishop Nicole d'Oresene came out with his theory of a moving earth. His criticism of Aristotle's optical was later used by Copernicus and Galileo in their heliocentric theory. Jean Buridan, d'Oresene's teacher, came out with his impetus theory the precursor of Galileo's mechanics and Newton's first law of motion. Nominalism that played a central role in the evolution of the western mind was a gift of another scholastic named William of Ockham.[21]

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[20] *Ibid*., p. 108.
[21] *The Passion of the Western Mind,* pp. 201-202.

True, the Church did condemn the Copernican system but it never restrained its use as a mathematical tool. Brooke gives the example of Francesco Lana who used "many models to express the truth to which the science of natural things could attain. What one model lacked, another would supply. If such eclecticism counts as a limitation, it hardly detracts from the achievement of Jesuits as patrons and teachers of science. Of the 195 members of the Paris Academy of Sciences to be honoured with an official eulogy before the Revolution of 1789, at least 20% had received a Jesuit education".[22] The Jesuits' contribution to learning was so impressive that even a Protestant crusader for educational reform, two generations before the Paris Academy of Sciences, had conceded that the state of learning had been "much quickened and strengthened by Jesuit schools".[23] The Jesuits' contribution was particularly impressive in the fields of electricity and magnetism.

Interestingly enough, the Copernicus system, which caused Galileo's problem, was motivated by religious sentiments. Copernicus who schooled himself earlier in priesthood admits that he was not satisfied with the philosophical works as they fell short of giving a scheme for the earth's motion, which he said was "built for us by the Best and Most Orderly Workmen of all". Like the past Muslim scholars, who contemplated wisdom in the Quranic substance and enriched their faith in the divine scheme of things, Copernicus reached God by his probing of the universe. Relating the produce of scientific work to God-consciousness, he said: "For who, after applying himself to things which he sees established in the best order and directed by divine ruling, would not through diligent contemplation of them and through a certain habituation be awakened to that which is best and would not wonder at the Artificer of all things, in whom is all happiness and every good?"[24]

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[22] *Science and Religion – Some Historical Perspectives,* p. 109.
[23] *Ibid*.
[24] See Charles G. Wallis' translation in *Great Books of the Western World, Ptolemy, Copernicus, Kepler,* Chicago: Encyclopaedia Britannica, 1939, p. 510.

All said, instead of conflict, religion and science would continue to influence each other. Science may even help in giving new meanings and depth to the understanding of the religious texts by its dig of new evidence as it is happening in the case of the Quranic contents. And religion may humanise science by releasing it from its current secular materialistic mould. To inject conflict into them or inflate it is to negate their essential natures, which remain wedded to search for truth and universality.

11
Essentials for Knowledge Based Economy and the New S&T Initiatives

S.T.K. Naim

After decades of neglect, Science & Technology has received unprecedented attention in the past three years mainly due to the dedicated and committed efforts of Dr. Atta-ur-Rahman. The National Commission for Science and Technology (NCST), the apex decision-making body headed by the Chief Executive of Pakistan has met twice in the last two years. An agenda for building indigenous National S&T capacity was approved with an increase in the development budget of the Ministry of Science and Technology (MoST) by 5000 percent.

Several new initiatives have been taken. MoST has funded about 300 projects in last two years. Pakistan Council for Science & Technology, as the secretariat of the NCST has been deeply involved in the planning and implementation of a number of the new S&T initiatives which are targeted towards building a knowledge and innovation infrastructure through which the country can be set on the path of sustainable development.

Knowledge and innovation, rather than natural resources, are now the driving force for the creation of wealth and prosperity. Which countries will do best in the 21st century? The advantage will simply go to those that continually look for better ways to put their intellectual capital to work for economic and social benefits. Government has a major role to play in setting appropriate policies, standards and regulations, creating incentives, making strategic investments and fostering an environment conducive to the acquisition and deployment of knowledge and innovations. In short, our entire economy, and knowledge infrastructure would have to embrace innovation if we were going to compete successfully in the knowledge economy.

In this article I briefly discuss the essential requirements for building a knowledge economy and new initiatives taken by us for S&T development. Understandably the foremost requirement is that of highly qualified human resources.

In terms of human development Pakistan ranks at 132nd in the world according to the World Bank Report. Our knowledge and research base is extremely weak. Just 3% of our youth age 21-23 enrol for higher education as compared to 60-70% in the developed countries of Western Europe and in East Asian countries such as Singapore and South Korea. Over the years our universities and R&D organisations have experienced deteriorating standards in the quality of education and research due to the depletion of high level S&T manpower.

The foremost task therefore, was to address the issue of high quality manpower. This problem is being addressed through several programmes, which include:

Training of 700 Ph.Ds within the country and abroad in next four years under three different programmes:

a) The indigenous Ph.D scheme is designed to strengthen the R&D capabilities of national institutions. Supervisors are selected by PCST on the basis of their past research performance and experience of supervising Ph.D level research. Each Supervisor is entitled to receive Rs. 4,40,000 per student per year and can request for grants to supervise three students at a time. Students selected on merit are provided Rs 5000 per month as research grant. The remaining funds are used for purchase of research essentials and an honorarium of Rs. 25,000 per year per student for the supervisor. About 500 students selected on merit are offered research grants for Ph.D studies.
b) Under the Split Ph.D scheme 100 students are selected on the basis of their GRE results. Under this scheme the students are enrolled at the local universities to work on research problems relevant to solving indigenous problems and are then sent to the universities of developed countries

for one to two years to gain knowledge of the latest research and technologies in their respective fields.

c) Through the Teachers and Researchers Scholarship Scheme (TROSS); 100 university teachers have been sent abroad for Ph.D training. Each year 50 university teachers and researchers in particular those who obtained their Ph.D in the local institutions are being sent to the reputed universities abroad for postdoctoral studies. The immediate and temporary requirement of teachers and researchers at the universities and R&D organisations is met through the hiring of Consultants on contract for a period of one to three years. This has enabled the universities to retain some of the active retired scientists.

Expatriate and foreign experts are invited for short and long term period to work in our laboratories. 27 foreign/expatriate experts visited our institutions last year and applications for the visit of others are under process. This along with TROSS and split Ph.D scheme will increase our access to international knowledge and will hopefully help in developing long-term R&D linkages with the institutions of the developed countries.

To ensure young Ph.Ds trained abroad are gainfully employed when they return to the country, ‘’Starter Grants” provide immediate access to research funds so that they do not face the frustration of working at ill-equipped laboratories. They are allowed use of laboratories at public sector institutions, provided grant of Rs.2.0 million each for research essentials and an honorarium of Rs.15,000 per month if they are unemployed.

To check “Drain” and to encourage quality research, emoluments of scientists, engineers working in the public sector universities and R&D organisations have been substantially increased by linking their research performance to Research Productivity Allowance (RPA) and Special Science and Technology Allowance.

Scientists and Engineers who have published in international journal of repute are considered eligible for RPA and are placed in categories A-G depending on the Cumulative Impact Factor and Citations of their international publications. Those placed in category A for example, are entitled to RPA of RS.100,000 per month; fifty percent of which is added to their personal emoluments and the rest is to be utilised as student grants and for purchase of research related materials. Scientists with a Ph.D degree are entitled to an increase of Ph.D allowance from Rs.1,500 to Rs. 5,000 per month if they are actively involved in research.

The Higher Education Commission (HEC) has been constituted to bring about positive reforms in universities with the aim of introducing quality in teaching as well as research. The task for HEC to institute reforms towards a knowledge-based economy involves a shift in organisational culture. Knowledge-based work by organisations involves greater recognition of autonomy and self-direction of mind. An effective quality system is not based on external monitoring buttressed by quality bonuses, but on the intrinsic ethos of producing quality for its own sake based on the pride and self esteem of its workers.

Education at the under-graduate level also needs to be improved. We must provide incentive to our college teachers to up-grade their skills by linking salary to their teaching and research performance. Talented graduate students are a significant source of innovation and in that sense indispensable for research enterprise. Knowledge is best acquired not by passive rote memorisation but by the active involvement of the learner. Learning is by doing, not by watching or memorising.

The importance of elementary and secondary education is not to be overlooked. There is no example in history where a country has developed just by addressing the quality of graduate and higher education. We urgently and on priority basis need to address the problem of the high dropout rate, particularly of girls from schools at the primary to secondary-level, and the shortage of skilled teaching staff. The curricula of elementary and secondary schools need to be revised with emphasis on development and improvement in communication skills and of fundamental scientific and mathematical concepts. We can introduce quality in our educational institutions by linking the performance of the regional political leaders (Nazims and Councillors) to the performance of regional schools. Quality cannot be achieved without good governance and competition.

To attract qualified science and maths teachers, salaries that make the teaching profession attractive and competitive need to be offered. We must train a core of good science and mathematics teachers and should consider introducing merit pay or other incentives as a way to reward and retain them in this vital profession. Our high school graduates should also get a sense of how pursing mathematics or science courses can lead to interesting and challenging careers.

Technical education needs to be strengthened and the curricula made market oriented so that the students have incentives to opt for technical courses. We need to focus on developing or training our human resource for programmes aimed at improving productivity and efficiency in production in all sectors of economy, including agriculture. Programmes for promoting the implementation of new process technology must be accompanied by continuous improvement of the qualification of the employees.

Strong Research Base through Long-term Investment

After human resources, the second most important requirement is of a strong research base through long-term investments. Pakistan has 130 major R&D organisations and the number of universities and degree awarding institutions has recently increased to 93. Despite the increase in the number of institutions, very few scientists are involved in quality research. Pakistani scientists contributed only 670 papers in the international journals in the year 2000.

The international quality research is conducted in just four or five centres in the country. We therefore, need to analyse our system of innovation, identify strengths, weaknesses and missing links.

PCST organised a Peer Review study to critically analyse the performance of all R&D organisations and S&T departments of the public sector universities. Experts Committees made personal visits to 228 independent R&D centres working with 110 major R&D organisations and 300 S&T departments of the universities and have provided their evaluation reports. Based on the recommendations of this study and considering their past performance and relevance to the economy 11 R&D centres are selected to be upgraded as Institutes of Technology and six as Institutes of Pure and Applied Sciences. Out of these four have received funding and the PC-1 documents of others are being processed. The Peer Review study also recommended strengthening of 147 R&D organisations, merger of 29 and closure of six. The administrative departments of the provinces, under which these organisations work, have been requested to implement the recommendations.

Public sector universities (35) have been provided Rs. 4.0 million each to upgrade their research and information technology facilities. The indigenous Ph.D programme also provides funds for strengthening R&D infrastructure at the department level.

Through a scheme of repair and maintenance of laboratory equipment, R&D equipment worth over Rs 3.0 billion lying idle for want of spare parts or for simple repair and maintenance is to be made functional. About 150 Laboratory Technicians from all over the country are being trained.

Six major libraries in the fields of engineering, physical sciences, agriculture, earth sciences, chemical sciences and biological sciences are to be upgraded. These Libraries will be equipped to access data-bases around the world so that they can share the library resources and provide services to other libraries in the country.

Focused Strategic Research in Key areas of Wealth Generation

Strategic research areas have to be identified and focused research has to be undertaken in collaboration with industry and other stakeholders. Several steps have been taken in this direction. The priority areas of research that have been determined and approved in the third Meeting of National Commission of Science and Technology are:

a) information technology
b) biotechnology
c) pharmaceuticals
d) electronics
e) minerals development
f) renewable energy
g) metallurgy and Nano technology
h) engineering, X, electronics

Priority projects in each of these areas were identified by the National Experts Committees commissioned by PCST. These projects have been included in the Ten Year Perspective Development Plan

National Commission for Biotechnology has been established in the PCST premises to promote biotechnology research. In the last two years MoST has funded 21 projects worth Rs. 450 million for research in the area of medical, health and agriculture biotechnology. In the engineering sector, endowment fund worth Rs. 1.0 billion has been set up for promotion of post-graduate research at the engineering universities.

PCST has constituted Experts Committees comprising scientists and industrialists from public and private sector to identify emerging generic technologies likely to yield the greatest social and economic benefits. The Committees have been requested to formulate Technology Road Maps for immediate and long-term investment.

Collaborative Research

Local and international research networks are fundamental to the smooth functioning of an innovative system. A proposal for networking of institutions with shared research interests and the potential beneficiaries of research stakeholders (industrial cluster) is under process. Partnership in research not only among the public and private sectors, but also between firms and government laboratories is needed. Partnerships are essential for assembling a critical mass of knowledge, expertise and capital to level resources. Collaboration among scientists is an integral part of research, playing an important role in the advancement of S&T.

We must encourage multidisciplinary group research comprising scientists not only from R&D organisations and universities but also those working in industrial enterprises.

Scientific collaboration between countries is an important tool for building capacity particularly in areas where indigenous knowledge is weak. MoST has signed agreements with 21 countries, it also has joint Ministerial Commissions with 4 countries, Executive Protocol with 1 country and Memoranda of Understanding (MoUs) with 6 countries but effective collaboration is limited only to few countries of western Europe, and China. A joint Revolving Fund for S&T co-operation has been established with China, Syria, Turkey and Kazakhstan. During the year 2001-2 six projects for the establishment of R&D Revolving Funds for collaborative research with countries such as, Turkey, Syria, Kazakhstan and China were approved. The Ministry is in the process of identifying, short listing research projects that can be initiated with these countries.

Technology Development and Industrialisation

Joint projects are being initiated between research institutions and the industry for technology based production of high value added goods. This is based on public-private partnership where contribution of the public sector is 75% and the private sector 25%. 27 R&D projects in the field of agriculture, engineering, biotechnology, minerals and gem-stones, ocean and water resources, energy etc. have been funded.

Most developed countries have used public-private networks to bring together entrepreneurs, researchers, financiers and other key players in the innovation system to create dynamic new clusters of industrial activity.

Technology Development and Efforts towards Creating the Tri-Helix Linkage System

Clusters are groups of small and medium industries located in a region or closed area with a strong concentration of capital and business expertise. We plan to strengthen regional cluster centres, which can reach out to all Small and Medium Enterprises (SMEs) for their technology related problems to begin with. Slowly it could develop into an innovative centre of regional SMEs under the right conditions, the combined research, talents, facilities and entrepreneurial spirit of the cluster reaches a critical mass, which then leads to more firms to invest in the region and new entrepreneurs to be created. If this whole concept catches on, the cluster can have a significant impact on the region's development. We have provided funds to the fan and bed sheet clusters for purchasing training and research equipment. Efforts are being made to encourage other clusters such a leather goods, glass and ceramics, surgical goods, electronics, metal and materials to invest in R&D. Research turns money into innovation; innovations turn knowledge into money.

Communication Infrastructure

The knowledge-based economy requires a modern communication infrastructure. About two years ago a mere 26 of our cities had Internet access. Today there are almost 1000 cities on the Internet. The Internet bandwidth availability in Pakistan has increased from 35Mbps to 265Mbps over a span of one year. The Internet Tariff has been reduced to 1/16 in the past two years. To meet the growing demand of IT professionals, new IT universities are being established in the public sector. A Virtual university is functioning with 28 tutoring centres in 18 cities in public, private partnership. The number of tutoring centres is expected to increase to 100 during next six months. 30 public sector degree, awarding institutes have been provided funding for training of Bachelors and Masters candidates. International faculty is invited to impart IT education at salaries ranging Rs.100,000 to Rs. 300,000 per month. IT education at schools is promoted through training of school teachers.

Strengthening of the Metrology, Standards, Testing and Quality Control System

Ministry of Science and Technology is working closely with the Ministry of Industry to introduce quality standards for industrial products and processes so that they meet the demand of high standards and increasing competitiveness of the global economy especially with enhanced role of the World Trade organisation (WTO).

Pakistan Standards and Quality Control Authority (PSQCA) was established in 1996 through the merger of Pakistan Standards Institute, Metal Industry Research and Development Centre and Central Testing Laboratories. PSQCA has been provided funding for strengthening the R&D facilities and hiring of qualified manpower for the above three organisations. Eight analytical laboratories located in the industrial cities of Pakistan have been provided funding to upgrade their facilities.

The Pakistan National Accreditation Council (PNAC) has been established. The PNAC accredits agencies providing certification of ISO-9000 and ISO-14000 standards, laboratories for testing and calibration, for registration of auditors and training courses provided in quality control. So far 3,000 Pakistani firms have acquired ISO 9000 certification under this programme. The PNAC also organised 50 workshops, seminars in major cities to create awareness in the fields of quality, environment, product certification and testing and calibration.

A lot more needs to be done in this area, we need to develop metrology, standards, testing and quality (MSTQ) institutions at international pattern and standards and extend these facilities to all cities. Without a strong National Regulatory Standards Certification, Testing and Accreditation (NRSCTA) system our products and processes will not be accepted on the international market.

Support to Firms/Industry through Venture Capital

So far I have discussed the inputs to the innovation process, but a country also needs to invest at the other end of the innovation spectrum by providing support to firms particularly small and medium industries to innovate. This includes tax incentives and tax-free financing. Venture capital companies provide risk capital to entrepreneurs on equity participation or on loan basis. The case for establishment of venture capital companies is under process. Ministry is also working towards the creation of a Technology Development Fund (TDF) as a support mechanism for innovative technology-based firms. PCST is also making efforts towards the promotion and improvement of Intellectual Property Rights (IPR), but a lot more need to be done in this area.

I believe these are just a few steps in the right direction. The other essentials for an innovation economy include a liberalised or open economy, a targeted industrial vision and conducive environment for foreign investment and technology transfer and above all control of illegal trade. Since the knowledge economy rests on the foundations of basic knowledge we need to invest much more in building human capital, strengthening institutions and the most important, understanding the role of contemporary forces in shaping the way knowledge is used in the productive process.

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12
Conclusions and Summary

Inayatullah

I. The Central Issues

The central task before the contributors of this volume was to determine the state of science and technology (S&T) in Pakistan, identify the conditions that obstructed their development and find ways of removing them. As identified by the contributors this chapter summarises such conditions and list some of the recommendations that they have proposed.

The state of S&T in Pakistan can be inferred from several facts such as the share of publications of Pakistani scientists in the global output of science, the number of scientists and science teachers having Ph.D and the number of M.Phils and Ph.Ds that Pakistani universities produce. Measured against these criteria, the papers dealing with the state of S&T in Pakistan find that it is not very enviable particularly if it is compared with development of S&T in India.

Most Pakistani scientists already know through their direct experience the conditions that retard development of S&T. But these separate experiences need to be converted into broad propositions that can be verified with data. Only then such experiences can be useful for deriving a science policy. Both scientists and social scientists contributors to this volume have offered such propositions, which hopefully will help the makers of science policy to develop more effective policies in future.

II. Causes of Stagnation of S&T in Pakistan

The next issue that some contributors have dealt with is identification of the cause or causes of slow development of S&T in Pakistan commensurate with potentials of the country.

The causes they have identified include:

1. Inadequacies of science policies, imbalance in allocations of resources between nuclear and non-nuclear science.
2. Unfavourable conditions for development of S&T in Pakistan at the time of emergence of the country including weakness of local scientific manpower.
3. Poor implementation of programmes of non-nuclear science.
4. Absence of mechanism of monitoring of science projects.
5. Lack of support for development of non-nuclear science by political elite; and
6. Social and cultural hurdles inherent in Pakistani society.

Some of these causes are discussed below in the light of conclusions of some contributors.

State and Science Policy

The most critical factor that affected the development of S&T is the direction of science policy and lack of consistency in it. Pre-occupied with several political and economic problems, the politically unstable and fragile state of Pakistan did not have enough resources and capacity to develop and implement a coherent science policy. Very few political leaders grasped the significance of the development of S&T for solving economic problems such as poverty and unemployment. Still fewer realised the importance of basic science - the mother of new technologies - unaware that technology does not really take off without a strong scientific base. Lack of a serious commitment to the advancement of basic science in the country might also have been influenced by a perception that a poor country cannot afford to develop such sciences especially because they can be easily borrowed from scientifically advanced countries. In addition, policy makers might have been afraid that development of science and the resultant diffusion of the culture of science in Pakistani society might undermine the system of knowledge that legitimises their power.

Most framers of science policy preferred to manufacture or import turnkey technology, particularly military technology and finished consumer goods. Such a policy may have been well suited to achieve their preferred goals of national security, international status, and increase in superficial affluence and personal comforts.

Incoherent and poorly developed science policy may itself be the result of inadequacies of policy makers themselves. According to M. J., Moravcsik, most of them were people "with no personal experience in developing science, with no perception about the nature of science and its role in a country's development, and with no vision and no elan".[1]

It is not clear what role the scientists of the country played in setting the direction of science policy. One paper in this volume reports that from mid 80s leading scientists, engineers, technologists and policy makers of the country participated in discussions on science policy.[2] However, it is not certain if their participation made any difference in the contents of policy. A general impression from the papers in this volume emerges that such participation was limited and it did not affect the direction of science policy. Main role assigned to scientists was to implement the S&T agenda set by the government. Anis Alam in his paper argues that half a dozen representative bodies of scientists rarely questioned the science policies determined by the state. Instead these bodies "…almost always operated as spokespersons for the government in power".[3]

The passive role of scientists in policy making can be understood in the broader context of the country. With long authoritarian rule in the country, absence of a cohesive scientific community, complete dependence of scientists on state for resources, most scientists had no choice but to comply with the government set science policy. However, Anis Alam argues that

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[1] M.J., Moravcsik quoted in Riazuddin's paper in this volume "Fifty Years of Science in Pakistan in Socio-Economic Context," p. 51.
[2] Abdullah Sadiq, "Evaluation of Scientific Enterprise in Pakistan" in this volume, pp 25-32.
[3] See his paper "Why Science Doesn't Take Root in Pakistan? Few Preliminary Thoughts," p.39.

even if scientists had the necessary freedom to shape the policy, their perception of science as a collection of facts and theories to be remembered rather than a method of discovering new truths and mind liberating culture would not have produced an alternative science policy.

Whatever science policies were made they did not make much impact on development of S&T for lack of effective implementation. Isa Daudpota in his paper in this volume gives a graphic picture of it. "In the musty cabinets of the Ministry of S&T (MoST) lie piles of policy documents, bearing marks of time and apathy. These tombs of good intentions have over the years listed all the wonderful things that S&T can do for us, if only we had the political support and the money to make them happen."[4]

Nuclear vis-a -vis non-nuclear science

One momentous decision taken by the Government of Pakistan in early 70s that set the direction of development of S&T was to develop weapons oriented nuclear programme. The decision was mainly the outcome of an imbalance that emerged from 1971 War between the conventional armed forces of India and Pakistan in favour of the latter. To rectify this imbalance Pakistan has to raise its defence expenditure at the cost of expenditure on social sectors particularly on education. In his paper in this volume Riazuddin illustrates this "by the fact that though we spend about US $2,000 per soldier in Pakistan we spend about US$ 2 per student".[5]

The decision to develop nuclear programme seriously affected the overall development of science in the country as nuclear science and non-nuclear science became competitors for scarce material and manpower resources. The nuclear technology always won the competition.[6] With easy and effective access to

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[4] See his paper "Warped Science Agendas: A Way out of the Morass," p. 57.

[5] Riazuddin, "Fifty Years of Science …," p. 47.

[6] For a detailed discussion of this issue see the paper of Abdullah Sadiq in this volume, pp. 25-32.

the country's decision makers, the heads of nuclear programme were more effective than the heads of non-nuclear science organisations to secure greater resources for their programme. Consequently they were able to provide greater rewards to their colleague and motivate and inspire them to meet their work targets.[7]

As greater resources started flowing into nuclear programme, it attracted the best available professional manpower and arranged their education in leading centres of learning around the world. The attraction of working in a privileged nuclear programme lured many scientists working in universities and research institutes to join it. This internal brain drain from non-nuclear to nuclear programme has remained un-replenished even now. In addition nuclear programme barred Pakistani students from securing admissions in subjects even remotely connected to nuclear knowledge. The nuclear programme invited sanctions by the industrialised countries forcing Pakistan to mobilise its own material and human resources to develop it. All these factors have serious implications for the development of non-nuclear science.

The above argument that nuclear programme damaged the non-nuclear S&T has been questioned by some commentators on this issue in this volume. They point out that the nuclear programme alone did not cause slow development of non-nuclear science. Several other factors contributed to it including weak educational base, presence of "feudalism", failure to reward scientists for their work adequately compared to military and civil servants. Misallocation of resources on infrastructure development and import of expensive laboratory equipment also affected it. In addition not enough attention was given to induct, train and retain quality manpower that could effectively use these sophisticated facilities.[8]

The poor implementation of non-nuclear S&T also contributed to their poor performance. In support of this conclusions the

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[7] *Ibid*.

[8] *Ibid*.

findings of Munir Committee Report that analysed the state of over 165 S&T organisations supported by the Federal Government have been cited. The Report concluded that S&T organisations were "under-funded, under-staffed, poorly managed and therefore non-productive. They spend 95% of their budget on establishment charges leaving little or nothing for actual research".[9]

Abdullah Sadiq in his paper in this volume has identified three factors that obstructed the development of non-nuclear S&T. They include lack of linkage between different processes in implementing a project, misplaced priorities and absence of built-in monitoring and evaluation mechanisms.

Anwar Nasim argues that the cost of nuclear programme should not be an important consideration for determining its utility as it was a political necessity for Pakistan given its hostile international environments. Only the nuclear programme of Pakistan can deter larger Indian conventional forces which are also equipped with nuclear weapons from over-running Pakistan's part of Kashmir and from their direct attack on Pakistan. Besides, Anwar Nasim argues that while determining the cost of the nuclear programme its spin off benefits such as increase in the production of food, development of better cotton and grain varieties, generation of electricity and improvement in the capacity of some medical institutions to treat diseases such as cancer should also be taken into account.[10]

Shahzad Mufti points out that nuclear programme has only marginal affect on development of S&T. There are more significant factors such as lack of education, discriminatory material rewards to scientists compared with Armed Forces and

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[9] Quotation from *Final Report* of Prime Minister's High Level Review Committee on Science & Technology, 30th July 1996, headed by Munir Ahmad Khan, then chairman of PAEC in Anis Alam's paper in this volume, pp. 35-43.

[10] See Anwar Nasim's comments on Anis Alam's paper, p.44.

civil bureaucracy and lack of such rewards has resulted into external brain drain.[11]

Intellectual Culture of Pakistan

Going beyond the impact of contents of S&T policy and weaknesses in its implementation on slow development of S&T, some writers in this volume have enquired into the basic question why S&T has not flourished in Pakistan.[12] Putting the issue in the broad context of culture and social structure of Pakistan, Rahman argues that non questioning culture of Pakistan is a significant factor in retarding S&T. Such culture did not develop as political and intellectual elite of the country thought that it would threaten the ideological consensus which they regard is necessary for internal unity of Pakistani society.[13] This non-questioning culture discourages the development of attitude of questioning and doubting without which culture of science and S&T itself cannot develop. Rahman further maintains that a number of issues such as "the beginning of life and the solar system are often treated as taboo areas out of bound for fresh questioning".[14] The literal interpretation of religious scriptures, learning by rot and memorisation fostered by educational system of Pakistan rather than intelligent acquisition and application of knowledge has further strengthened these taboos.[15]

The non-questioning culture of Pakistan, Rahman argues, is re-enforced by hierarchy-oriented social system of Pakistan. Science teachers in Pakistan with low status and prestige in the society rather than producing new knowledge become merely disseminators of knowledge produced by others. They do not inculcate and inspire a critical attitude among students. The

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[11] See his comments on Anis Alam's paper in this volume, pp. 45-46.
[12] Anis Alam, "Why Science Doesn't Take Root in Pakistan? Few Preliminary Thoughts," Tariq Rahman, "Impediments in the Development of S&T: Cultural and Social Structure" and Inayatullah, "The Ideological Predicament of Contemporary Muslim Scientists."
[13] See Tariq Rahman's paper in this volume, pp. 63-67.
[14] *Ibid*., p. 64.
[15] *Ibid*.

situation has taken worse turn with proliferation of private universities, which are more interested in teaching job-oriented technical subjects at the cost of pure science. Their students do not understand and experience the mind liberating role of science.[16]

Carrying the argument of Rahman further, Inayatullah maintains that science as a method of discovering new knowledge flourishes only in the presence of culture of science which according to him, includes a set of norms.[17] They include that a scientist should add to the existing stock of knowledge, rely exclusively on logic and evidence without depending on authority. He must question the validity of received knowledge, regard his findings as tentative, and abjure any claim for absolute and final truth.[18]

Though there is a general agreement in the global scientific community on these norms, only a small number of daring and defiant souls strictly follow them at concrete behavioural level. Among the several reasons for failure to adhere to such norms, the crucial one is the degree of conflict between culture of science and the general culture of societies particularly their religious culture. In Muslim societies such conflict appears to be sharper than non-Muslim societies. Science (more specifically scientists) generally assumes that the nature functions in accordance with certain unchangeable laws. Muslim theologians and some Muslim scientists believe that the creator of universe who has made these laws can override them also. Moreover, science accepts as valid only the knowledge that can be externally validated. Muslim theologians in contrast accept the validity of religious knowledge without seeking its external validation through scientific methods. While science starts with uncertainty and attempts to reduce it, the pursuit of religious knowledge starts with certainty and is continued to add more certainty.

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[16] *Ibid*., p.65.
[17] Inayatulllah, “The Ideological Predicament …,” pp. 69-70.
[18] Khwaja Masud, “Islam and Science” also identifies similar elements of culture of science, p. 100.

Inayatullah further suggests that the contradictions between culture of science and culture of Islam as interpreted by orthodox theologians has led Muslim scientists in general and Pakistani scientists in particular to take several different and sometimes contradictory positions on relations between science and Islam. Some of them are summarised below:

1. Degree of compatibility
   a. Science and Islam are allies and not antagonists.
   b. Science flowers in cultural environments in which questioning of all propositions, and freedom of expression is guaranteed. *Ulema*'s interpretation of Islam puts severe limitations on both.
   c. Science and Islam are neither allies nor antagonists. They are two different approaches for understanding reality.
2. Quran and science
   a. The Quran is simultaneously a book for guidance of Muslims and human race as well as a book of science.
   b. The Quran is primarily a book for guidance and Muslims need not look for laws of science in it.
3. Islam and development of science
   a. Islam encourages development of science by inviting reflections on signs of God in nature and history.
   b. Invitation to believers to reflect on nature is for discovering larger truths of life and not necessarily for determining cause and effect relations in the natural phenomena.
   c. Emphasis of the Quran on inductive method led to flowering of science in early period of Muslim history. Modern science has developed by using this method.
   d. Modern science is a culmination of a long process to which several civilisations contributed including that of Muslims.

4. Reorientation of Science

a. As modern science has developed in the womb of materialistic western civilisation, it serves only the narrow nationalistic and material interests and not human welfare. Therefore Muslim scientists have a religious duty to Islamise so that it serves superior moral goals.

b. Science as a body of knowledge does not and cannot determine by itself how it is to be used.

Though some of the above contradictory positions on relations of Islam and science always existed in one form or the other in intellectual history of Muslims, Inayatullah suggests that they have become sharper now due to certain developments in Muslim world and Pakistan. These include the rise of Islamic revivalist movements in Muslim countries, emergence of a group of intellectuals committed to an Islamic framework of knowledge, and Gen. Zia's attempts to Islamise Pakistani state and society which stimulated the process of Islamisation of knowledge. The process gained support also from the drive of Muslim intellectuals and scientists to break the domination of other societies on creation of knowledge and from the search of expatriate Muslim intellectuals living in non-Muslim societies to secure and assert their separate Muslim identity. Denying the universality of science and Islamising science could be a way of doing it.

As the forces for Islamising science, according to the pattern suggested by *ulema* and other intellectuals sympathetic to the Islamisation project, became stronger, the barriers to diffusion of culture of science also gained strength. The limited development of S&T unaccompanied by diffusion of culture of science could not effectively resist this process and could not weaken the traditional structures of society and liberate human energies suppressed by them. As a result creativity in Pakistani society in the field of scientific knowledge and search for new patterns and meanings in nature and life did not flower.

Inayatullah suggests that the impact of these developments may have created certain confusion among Muslim scientists and intellectuals which prevented them from objectively and courageously confronting the reality of backwardness of science in their societies, from identifying the causes of such backwardness and from developing effective strategies for overcoming it. It also may have weakened curiosity, inquisitiveness and passion for developing new and creative scientific insights.

Following the line of argument of the above cited writers, Anis Alam has summarised the negative impact of such developments on science in Pakistan.[19] He suggests that a combination of power of *ulema*, revivalist movements and Zia-ul-Haq's authoritarian military rule weakened the development of science in Pakistan in several ways. It undermined the objectivity and rationality of science by rekindling the debates long forgotten in Europe, promoted a confusing mixture of science and religion. Scarce resources that ought to have been devoted to the promotion and development of science were wasted on activities that only promoted an anti-scientific attitude and values. Several seminars and conferences were organised in 1980, 1983 and 1986 to impart Islamic orientation to science. "Competent scientists instead of diffusing knowledge in their area of specialisation spent their energy to prove that religion offers a better understanding of the physical, chemical and biological and cosmic world than science."[20]

Like Inayatullah, another writer Masud has analysed the relationship between science and religion, identifies a number characteristic of culture of Science. According to him "Modern science has flourished in an atmosphere marked by scepticism. It puts to doubt all dogmas. It does not take anything for granted. The beliefs of a scientist are tentative and not final. They are not based on authority. They are based on evidence.

[19] Anis Alam, "Why Science Doesn't…," pp. 35-43.
[20] *Ibid*., pp. 41.

Modern science is iconoclastic in dealing with convictions based on tradition or authority".[21]

However, Masud does not see a conflict between culture of science and culture of Islam. Relying on Iqbal's claim that the Quran gave the gift of inductive spirit to humanity, Masud, argues; "Modern science is not antagonistic to the Quranic spirit which is also iconoclastic…. The Quran appeals for *tadabbur, tafakur* and *taqqul* and abhors obscurantism, dogmatism, irrationalism and intolerance. …If there is any conflict it is between scholasticism and science. Former believes in order to understand while latter understands in order to believe". [22]

Why has not science flourished in contemporary Muslim world? Masud's answer "…is that Muslim world has fallen a victim to irrationalism, traditionalism, dogmatism and obscurantism. We dread the new, the novel and the original. We love clichés. We are only good at repeating timeworn, moth-eaten views. We revel in interpretations, but flinch from creativity. We bask in the glory of the past. We do not have the courage to face harsh reality. We are in the stranglehold of mimicry".[23]

Responding to the thesis of conflict between science and religion in the papers of Anis Alam, Inayatullah and to some extent of Masud, Jan argues that secularist writers have exaggerated this conflict, besides other reasons, for political purpose of "secularising" Pakistani society and for dislodging religion from the public place.[24] Wedded to search for truth and universality, religion and science, he argues, can co-exist harmoniously. Discoveries of science can help religion in giving "…new meanings and depth to the understanding of the religious texts by its dig of new evidence…and religion may humanise science by releasing it from its current secular materialistic mould".[25] Jan argues that those who limit the "…

[21] Khwaja Masud, "Islam and …," p. 100.
[22] *Ibid*.
[23] *Ibid*., p. 101.
[24] Tarik Jan, "Religion and Science …," in this volume pp. 104.
[25] *Ibid*., p. 120.

choice for policy makers between progress (science) and backwardness (religion)" are captives of "… a narrow band formulation" and their argument "… is seriously flawed". He adds that "science by itself is incapable of parenting any wholesome model for societal development".[26] Jan also questions the assumption that the scientists are objective observers of reality as their perceptions are contaminated by contents of their mind and shaped by nature of state and structure of society in which they live and work.

In his paper "The Impact of Islam on Science" Qadir points out that Muslim Philosophy of knowledge in some ways is much closer to the modern conception of science than that of Newton. He argues that several beliefs and practices among Muslims of earlier times contributed to the development of modern science including emphasis on observation and abolition of slavery in Islam. The abolition broke the taboo against working with one's hands and facilitated conducting experiments. Further, as interest in the development of science was focussed on serving the Muslim community it created a strong emphasis on development of technology. Qadir also notes that *mutakalamun and ulema* in the later Muslim period developed a different view of Islam and believed that all knowledge that was relevant and valid was already given in the *Quran* and that the work of earlier Muslim scientists was either irrelevant or incorrect. Such a view led to the decline of scientific activities among "Muslims of the time and for its dearth in the modern Islamic community".

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[26] *Ibid*., p. 105-106.

Sadiq and Daudpota in their papers have raised another important issue – the distribution of benefits of whatever development of S&T has occurred in Pakistan. Both argue that its real beneficiaries are mainly the upper and the upper-middle classes and not the common people who can not afford to buy their products. Isa further argues that people's needs received low priority in the agenda of science partly because some scientists preferred to work on sophisticated scientific topics publishable in prestigious journals.

Considering that most papers presented in the seminar and now included in this volume have based their evaluation of policies and performance of S&T in the past, Naim argues that over-concern with past failures is not very productive. Instead we should try to understand the initiatives taken by the Ministry of S&T (MoST) during the period when Prof. Atta-ur-Rahman took over as Minister for S&T and help them to succeed. Her paper describes these initiatives in detail.[27]

III. Recommendations

On the basis of conclusions derived from papers in this volume summarised above we offer two types of recommendations - short term and long term to reverse the decline in creativity and development of S&T in Pakistan. The short term recommendations are suggested to improve the performance of existing non-nuclear S&T. The long term recommendations deal with the problems emerging from the character of science policy, from inadequacies of educational system, from the distortions in the socio-economic structure of Pakistani society, and from hurdles that prevent the diffusion of culture of science in the society particularly among scientific community and intelligentsia.

A. Short Term Recommendations

1. Reorient the current science policy giving highest priority to the basic needs of common people, such as the problem

[27] S. T. K. Naim, "Essentials for Knowledge Based Economy and the New S&T Initiatives," pp.121-132.

of shortage of food, clean water and energy. This may not be "high science" but it is essential science.

2. Define the "impact factor" somewhat differently. The scientists who make significant contributions to the solutions of needs of the people should be given higher rewards.
3. Build into science policy the necessary mechanisms of planning, monitoring and evaluation.
4. Evaluate performance and achievements of scientists through regular peer and end-user reviews.
5. Use the findings of such reviews for future funding of individuals, institutions as well as scientific and technological disciplines.[28]
6. Raise the level of remuneration of working and teaching scientists, attract and retain the people who are truly committed to pursue a science career and are interested in scientific research and challenge them to solve the most difficult problems faced by the society.
7. Give the necessary freedom to those scientists who have an aptitude and passion for creative work to work on the frontiers of knowledge in their respective fields and to reward them for excelling in it.
8. Attract the most creative Pakistani scientists living abroad and provide them conducive working environments.
9. Inspire and motivate the talented youth of the nation at crucial stage in their careers to opt for careers in S&T through highly competitive high profile programmes such as the Physics Talent Contest.
10. Initiate similar programmes in mathematics, biology, chemistry and computer and information sciences.
11. Establish special institutions for the training and education of talented youths who have demonstrated excellence and to provide liberal scholarships for their higher education in scientific and technological disciplines.
12. For rapid development of S&T in Pakistan it is a must that we educate our society; change the existing power structure and develop cultural norms and values which

[28] Abdullah Sadiq, "The Scientific Enterprise …," pp. 31-32.

help diffuse culture of science and attract brilliant people to vocation of science. For this purpose certain common courses for the students at different levels of schooling may be developed focussing on the nature and culture of science and its history both at global and national level.

B. Long Term Recommendations

The short term measures, important as they are, cannot produce adequate results without certain long term changes in science policy, society and culture. Such changes do not occur quickly. However, as the experience of some countries of East Asia show they could be brought about rapidly, if one has a clear insight into cultural social, economic and political factors that obstruct the process of development of people-oriented S&T. A few long term measures are suggested below for further discussion.

1. Encourage multi and interdisciplinary research, bring different disciplines of science together and integrate them into knowledge of social sciences and humanities in order to develop a holistic view of reality.
2. Create an intellectual environment in which a fruitful dialogue could be held to discuss some important but explosive issues, which have not been discussed openly and freely in the country before. This volume has identified two such issues: uneven allocation of scarce resources of the country between nuclear S&T and non-nuclear S&T, and failure of political and intellectual elite of the country to encourage the development of culture of science among scientists and in the society.
3. Facilitate a dialogue among the scientists and intellectual of the country about relations between science and religion in order to promote clarity and remove existing confusion on this issue.
4. In such a dialogue let scientists and intellectuals examine the implications of choosing the path of Islamisation of knowledge and their motivation for it. In some cases such motivation may spring from the desire to glorify the achievements of ancestors, to derive science from religion and for seeking support from knowledge of science to fortify

their faith. They should also analyse whether such a path would help them develop a science that would help their country to realise its potentialities and enhance collective well being of people of Pakistan. Let them also examine the benefits of embracing the scientific methodology, imbibing the spirit of culture of science, owning the achievements of science as a collective heritage of human race to which at some stage Muslims also made certain contributions. Let them also identify and work to create conditions in Pakistan in which a non-parochial and universal science flourishes.

Appendix-I

List of questions and issues that need be studied to develop more comprehensive understanding of development of science in Pakistan

I. Impact

1. Impact of S&T developed in Pakistan

    a. on global stock of scientific knowledge
    b. on the welfare of people of Pakistan

2. The impact of culture and social structure and development of S&T
    a. Identification of cultural prescriptions and prohibitions that block questioning and enquiring into and critically reviewing the existing knowledge and beliefs.
    b. Extent of influence of social system based on patron-clients and unequal authoritarian relationship
    c. Extent of freedom to engage in such an inquiry
    d. Role of parochial vis-à-vis universal human values in development of S&T

3. Impact of partition on development of S&T
    a. Commitment and interest of leaders of Pakistan movement in development of science.
    b. Role of migrant scientists.
    c. Quality of infrastructure Pakistan inherited.

4. Impact of political and policy environments on development on S&T
    a. Consequences of political instability on S&T policies.
    b. Impact of different types of political regimes (civilian and military) on determining priorities, allocation of resources for S&T and consequences of competition for scarce resources between security

oriented S&T and development oriented S&T for development of S&T.

5. State of economy and its impact on development of S&T
    a. Level and pattern of economic development.
    b. Level of human resource development.
    c. Patterns of use of technical and financial assistance from abroad and internal and external loans for development oriented S&T.
6. Impact of sanctions imposed at different times on S&T
7. Administrative environments and development of S&T
    a. Quality of leadership and management in science organisations.
    b. Extent of participation of scientists in policy making
8. Place of generalist vis-à-vis specialists in the administrative hierarchy
9. Specialisation and technocratisation of scientists and its effect on development of S&T

Appendix-II

Objectives and focus of seminar on "The State of Science and Technology (S&T) in Pakistan and Factors that Determine it"

This is the first seminar organised by Council of Social Sciences under its Science and Society programme on the theme of "The State of Science and Technology (S&T) in Pakistan and Factors that Determine it**".** Both natural and social scientists are participating in it to understand a problem of public interest and academic value. It is hoped that the seminar will help establish a dialogue, a common conceptual framework and a shared understanding of the issues involved in development of science in Pakistan. It may also set a pattern for more intensive and productive seminars on the related themes such as how development of S&T affects the Pakistani society.

Science and Technology play an important role in the development of a country. They enhance its capacity to control and shape its environments. Science also promotes a culture of questioning the existing knowledge and encourages a continuous search for greater truth. Such questioning fosters creativity and search for new patterns and meanings in nature and life. As science together with its offshoot technology advances, it also helps break down the traditional structures of society and thus liberates human energies contained by pre-scientific social order.

The Central Issues

Before a society reaps the benefits of S&T it must create conditions in which they could flourish. Thus the central question before the seminar is to identify the societal conditions that obstruct development of S&T in the country and find ways to remove them. Knowledge of such conditions may be already available to scientists through their direct experience but this experience must be converted into broad propositions on which concrete measures for fostering development of science in Pakistan can be based. With their special knowledge of how societal conditions affect development, social scientists in the seminar can help identify the factors that retard development of S&T. The main theme of the seminar for analytical purposes has been broken down into two main questions:

1. What is the present level of development of S&T in Pakistan?
2. What factors have prevented S&T in Pakistan to move at a faster pace?

For determining the level of development of S&T certain universal and Pakistan- specific criteria of evaluation needs to be identified and applied to situation in Pakistan.

The question about interpreting the level of development of S&T is challenging and difficult one. Below are identified four areas that the seminar needs to investigate for finding out the impediments to progress of S&T in Pakistan. More areas can be added as the discussion proceeds.

a. Political and policy environment
   i. Effect of political and policy environments on development of S&T particularly the consequences of political instability on S&T policies.
   ii. Impact of different types of political regimes (civilian and military) on determining priorities, allocation of resources for S&T and consequences of competition for scarce resources between security oriented S&T and development oriented S&T for development of S&T.

b. State of economy and its impact on development of S&T
   i. Level and pattern of economic development
   ii. Level of human resource development
   iii. Patterns of use of technical and financial assistance from abroad and internal and external loans for development oriented S&T.

c. Administrative environments and development of S&T
   i. Extent of participation of scientists in policy making and the issue of place of generalist vis-a-vis specialists in the administrative hierarchy.
   ii. Specialisation and technocratisation of scientists and its effect on development of S&T.

d. Culture and social structure and development of S&T
   i. Impact of cultural prescriptions and prohibitions against questioning and inquiring into existing knowledge and beliefs. Freedom to engage in such an inquiry may be necessary for releasing scientific creativity.
   ii. Influence of social system based on patron-clients and unequal authoritarian relationship that constricts the development of S&T.
   iii. False patriotism bereft of universal human values.

Appendix III

List of participants in the Seminar

1. Professor Attaur Rahman
2. Dr. Abdul Hameed Nayyar
3. Dr. A. H. Toor
4. Dr. Abdullah Sadiq
5. Dr. Anis Alam
6. Dr. Anwar Hussain Siddiqui
7. Dr. Anwar Nasim
8. Dr. Aslam Syed
9. Dr. Fazal Rahim
10. Ms. Foqia Sadiq
11. Dr. Inayatullah
12. Mr. Isa Daudpota
13. Dr. Kausar A. Malik
14. Dr. Khalid Mahmood Khan
15. Dr. Khurshid Hasnain
16. Dr. Khwaja Yaldram
17. Dr. M. D. Shami
18. Dr. M.S.I Dhami
19. Dr. Mohammed Ali Mahesar
20. Dr. N. M. Butt
21. Dr. Shahzad A. Mufti
22. Dr. Sarfraz Khan Qureshi
23. Dr. Tanveer Kausar Naim
24. Dr. Tariq Rahman
25. Mr. Zafarullah Khan

About the Authors

1. Dr. Asghar Qadir is former Professor of Mathematics, Quaid-i-Azam University, Islamabad.
2. Dr. Abdullah Sadiq is Vice Chancellor of Pakistan Institute of Engineering and Applied Sciences (PIEAS), Nilore, Islamabad.
3. Dr. Anis Alam is Professor of Physics at the University of the Punjab, Lahore.
4. Dr. Riazuddin is Director, National Centre for Physcis at the Quaid-i-Azam University, Islamabad.
5. Mr. Q. Isa Daudpota is affiliated with Beacon House National University, Lahore.
6. Dr. Tariq Rahman is Professor at the National Institute of Pakistan Studies (NIPS), Quaid-i-Azam University, Islamabad.
7. Dr. Inayatullah, is an Islamabad-based independent researcher.
8. Prof. Khwaja Masud is former Principal Gorden College, Rawalpindi and a free lance columnist.
9. Mr. Tarik Jan is Senior Research Fellow at the Institute of Policy Studies, Islamabad.
10. Dr. S.T.K. Naim is Chairperson, Pakistan Council for Science & Technology, Islamabad.

COSS Publications

Books:

a. S. H. Hashmi (ed.), *The State of Social Sciences in Pakistan*, 2001
b. Inayatullah (ed.), *Towards Understanding the State of Science in Pakistan*, 2003
c. S. Akbar Zaidi (ed.), *The State of the Social Sciences in Pakistan in the 1990s*, 2003

Monographs:

a. Ayesha Jalal, "Religion as Difference, Religion as Faith: Paradoxes of Muslim Identity", 2002.
b. S. Akbar Zaidi, "The Dismal State of the Social Sciences in Pakistan," 2002.
c. Rubina Saigol, "Becoming a Modern Nation: Educational Discourse in the Early Years of Ayub Khan (1958-64)," 2003.

Bulletins:

a. COSS Bulletin No. 1, 2000.
b. COSS Bulletin No. 2, 2001.
c. COSS Bulletin No. 3, 2002.
d. COSS Bulletin No. 4, 2003.

Publications under Preparation

1. *The Social Sciences in Pakistan, 1985-2003: Identification of Trends, Problems and Prospects*

2. The State of Professional Associations of different Social Science Disciplines

3. History of Science and Technology in Pakistan

Contents of COSS Website
www.coss.sdnpk.org/.

1. Introductory brochure
2. Four bulletins
3. The book, *The State of Social Sciences in Pakistan*
4. Two monographs one by. Ayesha Jalal and other by S. Akbar Zaidi
5. Two papers, one by Prof. Abdul Haque on “Development of Psychology in Pakistan” and the other by Prof. Hassan Nawaz Gardezi “Contemporary Sociology in Pakistan”
6. List of Members of COSS with telephone numbers and postal and email addresses
7. Bibliography on poverty by S. Akbar Zaidi
8. List of Pakistani Journals of Social Sciences
9. Names and telephone numbers of chairpersons of Social Science Departments in public universities

Ad hoc Organisational Structure of Council of Social Sciences (COSS)

Before the elections of its office holders and members of Working Committee in a General Body meeting, COSS is presently functioning with five ad hoc office holders.

President: Dr. Inayatullah

Secretary: Dr. Kamran Ahmad

Treasurer: Dr. Zarina Salamat

Member: Dr. Rais A. Khan

Member: Dr. M. Naeem Qureshi

Current Research Projects of COSS

COSS has undertaken the following studies first two with funds provided by UNESCO:

1. "The Social Sciences in Pakistan, 1985-2002: Identification of Trends, Problems and Prospects." The book will contain 18 discipline-specific and five general papers.

2. The study of national, regional and departmental professional associations of six social science disciplines which include Philosophy, Political Science, History, Economics and Psychology.

3. Publication of a handbook of Ph.D and M. Phil theses since the emergence of the country. The publication will include the name of the public university, the name of scholar, the name of the supervisor, the title of the theses and the year of its acceptance.

4. Compilation of data about the number of social science departments, the number of teachers in each department and their qualifications from 1963 to 2001.

Introduction to Council of Social Sciences, Pakistan [COSS]

Registered on 3rd June, 2000, Council of Social Sciences, Pakistan (COSS) is a service oriented, non-profit and autonomous organisation of social scientists. It is committed to:

- Work towards evaluating and raising the standard of social sciences.
- Fostering interdisciplinary orientation in social sciences and strengthening their links with natural sciences.
- Building and strengthening a community of social scientists belonging to different disciplines and working in recognised universities, research institutes and civil society organisations by providing them a platform that promotes interaction among them.
- Foster scientific approach among the public through means such as seminars, discussions in the media and dissemination of non-technical versions of outstanding works of social scientists in national and regional languages.

By June, 2003 COSS had 227 members. They include 36 life members, 189 regular members and two institutional members. Of them, 109 are located in Islamabad and Rawalpindi, 34 in Karachi, 33 in Lahore, seven in Peshawar, four in Quetta, two in Multan and one each in D. I. Khan, Jamshoro, Khairpur, Hyderabad and Gilgit. Thirty three members come from abroad. Since its inception COSS has reprinted the book *The State of Social Sciences in Pakistan,* published two monographs one by. Ayesha Jalal "Religion as Difference, Religion as Faith: Paradoxes of Muslim Identity" and second by S. Akbar Zaidi. It has issued four bulletins, which carried reports on developments in Academia, publications and activities of social scientists, and on seminars and conferences in which COSS members participated.

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