INDIAN SCIENCE CONGRESS ASSOCIATION

(Registered under Act XXI of 1860)

PROCEEDINGS
OF THE
SIXTY-FIRST SESSION
NAGPUR—1974

PART II

PRESIDENTIAL ADDRESSES

14, Dr. Biresh Guha Street, Calcutta-17.

PROCEEDINGS

OF THE PAST SESSIONS OF

INDIAN SCIENCE CONGRESS

PRICE LIST OF COMPLETE VOLUMES

				Rs. P.
1st	Session	1914,	Calcutta	0.75
2nd	"	1915,	Madras	1.50
3rd	"	1916,	Lucknow	2.62
4th	"	1917,	Bangalore	2.25
5th	"	1918,	Lahore	5.62
6th	"	1919,	Bombay	3.00
7th	"	1920,	Nagpur	3.75
8th	"	1921,	Calcutta	4.87
9th	"	1922,	Madras	5.25
10th	"	1923,	Lucknow	7.50
11th	"	1924,	Bangalore	6.75
12th	"	1925,	Banaras	9.00
13th	"	1926,	Bombay	12.37
14th	"	1927,	Lahore	9.75
15th	"	1928,	Calcutta	12.75
16th	"	1929,	Madras	12.00
17th	"	1930,	Allahabad	15.00
18th	"	1931,	Nagpur	13.87
19th	"	1932,	Bangalore	18.75
20th	"	1933,	Patna	17.25
21st	"	1934,	Bombay	12.75
22nd	"	1935,	Calcutta	15.00
23rd	"	1936,	Indore	18.00
24th	"	1937,	Hyderabad	16.50
25th	"	1938,	Calcutta	30.00
26th	"	1939,	Lahore	20.00
27th	"	1940,	Madras	27.37
28th	"	1941,	Banaras	30.25
29th	"	1942,	Baroda	25.50
30th	"	1943,	Calcutta	19.50
31st	"	1944,	Delhi	18.00
32nd	"	1945,	Nagpur	18.25
33rd	"	1946,	Bangalore	21.25
34th	"	1947,	Delhi	23.12
35th	"	1948,	Patna	23.00
36th	"	1949,	Allahabad	21.75
37th	"	1950,	Poona	23.75
38th	"	1951,	Bangalore	27.75
39th	"	1952,	Calcutta	32.37
40th	"	1953,	Lucknow	36.00
41st	"	1954,	Hyderabad (Deccan)	28.00
42nd	"	1955,	Baroda	33.19
43rd	"	1956,	Agra	36.12
44th	"	1957,	Calcutta	35.37
45th	"	1958,	Madras	39.25
46th	"	1959,	Delhi	41.00
47th	"	1960,	Bombay	40.75
48th	"	1961,	Roorkee	40.31
49th	"	1962,	Cuttack	37.80
50th	"	1963,	Delhi	46.75
51st/52nd	Session	1964/65,	Calcutta	48.32
53rd	Session	1966,	Chandigarh	37.00
54th	"	1967,	Hyderabad	44.19
55th	"	1968,	Varanasi	51.87
56th	"	1969,	Bombay (Powai)	51.00
57th	"	1970,	Kharagpur	51.00
58th	"	1971,	Bangalore	51.00
59th	"	1972,	Calcutta	51.00
60th	"	1973,	Chandigarh	51.00

The publications or information about them are obtainable from the Indian Science Congress Association, 14, Dr. Biresh Guha Street, Calcutta-17. Orders should be addressed to the Indian Science Congress Association and not to any official by name or title.

All Cheques, Money Orders, etc., should be made payable to the Treasurer, Indian Science Congress Association. Orders for books should be accompanied by full name and address legibly written, and should be sent on a separate sheet of paper containing no other communication. In India books are supplied by V.P.P.

SIXTYFIRST ANNUAL SESSION OF THE INDIAN SCIENCE CONGRESS NAGPUR 1974

General President : Prof. R. S. MISHRA, Ph.D., D.Sc., F.N.A.Sc., F.A.Sc., F.N.A.

General Presidential Address

MATHEMATICS—QUEEN OR HANDMAIDEN

I am very grateful to the scientists of India and to the members of the Indian Science Congress Association for the signal honour they have conferred on me by electing me the President of its Sixty-first Session. I deem it a great privilege especially when I look back and find that this office has been held by outstanding leaders of thought in science like the late Pt. Jawaharlal Nehru, one of the noblest sons the country has produced. He was a symbol of people's aspirations and the achievements in science and technology since independenc are the result of his vision and encouragement. I am conscious of my limitations and derive consolation from the observation Sir Isaac Newton made nearly three hundred years ago, "If I have seen further it is by standing on the shoulders of giants". I owe you my sincere apologies for any lapses on my part in living upto the glorious tradition of the past.

A tree loves the ground on which it stands. Being interested in mathematics from early childhcod, though having no mathematical background in the family, I have decided to talk to you about mathematics and its applications in sciences and humanities with special reference to social behaviour.

From ancient times mathematics has been regarded as the Queen of Sciences because as George Cantor had once remarked 'The essence of mathematics lies in its freedom'. The wonderful freedom and joy of creation that mathematics offers have been well recognized. The fourth verse of Vedang Jyotish brings out the fact as follows :

यथा शिखा मयूराणाम् नागानाम् मणयो यथा ।
तद्वद्वेदांग शास्त्राणाम् गणितम् मूर्धनि स्थितम् ॥

As are the crests on the heads of peacocks, as are the jewels on the hoods of snakes, so is Ganit at the top of all Vedanga sciences.

In ancient times the civilization of a country was measured by the mathematical advancement it had made. Through all these years mathematics played a fundamental role in transforming society. It advanced human civilization, helped man in adapting himself to his environment and assisted him to meet his material needs. It also made it possible for technologically advanced nations to achieve military power, security and conomic strength.

Mathematics—the Queen of Sciences, is beautiful but not in general attractive. She attracts only those who are dedicated to her and who have made her a part of their being. In this connection I am reminded of an anecdote : Lord Rutherford once remarked to Neils Bohr, 'Though you are BORE (BOHR), you have a charming wife'. Whatever you think of us, we mathematicians are undoubtedly proud of our charming Queen—Mathematics.

There was a time when mathematics was studied for its own sake with curiosity as the impelling motive and for the sheer joy and thrill of its creation. Mathematicians felt satisfied with their discoveries and did not bother about their useful applications. Creators in mathematics were comparable to wholesale dealers whereas the transmitters of knowledge to retail sellers. A Cambridge don when once asked what applications his theory had, replied 'Thank God, it has one'.

Initially there are two aspects of mathematics—pure and applied. But it is extremely difficult to draw a line between the two. They cannot be put in air-tight compartments. Their intersection set is certainly a non-null set. Danzig had once remarked, 'Applied Mathematics is like wine which becomes pure in course of time'. There is a deep truth in this. A striking example supporting this statement is that of trigonometry which started with navigation but soon became a branch of pure mathematics.

Times are changing and the world is moving towards socialistic order. The queen is not lagging behind and has become modern. We hear now-a-days so much of modern or new mathematics.

With the pressure of science and technology steadily increasing on human affairs and with the renewed and added applications of mathematics to science and technology, mathematicians cannot afford to spend their precious time in absorbing useless mathematical knowledge acquired through obsolete methods. There has been a lot of rethinking on our mathematics curricula leading to radical modifications. But old habits die hard and habits of thought are most difficult to shake off with the result that the teachers of mathematics become antiquated and unrealistic in an age marked by new realism. It is necessary, however, that they 'water the subsoil' and ponder over the basic attitudes and presuppositions with which the

minds and personalities of students are formed. Thanks to the organisation of summer schools for school and college teachers by U.G.C., N.C.E.R.T., U.S.A.I.D. and other agencies, we have evidence of a new wave of consciousness about modern mathematics in the country and mathematicians now instead of living in the past, live rather in the future. The syllabi have generally been revised at all levels. Some of our mathematics syllabi can compare favourably with the corresponding syllabiof any advanced country. It has generally been realised that the difficulty of imparting instruction in modern mathematics does not lie with the students so much as with the teachers, who suffer from stubborn misconceptions.

There is another aspect which has usually been lost sight of. In classical mathematics parents could help their children in home assignments. But they are unable to do so in modern mathematics with the result that though good students are able to develop their initiative and critical faculty, average students are not able to cope with the progress in the subject. This may result in parents losing control over their children. I would, therefore suggest to U.G.C. and N.C.E.R.T. that some summer or winter schools for parents may also be organised each year.

In modern mathematics too much of drill is avoided. Though there are varying views on problem solving, I would content myself by quoting a Chinese saying, 'If you give one a fish, you feed him for a day. If you teach him how to fish, you feed him for many days'.

Mathematicians have very aptly realized that the domain of the possible is much larger than their imagination. There are a number of examples where the results which seemed absurd when they were discovered, had wide and useful applications later on. Witness the study of matrix algebra by Sylvester and Cayley purely for mathematical curiosity and its indispensability in modern quantum theory. While discussing the reform of mathematical curriculum at Princeton University in 1910, physicist James Jeans asserted, "We may as well cut out group theory. That is a subject which will never be of any use in physics". But Oswald Veblen disregarded Jeans' advice. It has turned out that group theory later grew into one of the central themes of physics. As an example, one of the fundamental particles, the baryon Ω^- was predicted by group theory and discovered later experimentally.

The doubling period of mathematics, as of any other science is ten years. This means that the next ten years will produce as many mathematicians or as much mathematical literature as the humanity has produced so far. The first statement may roughly be stated in other words as follows : Ninety percent of all the mathematicians who ever lived since the dawn of human civilization are living now. Though the activities of

the present generation of mathematicians are based on the recorded achievements of the past, if the phenomenon of the doubling period continues for two or three centuries more, as it has continued so far, the majority of the people of the world will be mathematicians and on the same analogy scientists of all the disciplines. Thus everybody will become everything. Will it not be a sad day for all of us ?

It is my conjecture that a time would come when the growth of mathematics would slow down from this fast rate. We may run out of men (which does not appear to be a possibility at present), materials or incentives or mathematics may become so complex as to impede its own progress.

Mass education in mathematics has, however, at least one advantage. We can build on a large base of students for the making of new mathematicians. Many potential mathematicians are lost after or even before their high school career. Of those who go through the mill of college or university education, a large number are able to take up post-graduate work and research. This means an opportunity for creative work for which generous financial support which is considered to be an important national investment, is given. But I would like to put in a word of caution. Though with every financial support one is required to submit periodical progress reports not every research project meets with success; if every one ends with successful results, the investigator perhaps did not set sufficiently high goals before himself. Also, generally there are no direct and obvious returns. I would, therefore, suggest that agencies for academic audit must be created for every research project undertaken with or without financial aid.

The problem of language has been agitating the minds of scientists in this country and also in some other countries. It is a controversial issue whether scientific education should be imparted in the regional language or the national language or an international language. Mathematicians, by habit, try to avoid controversies. They tried to evolve a common language, for instance, the set theoretic language, which could be understood everywhere in the world. It is my fervent hope that the effort in having a common mathematical language will be continued so that mathematics may know no barriers of language or national boundaries. I would urge other scientists also to develop their own language in their respective disciplines so that international communication is maintained. The importance of language in mathematics is effectively brought home by the following anecdote : A leading mathematician was an important member of the senate of his university. For twentyfour years he did not speak a word in the senate meetings but because of his towering personality sufficient funds were always made available to his department. In the last meeting during the twenty-fifth year the Professor of Languages pleaded vehemently for a cut in the

mathematics grant and the corresponding increase in the grant for languages. His plea was that mathematics did not require any grant since its professor had never sought it. When the grant for mathematics was on the point of being slashed, the mathematics Professor got up and spoke just a sentence, 'But mathematics is a language' and sat down. The entire mathematics grant was restored.

Recent advances in mathematics and other sciences have influenced one another so reflexively that it is difficult to state the relations between them unambiguously. Mathematics has changed it role due to the change of its relationship with other disciplines. Though keeping its individuality as the Queen, it has become in the words of E. T. Bell 'Handmaiden of Sciences'. Now its utilitarian aspect has become very important. At present there is no discipline in science or humanities where the potential use of systematic research and knowledge in mathematics is not made. It has been observed that mathematics has the power to solve many of the problems of human race. But then there is no national policy or the proper climate of public understanding and awareness which could ensure the free, effective and quick communication of mathematical ideas and researches to those who need them. Though mathematicians would like to make their own contributions to the formulation of the basic values and the objectives of social life, there has also been a lack of social awareness in the mathematical community.

It is true that useful work in sciences and humanities requires mathematical methods. This means that mathematics should be learnt by men of other disciplines as well. But unless one has a strong background in mathematics, one may not be able to see beyond the models already in use and may not be able to make effective contributions. Again, mathematical knowledge means not only technical mathematics but the whole range of empirical enquiry in a controlled way. For non-mathematicians the task of learning mathematics and having a firm grasp over it from the point of view of its healthy and effective use is not an easy one. Wrong use of mathematics may lead to disastrous results. It would perhaps be more advantageous if mathematicians acquire knowledge of some other disciplines. Let them cast mathematical nets over chains of happenings in the physical world and obtain equivalence relations between mathematically predicted and experimentally observed results. Just as individuals who create wealth share it with others through trade, incometaxes etc. creators in mathematics must share their knowledge with others. They must develop a sense of social responsibility through social motivation. It must be realized that the betterment of mankind, depends not on mathematics and the mathematicians alone but on the application of mathematical

knowledge to human affairs, and the spirit of rationalism, mathematics fosters.

We will now deal with some of the applications of mathematics. Massive efforts have been made for tackling problems in agriculture, defence, population, industry, energy, health and poverty. Recently we have gone in for space research and exobiology. Mathematics has a major contribution to make in all these spheres. Its role, however, is so implicit as to go unnoticed. There is an impression that mathematical community has not been responsive to the nation's problems because of its exclusive concern with abstractions. This impression, however, is absolutely wrong. Mathematicians are very much alive to the problems of humanity. Their contribution to human welfare is by no means insignificant.

We are prone to consider the problems of social life in isolation from each other. Such an approach, however, results in a waste of efforts. Mathematics is a science which can give an integrated view of things apparently disjoint and hence its validity in dealing with the problems of life. In the words of our Prime Minister, Mrs. Indira Gandhi, 'Life is one, the world is one ...'

Though we are contracting horizontally and expanding vertically through explorations in space and time, the problems on earth and its environment are not only increasing exponentially but are having jumps. With the development of medical sciences leading to the eradication of some of the infectious diseases like plague, cholera, smallpox, and the decline of infantile mortality, longevity has increased and so also the population of the world. This has necessitated the balance of population against resources, the production of more food grains, increase of cattle wealth and the growth of industrial, commercial and other human activities. All these involve more of automation with the resultant problems of population of land, water and atmosphere. Consequently our crops, cattle and other live stock, birds, fish and marine life are all getting affected. Increase in national income and changes in the pattern of life are responsible for environmental anomalies and depletion of natural resources. Any scientific, economic, technological and political measure also produces degradation of the environment.

The more affluent a society, the greater are its environmental problems. India is a developing country and naturally its problems of environmental deterioration and pollution are gradually increasing.

In many western countries pollution has been responsible for the increased rate of death and disease, child delinquency and mental disorders.

There are two aspects of pollution. It may be taken as a mere nuisance. In that case it does no more than inconvenience the society and

can be cured by political decisions and investment of funds. Secondly pollution damages and depletes the environment irretrievably and has unpredictable and unmanageable consequences. It ignores all political boundaries.

Rene Dubos drew pointed attention in 1972 to the transformation of environmental and social situations arising out of their interactions. Man evolved on the earth as any other animal, but is perhaps the most recent amongst about 1.3 million species of plants and animal populations. He differentiated from the others because of his mental faculty and resultant cultural evolution though always sharing with them the resources of the biosphere. It is significant that these very organisms had earlier created environmental conditions favourable to man and so the latter appeared on the scene. Even today man's life support system is maintained by the activities of plants and other organisms. But Meadows' exercises in mathematical modelling in 1973 clearly demonstrated how exponential rates of population growth concomitant with increases in industrial exploitation along with lagging supplies of food, have jeopardised our existence. It is true that Meadows did not take into account the social feed back system while projecting the trends of growth found during the last few decades, in his five independent parameters of the world model. But knowing the slow impact of educational processes against mounting technology to satisfy the unbridled needs of man, it is realised that the catastrophe predicted by the mathematical reasoning to happen within the life time of the next generation, could be postponed but only by a few years. Thus social scientists have very limited choice to offer to save our race. The dilemmas of life are of such a baffling nature that Sir Kingsley Dunham in his presidential address at the 1973 Canterbury Meeting of the British Association for the Advancement of Science raised the query : 'Can our species survive the next few hundred years ? There is a ray of hope in pursuing the reasoning of mathematical modelling for the desired conservative management of resources. The International Biological Programme due to complete its decade of activity this year had a built in modelling programme in the analysis of diverse ecosystems of the world as its objective. Predictive modelling and simulation techniques are showing the way of managing grasslands, forests and aquatic systems.

Environmental problems pertain not only to one country or nation but to the whole world. Environmental or ecological science is a branch of science where the collaboration of all the countries of the east and the west on equal terms is required. An International Institute near Vienna sponsored by the academies of many countries has been established. U.N. E.S.C.O. has also launched a long term multidisciplinary and

intergovernmental programme known as Man and the Biosphere programme, inviting input of the world scientists towards the solutions of the critical problems of our age.

The Government of India established 'The National Committee on Environmental Planning and Coordination' under the Ministry of Science and Technology, which is forging ahead the coordinated planning of the environment.

These considerations lead us to the question posed by our Prime Minister in June 1972 at the Stockholm conference of U.N.O. on Human Environment "Are not poverty and need the greatest polluters ?" We have to examine how best the world resources and cultural efforts can be channalised and shared by all the inhabitants of the planet. Mathematics and Statistics of high order are needed for social engineering to be practised for वसुधैव कुटुम्बकम् (The whole world is a family).

All developments are energy-based. We have gone a long way from muscular energy to fuel and fossil energy and thence to nuclear energy. The measure of civilization today is the per capita energy requirement. There is a race amongst nations for producing more of energy. The main source of energy for the biosphere is the sun. Fossil fuel resources are being used for producing extra energy. But the indication is that all the fossil fuels will be exhausted before the other forms of energy are put to common use. Moreover, the deposits of fossil fuels contain the carbon withdrawn from the air and set aside by nature. In the process, the air was purified by the green plants through the geological periods. Thus carbon dioxide was reduced to 0.03 percent and oxygen was increased to 21 percent. This natural withdrawl of carbon from the grand elemental cycle, created part of our life support system and man evolved within this nature-made system. Burning all the fossil fuel will mean reversing the process to our own danger. The consequences of increase of carbon dioxide in air through its thermal effects need not be pointed out.

Use of nuclear energy through radioactive elements on a large scale, is also fraught with danger. Besides posing ecological problems giving rise to crisis of highest magnitude like pollution, calculations clearly indicate the cumulative effect of escaped nuclear radiations in the biosphere and indeed the claims made by technologists in providing clean energy from atomic fission is too tall a talk. As such solar power is our major hope. The sun has set life moving on this planet and it alone has the secret of keeping it in motion in the future. I will come back to solar energy a little later.

Environmental problems are difficult because they involve conflicts of interest. In a city with cloth mills, for example, the cloth will be made

available to the customers at cheap rates. But the smoke with sulphur and carbon dioxide and dust will pollute the atmosphere affecting the health of a large number of people. Moreover, a river might be used as a costless sewer to dispose of waste material. This will mean pollution of water.

Another point for consideration is that we have to take a long-range view of our environment and ecological balance. If action is not taken immediately, it may not be possible to retrieve the situation.

The nature is bountiful. Tempo of modern life, however, means imbalance in nature. Mathematics has proved helpful to the biologist and the ecologist by way of suggesting predictive models and the present day development of 'system analysis' is a boon to the scientist. The development of mathematical biology is a gift of mathematics. During the last 25 years quantification of biological information became an essential requirement and many mathematicians learned biology as many biologists learned mathematics. This interaction led to the development of gene engineering, mathematical biology, system analysis etc. Mathematics also determines the limits beyond which the solutions to problems cannot be effectively sought.

Since environmental problems are highly complicated requiring expert knowledge for a satisfactory solution, it is but necessary that mathematics be brought into the picture when common structures of concepts and natural laws thus obtained are built up to develop models. It can then help in clear formulation of the problems, in pointing out various possible alternatives and in arriving at meaningful solutions.

Environmental science is now being studied in many universities and institutes. It is a science with multidisciplinary approach. It gives an opportunity to build on a non-pollutive technology so as to avoid mistakes of the developed countries. But it is not my purpose to examine the possible role of the various disciplines represented in ISCA vis-a-vis environmental problems. I would like to submit that the task of the scientist is to measure, understand and predict environmental changes. For this monitoring instruments have to be developed and meaningful experiments carried out. The results have to be mathematically analysed and understood so that the environmental processes may be correctly predicted.

Production and productivity can be estimated. But so far we have no effective means of measuring deprivation and human misery due to pollution. We have to devise means so that there is maximum gain with minimum loss. At present net loss is greater than the net gain. In this mathematics will play a major role. However, any action against

environmental degradation must cover a large area and the public must be educated to develop environmental consciousness.

I turn now to yet another problem of grave importance. The country as a whole is facing power shortage. Ignoring the factors responsible for power crisis, I would plead for new sources of energy being found out, so that our requirements for industry, transport, communication, heating, cooling and generation of electricity are adequately met. Fossil fuel is one source of energy but besides its harmful use indicated earlier, it would not last indefinitely. Atomic energy will last much longer, but the raw materials required, like uranium and thorium are limited and its use also is fraught with danger. The energy which the country can bank on for a long time is the solar energy the supply of which is continuous and ample. The sun pours energy onto the earth 100,000 times more than world's present electric power capacity. The amount of solar energy absorbed by the Rajasthan desert during a year may be equivalent roughly to the heat generated by all the coal, oil and gas burnt in a year in the whole world. India is a tropical country and the sun-shine is abundant. But the collection, storage and use of solar energy are at present much more expensive than using fossil fuel. On the other hand, because of the limitations of resources and working cost, fossil fuel also is becoming more expensive. Research on solar energy must, therefore, receive the high priority. Methods must be devised for its storage and cheap distribution. So far sufficient financial help has not been forthcoming for research on harnessing solar energy. But it would be a worthwhile undertaking. Development of appropriate technology to concentrate this energy at a cheap rate requires the use of mathematics at every stage including tool making stage.

Connected with solar energy research is the problem of improving the design of outer surfaces of homes and offices so that heating and cooling load is properly controlled. Materials which withstand long weathering and exposure to the sun have also to be developed.

Another area which is multidisciplinary and in which mathematics can be fruitfully employed is gerontology (science of ageing). It is a problem of universal importance. One can perceive a decline in the vigour of every organ of the body after the age of forty or so. Efficiency or output of work begins to decrease; the rate of decrease becomes faster with increasing age. What initiates this phase of decline is still a mystery.

Advances in medical science have increased the average length of human life. Consequently the number of people living beyond the age of 60 has increased considerably. In India approximately 3 percent of the population would come in this category and the number is increasing. Taking the country as a whole there are about 15 million people in this age group.

This comprises a large number who have retired from active life and have no means of livelihood. They are entirely dependent on younger generation. This load is appalling. In advanced countries the proportion of old people is even higher and national plans have been formulated to solve the problem.

Much effort has been made to control dreadful diseases like polio, leprosy, tuberculosis etc. The disease of ageing is the most dreadful of all. It incapacitates man slowly but surely till death, for any kind of useful work. We are helpless spectators of the process that goes on in the body. It is rather surprising that though the problem is one of the most challanging ones and a lot of work can be done on it and though every body is interested in having the least ageing effect while growing old, very little work is being done in this direction. Its solution may be one of the greatest of all discoveries. A mathematical analysis of the various parameters responsible for the decay will be helpful in constructing necessary models to deal with the problem in a systematic way.

We are living in the age of computers. They have assumed tremendous importance in practically all branches of science and humanities, industries, government offices and private and public undertakings. But we do not have as many computers as we require for the national development. I would, therefore, urge the government and the industries to turn their attention to the manufacture of indigenous computers on a large scale so that the country's needs are met. The use of computers, however, has to be made with a certain measure of caution so that the problem of unemployment in this over-populated land does not get accentuated. For developing soft ware and machine languages for computers highly sophisticated mathematical theories of operations research, Boolean algebra, mathematical logic, automata theory, recurrence function theory etc. are required. But there are very few universities and institutes in the country where computer science is a subject of independent study though there is a great potential for its development. All these matters need urgent attention.

I will now indicate the areas of mathematical applications required in some of the fields mentioned above. For mathematical models in biology and medicine we require mathematical genetics, ecology, programming and neurophysiology, heamodynamics and reliability and information theory, biomechanics, bioengineering bioelectronics and cybernatics. Computer science requires the use of mathematical logic, automata theory, recurrence function theory etc. Econometrics, operations research, mathematical programming, control theory and information and reliability theory are some of the tools in industry. In space research, space

mechanics, space physics and space dynamics are the main contributors. These are some of the typical applications of mathematics. There are numerous others which are not being mentioned for want of space and time.

Finally, I would like to address a few words to and for mathematics teachers. Mobility amongst them is very much lacking in the country. The reasons for this are social restrictions, domestic responsibilities, ways of life, climatic and weather conditions at different places and the restrictions imposed by institutions and governments. The advantages of mobility are manifold. It promotes national integration and does a lot of good to the individuals as well as to the subject proper and the allied subjects.

Generally the more resourceful teachers in mathematics and other seiences move from one place to another. Because of their resourcefulness, they are able to collect costly equipments at the place of their work. But when they change places the equipment remains unused. If statistics were collected one would simply be appalled to learn how much of costly equipment has been lying idle in a number of institutions due to the reasons given above and due also to other causes like the nonavailability of spare parts, scarcity of trained hands to handle and repair the machines etc. Working out the details in a leading university I noticed that with the interest on the dead money in the form of instruments lying unused, the university can have as many more technicians as they have lecturers. It is, therefore, my fervent desire that mobility amongst teachers be encouraged by all concerned. At the same time wastage must be avoided at all costs and ways and means must be found so that no equipment lies unused. Duplications also should be avoided. The country is poor but even the advanced countries cannot afford wastage and duplication.

In India our aim is to achieve complete self-reliance in the vital sectors. As far back as 1958 the Government of India formulated the National Science Policy through the Scientific Policy Resolution to generate a scientific ethos in the country. This applies to mathematical sciences as well. Recently we have reiterated our resolve to achieve this objective and our government has taken commendable steps in this direction. It appears, however, that we have developed a psychology of dependence on the foreign technical know-how and several of our industries have yet to come forward and undertake the responsibility of developing indigenous talents.

I have dwelt on some of the applications of mathematics. There are many other applications which are important not only for other disciplines but for mathematics also, which is a self-generating science.

Most of what I have said above applies not only to mathematics but to other sciences as well. I have done so because of my obvious transparent and strong bias towards mathematics.

I have drawn attention to some of the outstanding situations that a mathematician has to face. There are numerous other problems which he has to encounter. He is like a cork bobbling on the surface of the ocean. No matter how rough the ocean is, the cork stays afloat. Nothing can happen to it. But a mathematician has an explicit advantage that he is not a bureaucrat and as such he is sure to be consulted and listened to by the governments, the public and the society.

The study of mathematical sciences which includes pure mathematics, applied mathematics and applications of mathematics must be provided adequate incentives. Though there are specialised Councils in India catering to the needs of various disciplines like Atomic Energy Department, Botanical, Geological and Zoological Surveys, Council for Scientific and Industrial Research, Defence Science Organisation, Department of Space Research, Electronic Commission, Indian Council of Agricultural Research, Indian Medical Research Council, Research and Development Organisation of Railways etc. no council exists for mathematical sciences. Mathematics research in India has been made the responsibility of the Atomic Energy Commission. The University Grants Commission created some advanced centres, but they are either in pure mathematics or in applied mathematics only. I would suggest, therefore, the formation of a Council for mathematical sciences with wide advisory powers. The University Grants Commission also should establish an advanced centre with provision for research in all the three aspects of mathematics viz. pure mathematics, applied mathematics and applications of mathematics. Mathematical science should be treated as an integrated whole and should be nursed at all levels.

I cannot close my address without a little introspection. In recent past India has produced outstanding experimental scientists in disciplines like physics where costly equipments are involved. Though in mathematies we genrally require only paper, penal, books and journals and not very costly equipments, the country has not produced as many first rate mathematicians as it should have done. The traditions of mathematics in the country have been rich but I do not understand why there has not been continuity in the thread.

I have referred above to some of the problems which a mathematician has been facing and trying to solve. He has his absolute reliance in the respect for truth and independence of learning. Whatever he has achieved so far is a challenge for the future. However, his plight is like that of a physicist who is born blind. The physicist has mastered the theory of colours so that he is able to work successfully on the formulae which he has obtained. Some body intending to acquaint him with the

true meaning of colours tells him that fire is red, snow is white and grass is green. Since he has been never colours, he associates heat with red colour, coldness with white colour and softness with green colour without ever getting into the meaning of colours. Similar is the predicament of the mathematicians who try to understand nature. They evolve formulae, get results, interrogate, interpret, observe, predict, verify and yet remain wonderstruck. God does not reveal his creation so easily.

PROCEEDINGS
OF THE
SIXTY-FIRST
INDIAN SCIENCE CONGRESS
NAGPUR, 1974

PART II—PRESIDENTIAL ADDRESSES

CONTENTS

ADDRESSES OF THE GENERAL PRESIDENT : Mathematics — Queen or Handmaiden — Prof. R. S. Mishra, Ph.D., D.Sc., F.N.A. Sc., F.A. Sc., F. N. A.

GROUP A

Sectional Addresses Page

I. MATHEMATICS : Evolution of Stars — Prof. R. S. Kushwaha, Ph. D., D. Phil., F.N.A. 1

II. STATISTICS : Stochastic Processes and Inference — Prof. T. V. Avadhani, M.A., Ph.D., F.S S. 19

III. PHYSICS : Interaction of Slow Neutrons with Solids — Prof. L. S. Kothari 47

IV. CHEMISTRY : Activation Analysis and its Application — Prof. B. C. Haldar, M.Sc., P.R.S., D.Phil., F.R.I.C., F.I. Nucl. E. (London).... 73

V. GEOLOGY AND GEOGRAPHY : "Phosphorite — its Present Status and Guides for Further Search in India" — Shri Mukti Nath, M.Sc. 91

GROUP B

VI. BOTANY : "Living with Algae" — Prof. R. N. Singh ... 1

VII. ZOOLOGY AND ENTOMOLOGY : Sterility and Population Control in Insects and other Animals — Prof. H. S. Chaudhry, M.Sc., D. Phil., F. N. A. Sc. 27