D. S. Kothari

DAULAT SINGH KOTHARI

(1906 — 1993)

Elected Fellow 1936

Early Life and Education

DAULAT SINGH KOTHARI was born on July 6, 1906 at Udaipur (Mewar State, Rajasthan). He was the eldest of five children - four sons and a daughter. (The daughter died very young in life.) His father, Shri Fateh Lal Kothari started his career as a school teacher and served as Headmaster of Government Schools at Bhilwara and Udaipur for a number of years. During the plague epidemic of 1918 which swept the whole country, he died at the early age of 38 years, leaving behind four young boys and their mother in great economic difficulties. As luck would have it, Fateh Lal ji's friend, Sir Siremal Bapna, who was at that time the Chief Minister of Indore State, invited the young Daulat Singh to come to Indore to stay with him and study with his children. He matriculated in 1922 from Maharaja Shivajirao High School , Indore. In 1924, he passed the Intermediate examination from the Intermediate College at Udaipur, standing first in the Rajputana Board and securing distinctions in three subjects - Physics, Chemistry and Mathematics. The Maharana of Mewar was pleased to grant him a scholarship of Rs. 50/- per month for higher studies, which for those days was a very generous grant. He joined Allahabad University and passed BSc in 1926 and MSc in 1928 with specialization in Wireless (now renamed Electronics). Professor MN Saha, who during those years headed the Physics Department, was greatly impressed by him because of his depth of understanding and capacity for independent thinking. Their very close association which started during Kothari's student days, continued for life.

Daulat Singh Kothari, as also his brothers were strongly influenced by their mother, Mrs Lahar Bai (nee' Ordia). She was a devout Jain and a highly principled lady. Inspite of great hardships she had to undergo, she never lost hope and by her example taught her children hardwork and compassion for others.

Daulat Singh was married to Sujan Kunwar (nee' Surana) in January 1925.

After passing MSc with top position in the class, he was appointed demonstrator in the Department of Physics of Allahabad University. Soon he was awarded UP State Government scholarship to go abroad. To take care of his mother, family and the education of his younger brothers he asked for a loan from Mewar State Government. He was granted interest free loan of Rs. 3500/-, which he repaid on return from England in monthly instalment of Rs. 60/-.

In September 1930, he sailed for England hoping to work with Lord Rutherford at Cavendish Laboratory, Cambridge. But things did not turn out as he had imagined. On reaching London, he met the British Officer-in-Charge of admissions at India House. Kothari was informed that he was being considered for admission at Oxford and admission in Rutherford's Cavendish Laboratory was totally out of question. Kothari was greatly disappointed. As luck would have it, one of his friends from Udaipur, Mr Gulam Ali, met him and told him that he was going to Cambridge next Sunday and invited Kothari to accompany him. Kothari readily agreed, for he considered this a good opportunity to atleast see Cambridge and the Cavendish Laboratory. On arriving in Cambridge, both friends went to see the Cavendish Laboratory, which they thought would be closed, it being a Sunday. On entering the building, they were met by a lady who enquired about the purpose of their visit. On mentioning the name of Rutherford, the lady immediately took them to the library where Lord Rutherford was sitting and reading a journal. Kothari was dumb-founded. He hesitatingly said, 'Sir! my teacher Professor MN Saha from Allahabad University had written to you about me. My name is Daulat Singh Kothari.' 'Oh, Mr Kothari, I am reading your paper right now. It is very interesting. Have you finished all admission formalities? If not, please complete them soon. My secretary will help you.' And so he was admitted to Cavendish Laboratory inspite of the bureaucrat at India House.

After obtaining the PhD degree from Cambridge, he returned to India in April 1933 and rejoined Allahabad University as a Demonstrator. The University refused to grant him increments for the period he was away and Professor Saha felt very unhappy at this. When a post of Reader and Head fell vacant at Delhi University, Professor Saha advised Dr Kothari to apply for it, and he was duly selected.

AT DELHI UNIVERSITY

The arrival of Dr Kothari at Delhi University in May 1934 marks a watershed in the academic and research life of the science departments. At the time he joined, the science departments functioned in a hired building in Kashmere Gate and imparted education only upto BSc degree. Mr Khub Chand, MA, MSc was In-charge of the Physics Department. It was from him that he took charge as Reader and Head. It was soon after this that things began to move. The Government of India agreed to give the Viceregal Lodge Estate for establishing the University. It was decided that the Physics Department would be housed in the western wing and the old Viceregal kitchen would be suitably modified to house the Chemistry Department. The old Ball-room was to be used for the Library.

On June 18, 1934, the Faculty of Science decided that teaching in Chemistry and Physics be extended to MSc level. This was the beginning of the now famous Faculty of Science of the Delhi University. It also marks the beginning of Dr Kothari's career as teacher, researcher and organizer. No academic work was too small or too big for him. He even accepted examinership of the Intermediate classes and persuaded Professor Saha to come to Delhi as a practical examiner for BSc classes.

From 1938, with the appointment of Sir Maurice Gwyer, former Chief Justice of the Federal Court of India, as full-time Vice-Chancellor, great events started taking place. With full support and encouragement from the Vice-Chancellor, Dr Kothari set for himself the goal of establishing an outstanding Physics Department. This required a new building, new equipment, a good library and above all bringing together qualified and devoted staff for teaching a curriculum which would be modern in outlook.

The complete science block was planned in 1938 (the total sanctioned grant being Rs. 50,000/-) and built in three quadrangles, one for physics, another for chemistry and the third for biology. It was completed in December 1939 and BSc Practical examinations of April 1940 were held there.

In the beginning, there was little equipment in the laboratories. For starting MSc teaching in Physics, the Government, in 940, made a modest grant of Rs. 50,000/- for non-recurring expenditure, and a recurring grant of Rs. 2,500/- per year for three years. In 1941, there were around 200 students with a staff of four — Dr Kothari, one lecturer and two demonstrators. During the subse-

quent year, Dr Kothari was appointed professor of physics, and MSc teaching was started. The first batch of five students passed MSc in 1944.

In 1943, for the first time in the country, the University introduced the three year BSc (Gen)/BA(Gen) and BSc (Hons)/ BA (Hons) courses. The admission to these courses required one year's preparatory course (established in 1942) after matriculation and these were organized in the colleges of Delhi. The first batch of three year degree course passed out in 1946. The MA and MSc courses continued to be of two years duration but were greatly modified in view of the modernization of bachelor's programme. The first batch the of new MA/MSc courses came out in 1948. The stamp of Dr Kothari's vision of modern physics can be seen in the revised courses which were introduced. Realising the importance of proper grounding in mathematics for physics students, a paper on 'Mathematics relevant to Physics' was introduced. A similar paper was also introduced at the MSc level and gradually other universities in the country followed this example. Another new feature in the Science Honours courses was the introduction of a one year qualifying course in 'History and Philosophy of Science'. Dr Kothari and other senior professors of the Science Faculty taught this course for a number of years.

Besides teaching MSc classes, Dr Kothari made it a point to teach BSc, I year class. These classes were very popular. The lecture theatre would be full and yet there used to be total silence. At the MSc level he was probably amongst the first to start teaching quantum mechanics from Dirac's classic on the subject. His method of teaching was unique in many ways. He would first clarify the concepts and emphasize on the fundamentals. He would very often first derive the results from simple physical arguments and calculate the order of magnitude of the quantities involved, before proceeding with detailed theory. He followed this procedure both at undergraduate and post-graduate levels. To illustrate this, we give an example. While teaching Heat and Thermodynamics to BSc students, he had to explain the equivalence of heat and mechanical energy. The normal method, described in text-books, is to note the rise in temperature in a calorimeter corresponding to a given amount of mechanical work. Dr Kothari thought of an entirely novel experiment. He would tell the class that 'whether you are a prince or a peasant, you are three-fourths water.' He would invite 5 to 6 students to come forward and do a certain number of sit-ups, rapidly. The rise in their body temperatures would be noted, before they begin to perspire. The heat generated in the process is easily obtained from the mass of the individual and the rise in

his body temperature. On the other hand, the work done can be calculated from the weight of the person and the change of height of the centre of mass (around the navel) between sitting down and standing up. It is remarkable that this simple experiment not only illustrates the relationship between work and heat, but one can also obtain a fairly correct value of J, the mechanical equivalent of heat.

Dr Kothari could attract outstanding physicists to join the Department. Among them were Professors RC Majumdar, FC Auluck, NK Saha, PK Kichlu, Drs PL Kapur, BN Singh, WM Vaidya, RN Rai and several others. The younger faculty included Drs AR Verma, KS Singvi, RP Bambah and Suraj Narain. Many of his students now occupy very high and senior positions in India and abroad, particularly the USA.

It is interesting to recall the academic atmosphere prevalent in the Department at that time. Dr Kothari's enthusiasm for research and teaching was infectious. Every evening when Dr Kothari walked back to his residence in Commissioner's Lane, a distance of about 2 km, young research workers and teachers often accompanied him. It would be a delightful walk across the ridge in the clean atmosphere of those days. They would leisurely discuss physics.

Soon after the New Physics Laboratory got started, Dr Kothari wrote to some physicists abroad to send their suggestions and good wishes. A number of them responded including Professor AS Eddington and Professor A Einstein. Professor Eddington wrote, 'With especial pleasure I send my good wishes for the prosperity of the New Physical Laboratory of the University of Delhi. It may be that at present it does not go beyond the modest aim of taking some small share in the world-wide activity of physical science. But great things come from small beginning; and nowhere are the prospects more fair than in your country, with its ancient traditions of scientific learning now awakening again into an intellectual revival gaining momentum year by year. The words used by Clark Maxwell at the foundation of the Cavendish Laboratory come to my mind; and with faith "in the unsearchable riches of creation, and of the untried fertility of those fresh minds into which these riches will continue, to be poured," I wish you success".

The letter from Einstein was brief but very significant :

"This is the sentence expressing my good wishes for your new Physics Laboratory :

Keep good comradeship and work with love and without pre-conceived ideas and you will be happy, and successful in your work." Dr Kothari very often quoted this message in his lectures and took great pleasure in explaining the significance and relevance of each word, such as, 'working with love and without preconceived ideas.'

Dr Kothari played a major role in the development and growth of the University Library in its formative years - 1934 to 1943. Soon after joining the University, in May 1936, he was unanimously elected Secretary to the Library Committe. ' As Secretary, Dr Kothari discharged his responsibilities with a sense of dedication. Many of the crucial things that he did have attained historical status. They have survived over sixty years and are very much existing even to-day in our own times.

'The first thing that he did as Secretary was to organise the Third All-Indian Library Conference at the University of Delhi in December 1937. The successful organisation of the conference was very much appreciated.

'Secondly, it is during his times that the Regulation on the use of Library was framed and formally adopted by the University. To-day, this Regulation is enshrined in the second volume of the University Calender.

'Thirdly, the annual report for the year 1937-38 tells us that under the guidance of Dr Kothari the library activities gained momentum. Investment of money in the Library and the use of the library by readers doubled up.

'Fourth, Delhi University Library was granted permission to be an institutional member of Delhi Library Association on 7th November 1939 under the signatures of Dr Kothari.

'Fifth, Dr Kothari saw to it that the requirement of annual stock verification was religiously carried out at the end of each session and the losses reported to the Executive Council.

'Sixth, Dr Kothari persuaded Vice-Chancellor, Sir Maurice Gwyer, to invite Dr SR Ranganathan from Madras University Library for suggesting a reorganisation plan of the university library. The Library Committee unanimously recommended Ranganathan's plan for acceptance to the Executive Council on 7th August 1942.

...Dr S Das Gupta - teacher of history at St Stephen College at that time — was picked up and sent for library training to Madras under Dr Ranganathan. On return, he was appointed the first University Librarian. To enable the newly appointed Librarian to be an ex-officio member of the Library Committee, Dr Kothari saw to it that the ordinance relating to the Library Committee was suitably amended. And it was amended on 24th October 1943. This was the last of the great things done by Dr Kothari. He stepped down from, the Secretaryship of the Library Committee in October 1943 after serving the Library for 9 years. He paved the way for the Librarian to be the Secretary of the Library Committee in future - a convention continuing even today.'*

During every summer vacation, Dr Kothari spent about a month and a half at Udaipur, his home town. His three brothers, who also worked outside Udaipur, would come there with their families during this period. Every year, he would invite some teacher of the Department or some physicist or mathematician friend to be his guest and stay with the family. Professors FC Auluck, PL Bhatnagar, KS Singwi (all three later became Fellows of the Academy), PB Bhattacharya (Dept of Mathematics, Delhi University) and quite a few others spent one or more summers with him. The atmosphere was informal, yet highly academic, and at the end of the vacation, two to three research papers were almost ready to be sent for publication.

He encouraged his students to take up research and teaching as a career. About low salaries in the teaching profession he would often say - 'where else do you find people being paid for doing what they want to do. As a matter of fact, if you are allowed to do what you want to do, you should be prepared to pay for it.'

The academic activities in the Department were strongly supported by frequent visits of renowned physicists, who included among others, Professors PMS Blackett, HJ Bhabha, N Bohr, S Chandrasekhar, N Bogolubov, KS Krishnan, PAM Dirac, P Kapitza, I Prigogine, CV Raman and MN Saha.

In 1899, a solar physics observatory was established by the then Government of India at Kodaikanal and it continued to make significant observations for a number of years. During 1943-45, the Government tried to pursuade Dr S Chandrasekhar to leave Chicago University and join Kodaikanal as its Director. This he did not accept as he did not want to leave the University. Dr DS Kothari

* Thanks are due to Mr ML Saini of Delhi University Library for providing the material

was sounded next but he too declined the offer. In December 1945, a five-member Committee, which included Dr Kothari and was headed by Professor MN Saha, visited Kodaikanal to 'prepare a plan for astronomical and astrophysical observations in India.' The Committee made many significant recommendations for updating of astronomical facilities in the country, including setting up of a large sized telescope for special stellar work. The Saha report proved very handy when Vainu Bappu, 20 years later, pleaded for setting up a stellar observatory at Kavalur in Jawadi Hills, Tamil Nadu.

In August 1948, Ministry of Defence of the Government of India requested the University to lend the services of Professor Kothari as its Scientific Advisor for a period of three years. Dr Kothari continued to take some classes even during this period. He joined back the University in 1952 and was permitted to act as Honorary Scientific Advisor to the Minister of Defence till 1961. In 1961, he was appointed Chairman of the University Grants Commission. He retired from the University in July 1971, on attaining the age of 65 years. He was then appointed Emeritus Professor and continued to interact with the Department throughout his life.

Organising Defence Science In India

Soon after Independence, under the enlightened leadership of Pt Jawaharlal Nehru, the country realized that progress was possible only by the application of science to solve its multifarious problems. This led to the setting up of research establishments in various fields, like atomic energy under Dr HJ Bhabha and the Council of Scientific and Industrial Research under Dr SS Bhatnagar. Responsibility for organising research in Defence Science was entrusted to Dr DS Kothari. He was appointed Scientific Advisor to the Ministry of Defence in 1948. The Government invited Professor PMS Blackett for advising them in organising defence science in India, who during the second world war had played a prominent role in organising defence science in the UK. As it happened, Professor Blackett was a good friend of both Pt Nehru and Dr Kothari. He and Dr Kothari had worked together in the Cavendish Laboratory, Cambridge under Rutherford. This helped not only in laying a firm foundation for defence research in the country, but also helped in evolving a fruitful interaction between India and the UK in this field.

In June 1949, the Government decided to establish Defence Science Organization. It started with 40 senior scientists, 100 junior scientists and 25 scientific

assistants, and was located in H Block- one of the hutments near the Central Secretariat. Today, it has grown into a poweful organization and it now employs over 25,000 scientists.

Dr. Kothari's philosophy and method of working is best described in the words of Mr Nagaratnam[1] who worked with Dr Kothari in the Defence Science Organization for a number of years : **'In giving a direction and a coherent shape to the Defence Science Organization, Professor Kothari had no precedents to go by. It is a tribute to his clear thinking and visionary foresight that he unerringly identified thrust areas of relevance in the country's geopolitical (both the then existing and anticipated future) context. Further, there were no ready-made specialists in any of these disciplines in the country. He carefully chose through personal contact, scientists (mostly from the universities) who had the necessary interest, aptitude and competence. He guided them personally in developing these disciplines on healthy lines. He himself spared no effort to get a mastery over all these areas (most of which were new to him). He organized weekly seminars on relevant subjects and made it a point to participate actively in each one of them, and particularly encouraged the younger scientists. He believed in humble beginnings and natural growth. He therefore started all these disciplines in a small way in corresponding "cells" mainly in the Defence Laboratory, Delhi. All of them grew over the years, and when they had reached a critical size they took off as independent laboratories or establishments located in different parts of the country.**

'....The following were among the diciplines that Professor Kothari indentified for development in the first phase : Operational Research, Ballistics, Explosives, Armaments, Rockets and Missiles, Electronics, Naval Technology, Engineering, Food, Life Sciences (including, medicine, physiology and psychology).'

Over the years, during his term as Scientific Adviser to the Minister of Defence, a number of Laboratories were established in different parts of the country. These included :

Institute of Armament Studies (now called Institute of Armament Technology) at Poona to study performance of existing weapons and design new ones. It also trains Armed Forces and defence civilian scientists in different scientific and technical aspects of armaments.

[1] A Nagaratnam, Father of Defence Science in India; **Education, Science and Human Values**, (Eds R[illegible] Mehrotra and RK Arora) Wiley Eastern, New Delhi (1994)

Naval Dockyard Laboratory (now known as Naval Chemical and Metallurgical Laboratory) at Bombay to provide scientific assistance for the proper upkeep of naval ships and equipment.

Indian Naval Physical Laboratory at Cochin was expected to carry out research in oceanography, acoustics, electronics, etc. to assist in anti-submarine warfare.

Centre for Fire Research at Delhi to promote fire-fighting training to fire-fighting defence personnel, improve fire-fighting techniques, develop measures to prevent fires, etc.

Solid State Physics Laboratory at Delhi to develop solid state devices and study basic properties of solids.

Defence Science Laboratory at Jodhpur to study arid zone problems and field test weapons and equipment.

Defence Food Research Laboratory at Mysore to study problems related to food served to armed forces under different evironmental conditions under which they have to serve.

Defence Institute of Physiology and Allied Sciences at Madras to conduct basic and applied research in physiology and bio-chemistry of problems related to Defence.

Directorate of Psychological Research at New Delhi, to conduct research on selection methods for defence personnel and evaluation to training methods.

Defence Electronics and Research Laboratory at Hyderabad with a view to applying electronics to defence equipment and missiles.

Scientific Evaluation Group at Delhi to evaluate the performance of weapons and equipment.

Technical Ballistic Research Laboratory at Chandigarh to study detonation of explosives and ballistics.

Dr Kothari clearly understood that Defence Science was meant to serve the needs of the armed forces. In spite of his background of a quiet academic atmosphere of universities, he successfully established intimate rapport with the Chiefs of the three Services - Army, Navy and the Air force. He won the respect

of all senior Service Officers by his encyclopaedic knowledge, humility and capacity to appreciate other's point of view. This is illustrated by the following remarks of a senior army officer made to one of us. He said that whenever, we went to discuss any problem with Dr Kothari, he would first listen to us and after grasping the problem, he would go to the blackboard, draw a diagram and write some equations and convert it into a problem to be solved scientifically. This showed his remarkable understanding of the scientific and technical aspects of the problems of defence.

Immediately after Independence, there was great enthusiasm amongst the scientists in the universities to help actively in the development of the country. To interest these scientists in problems of Defence, Dr Kothari periodically organized Defence Science Conferences where scientists from universities and research institutions interacted with persons from the Army, the Navy, the Air Force, the Ordinance Factories and other technical and research establishments. The first such conference was held in Delhi from April 20 to 22, 1949, and was inaugurated by the Defence Minister. It may be interesting to note that among the speakers were Dr SS Bhatnagar, Dr KS Krishnan, Professor RC Majumdar, Lt Gen KS Master, Director-General, Armed Forces Medical Services, Maj-Gen H Williams, Engineer-in-Chief, Armed Forces Headquarters, Com H Drew, Chief-of -Staff, Royal Indian Navy.

Because of Dr Kothari's deep understanding of the fundamentals of physics and astrophysics, he could use his knowledge very profitably in solving problems of defence. An outstanding example is the development of shaped charge for armour penetration. This proved decisive in defending the country against Pakistani invasion using most modern Patton tanks.

After the explosion of the nuclear bombs over Japan, Dr Kothari delivered two lectures on the possible mechanism of these devices, one to general audience and another to military officers. These were highly appreciated. Pt Nehru asked him and Dr Bhabha to write a book on this topic. The entire task was undertaken by Dr Kothari and the book '**Nuclear Explosions and Their Effects**' was published by the Government of India in 1956. An enlarged second edition appeared in 1958. The book received highly complimentary reviews and was translated into Russian, Japanese and German. The preface to the German translation said[1] **"Thus with the publication of the Indian book, a work has**

[1] A Nagaratnam, *ibid.*

come out which makes history ... history-making books are those which convey decisive knowledge at the right moment in an authentic form-unobjectionable and incorruptible, objective, consolidated and total - as the basis for the thoughts and actions of citizens and even of statesmen."

'It should be kept in mind that at the time Professor Kothari embarked on this task, information on the subject was extremely scanty in the open literature, most of it was kept secret by military authorities.... A major achievement of Professor Kothari in this publication, for which he received acclaim from all over the world, was his ability, relying only on published information but using his scientific acumen and critical thinking, to have presented the most authoritative data concerning all aspects of the effects of nuclear weapons.

Dr RE Lapp, while writing about the book in Bulletin of the Atomic Scientists (USA) (Dec. 1956 issue), stated : 'The apparent ease with which the Indian physicists diagnosed the structure of US weapons should be of interest and concern to our Atomic Energy Commission and Central Intelligence Agency. Indeed, the publication of some of the weapons data should encourage a bolder declassification policy by the AEC and Defence Department. It is to be hoped that the forthcoming US **Effects of Nuclear Weapons** will be as complete as the Indian account of the high-yield weapons.'

One of the discoverers of fission, Professor OR Frish wrote in *Nature* (UK) (April 20, 1957); 'The book before us.... contains information drawn from published sources only and yet gives a very adequate picture of the position. It puts, as if, the cards were on the table; from published accounts - the sources being quoted - it proceeds to work out the various forms of hazards (blast, heat and radiation) in front of the reader, with the help of very simple mathematics. The book reads well; physical and biological concepts - including the basic ideas of genetics - are explained in simple language as they come to be required.

'This is a valuable and dispassionate account of a supremely important subject, suitable for anybody who wants to inform himself.'

Chairman of the Atomic Sciences Committee of the Association of Scientific Workers, UK, Dr EHS Burhop wrote : 'The Defence Science Organisation of the Government of India and in particular Dr DS Kothari, of that Organisation, have rendered an invaluable service to the whole world by preparing this study of the consequences of the use and testing of nuclear weapons. Relying only on

published information, the authors have succeeded in the short space at their disposal in presenting the most authoritative data concerning all aspects of the effects of these weapons.

It may be interesting to recall an incident which led to the introduction of Gnat fighter planes into the airforce. Gnat was rejected by NATO and its design was therefore available for sale to other countries. It is told that Pt Nehru was in a dilemma whether to purchase this plane, which had been rejected by NATO. He sought the advice of Dr Kothari. Dr Kothari drew some diagrams and explained its advantages of small target size and great manoeuvrability over other bigger aircrafts of this class. The analogy with a mosquito brought home the point clearly. Though one can hear it buzz, it is difficult to locate and kill it. The designs of Gnat were then bought by India and everyone knows how useful they proved in our fight against Pakistan.

Dr Kothari helped to establish the Institute of Nuclear Medicine and Allied Sciences (INMAS) probably the first independent institute of its type in the world devoted to nuclear medicine. He persuaded INMAS to start a post-graduate diploma course in radiation medicine in collaboration with Delhi University (at that time, probably the only course of its kind in the world).

As Mr Nagaratnam[1] put it, **'The nation owes a deep debt of gratitude to Professor Kothari for the foundations he laid for the healthy development and growth of defence science in the country.'**

University Grants Commission (UGC)

Prime Minister Nehru had a deep feeling for universities. He considered them truely as temples of learning and expressed himself eloquently thus :

"A university stands for humanism, for tolerance, for reason, for the adventure of ideas and for the search of truth. It stands for the onward march of the human race towards even higher objectives. If the universities discharge their duties adequately, then it is well with the Nation and the people."

It was therefore appropriate that Dr Kothari who regarded teaching as the noblest profession and professorship of a university as the highest academic honour, was requested to head the University Grants Commission.

[1] *ibid.*

In early 1961, when Dr Kothari received this offer of the post of Chairman, University Grants Commission, he wrote to Shri VK Krishna Menon, the then Minister of Defence, requesting him to relieve him from the post of Scientific Advisor. In his reply the Minister wrote :

'I am grateful to you for your kind letter which, as you will appreciate, I have received with mixed feelings. I am anxious that your services with the unique qualities you possess should be available to our universities. At any rate, I am not of a self-sacrificing nature, especially where my public responsibilities are concerned, by which I mean that I would not normally sacrifice Defence interests. In this case, however, the alternative you have placed before me, namely, to deny Defence your services in part, places me in a dilemma. I have had no hesitation, however, even initially, in making up my mind. No one knows better than you how much I value your services and your own near - indispensability for Defence Science. However, there can be no Defence without proper education. I have therefore agreed to release you to take up the post of chairman of the University Grants Commission. But I am glad that you have acceeded to my request to continue as Chairman of the Research and Development Advisory Committee. I feel sure that I can leave it to your best judgement to meet both our needs and availability of your time and energy to give what best you can to Defence Science without defaulting on your duties to the University Grants Commission...'

The Government then requested the University of Delhi to lend the services of Professor DS Kothari as Chairman of the UGC. He continued on this post for almost 13 years.

In 1964, the Government of India appointed the Indian Education Commission with Professor DS Kothari as the Chairman. It was a 'great enterprise of educational thought, organizational structures and new linkages of institutions and stages of educational development suited to the needs and resources of a new resurgent India and the emerging horizons of a world society human welfare and solidarity'[1].

Dr Kothari's commitment to education was total. He realised that the future of the country depended essentially on education. This is borne out by the very title of the Report : 'Education and National Development'. The very first paragraph, which has been widely quoted, reads as follows :

[1] Prem Kirpal, Leader in Education; **Education, Science and Human Values** (Eds : RC Mehrotra and RK Arora) Wiley Eastern, New Delhi (1994).

'The destiny of India is now being shaped in her classrooms. This, we believe, is no mere rhetoric. In a world based on science and technology, it is education that determines the level of prosperity, welfare and security of the people. On the quality and number of persons coming out of our schools and colleges will depend our success in the great enterprise of national reconstruction, the principal objective of which is to raise the standard of living of our people.' The Commission took a total view of various aspects of education and made many recommendations. These include recommendations concerning work experience, social service, moral education, vocationalization of education, teacher training, research in agriculture and applied sciences, etc. The Report of the Education Commission was hailed as a landmark in educational development in India and other developing countries..... For UNESCO, ..., it served as a model for the launching in 1971 of the International Commission of the Development of Education under the Chairmanship of Edgar Faure.

'Kothari's leadership of the Indian Education Commission was a remarkable achievement, made possible not only by his vast experience and commitment to education, but also by the moral and intellectual qualities of a rare human being, deeply imbued with the spirit of sevice and compassion, derived from the nature of science and the essence of the cultural experience and traditions of India.'

It is interesting to recall a conversation with Dr Kothari long after this Report had been published. When asked if he had a chance to prepare the report now, how would he modify it. He explained that in early sixties the main emphasis was on rapid development of the country, and the aim of the Report was 'Education and National Development'. After many years, he felt concerned that what was expected had not been achieved. According to him, the missing link was the decline of character. He said that if he were to prepare the Report now, it would aim at 'Education and Character Building'. Once character is built, development will follow automatically. His vision of education is simply and beautifully brought out in a letter he wrote to a child - his great-grandson. He wrote : 'The true aim of all education is to **understand** the wonderful world around us, to develop self- discipline and to contribute to the **happiness** of our home, and the community. This makes education **enjoyable** and a most exciting, inspiring adventure.

Professor Kothari initiated a number of new activities in colleges and universities. To mention a few : UGC appointed a number of committees (i)

make specific recommendations on topics like Physical Education (**Chairman** - Dr CD Deshmukh), Health Services for Students and Staff (**Chairman** -Dr AL Mudaliar), Student Welfare and Allied Matters (**Chairman** - T Sen). He observed that some outstanding teachers were still active at the time of their retirement. He introduced a scheme for supporting such teachers for the next 2-3 years, so that their association with the Department/University could continue. Dr Kothari was keen that students in colleges should have opportunities for learning some handicrafts. He wanted units for making hand-made paper to be established in colleges. On an experimental basis, this was to be tried in a few selected colleges. Khadi and Village Industries Commission as well as some other organisations were approached to help in this. However, the Khadi and Village Industries Commission did not consider this feasible and the idea had to be abandoned.

Indo-US conferences were organized on teaching Physics, Biology, Chemistry and Mathematics in which some Nobel Laureates also participated. Following these conferences, four different Journals devoted to teaching each of these subjects were started and they are still continuing.

Dr Kothari observed that in some subjects certain universities had established outstanding research and teaching departments that were capable of coming up to international levels. He therefore introduced the concept of 'Centres of Advanced Study' which were expected to serve as national centres. These were liberally funded and some help also came from UNESCO.

Dr Kothari was convinced that the key to country's progress was education and his most enduring contributions have been in this field. He often emphasized that for a developing country, with limited resources, to get maximum return, the best investment is in the field of education. Soon after his term as Chairman came to an end, the them Education Minister, Professor Nurul Hasan wrote to him a letter :

'Now that your long and distinguished stewardship of the University Grants Commission had drawn to a close, may I say how much Government have valued the services rendered by you as its Chairman? During your tenure, you had occasion also to preside over the Education Commission and, in the context of the UGC's functioning, to see to the translation of some of the recommendations into action. The University Grants Commission, under your able guidance, has taken important and far reaching decisions in the development of hi

education; your own contribution has been both significant and abiding; the Commission has now come to occupy a position of eminence, trust and responsibility. The entire university community, which has always held you in high esteem, will, I am sure, remain grateful.

The cause of education, particularly higher education, has always been dear to your heart. I am confident that you will continue to work for this noble cause wherever you may be in the years to come. May I add my own sincere thanks for the great work you have done for us?'

RESEARCH WORK

Daulat Singh Kothari Started his research career almost after passing BSc examination. The first paper he published was with his teacher Dr GB Deodhar on 'Further Study of Elastic Behaviour of India Rubber' in the *Indian J Physics in 1928 (vol. 2 p 305-318).* His next paper on 'The Measurement of e/m with a Three Elerctrode Valve with Simultaneous Measurement of its Amplifying Factor' received wide attention and Professor MN Saha wrote : 'His method for determining the ratio of charge to mass of electron has now been adopted in all Indian laboratories (I have no knowledge of laboratories abroad)'. In an interesting paper (1929), his first one published abroad, he studied in detail Doppler-Fizeau effect considering light in the form of light quanta and not waves.

Soon his interest shifted to problems of astrophysics and degenerate matter. With Mr Ramesh Chandra Majumdar, he worked for some time on problems of thermal ionization and degeneracy of matter.

In 1930 he went to Cambridge to work with Lord Rutherford at Cavendish Laboratory. Here he made many notable contributions to quantum statistics, properties of degenerate matter, internal constitution of stars and other related topics. For example, he computed opacity coefficients of electron degenerate matter using a rigorous quantum mechanical treatment and showed that energy flow in degenerate stellar cores is mainly due to thermal conduction and not by radiative process. His theory of pressure ionization found wide applications - from white dwarf stars to planets. Some of the important conclusions were :

a. ionization can take place at high densities, owing to pressure, even at zero temperature;

b. it is possible for hydrogen to go over into metallic phase in the core of cold dense bodies composed mostly of hydrogen; and

c. no cold body can be more massive than Jupiter - i.e. around one-hundredth of the mass of the sun.

In his report to the High Commissioner for India in London, Mr H Thirkill, the President of Clare College, wrote : '...He recently submitted his thesis for the degree of PhD and his examiners, Professor Lord Rutherford and Professor Lennard Jones, spoke very warmly indeed of the excellent quality and character of his thesis.'

Dr Kothari's work on pressure ionization was an important contribution to our understanding of matter under high pressures and found wide ranging applications. Sir AS Eddington wrote *(The Scientific Monthly, USA,* **43,** 385-95, 1936): 'I mentioned that we only gradually came to realize that ionization could be produced by high pressure as well as high temperature. I think the first man to state this explicitly was DS Kothari. Stimulated by some work of HN Russell, Kothari has made what I think is an extremely interesting application. The relation of ionization to pressure is a curious one, at low pressure we decrease the ionization by increasing the pressure; but the ionization must have a minimum, for at high pressure the Fermi-Dirac complication steps in and the ionization ultimately increases with pressure. No one seems to have bothered much about this revised ionization law; they have been content to recognize or I think rather to guess that in white dwarfs the ionization would be pretty high. Kothari, however, has treated it seriously and worked out the degree of ionization in various conditions, including comparatively small masses in which the pressure is relatively low and the ionization in not very high.'

Speaking at the Galvani bicentenary celebrations (Oct. 1937) Professor A Sommerfeld said : "During the times of Galileo and Kepler, the planets were at the focus of astronomical interest, but in view of the developments of the last few decades the interest has shifted to stellar subjects and spiral nebulae. It is noteworthy that the Indian DS Kothari has developed an audacious relationship between the old fashioned planets and the now discovered newest heavenly bodies, the white dwarfs."

Soon after it was established (1936) that the neutron mass exceeds the mass of the proton by a small amount, Dr Kothari, for the first time, realized the significance of this fact in astrophysics. In his landmark paper 'Neutron

Degeneracy and White Dwarfs' he established the existence of an upper limit for the pressure exerted by degenerate electron gas. He also showed that hydrogen containing White Dwarf stars must have a radius less than about 6.4×10^6m. Commenting on this paper, MC Johnson (*Observatory* **61** 74-83, 1938) wrote : 'A paper has recently appeared (Kothari, *Proc. Ray. Soc.* **162 A,** 521-28, 1937) introducing somewhat dramatically into astrophysics the Neutrons, which has been familiar in atomic research since 1932..... Kothari's conclusions can be summarized in a few sentences, but the foundations are necessarily omitted from his brief publication and can only be found scattered in several branches of science. With some of these the majority of astronomers and many physicists are not critically familiar...'

He with his colleagues introduced other interesting ideas in statistical mechanics. They studied Fermi-Dirac and Bose-Einstein gases in uniform field of force, Thermodynamics of relativistic Fermi-Dirac gas etc. Dr Kothari considered non-equilibrium radiation with spectrum proportional to : $x^3dx/\{\exp(x+1)-1\}$ and called it non-degenerate radiation. He conjectured that departures from black-body radiation observed in stellar studies could be accounted for by his theory. Similar distribution was later observed while studying the thermodynamics of grey atmospheres.

Professor Kothari established an active research group at Delhi University. People from different parts of the country joined the Department. The group continued to publish outstanding work in various fields for a number of years under his guidance and supervision. He studied the effect of radiation on Lamb effect. This work was highly appreciated and was later experimentally verified. The problem of random fragmentation of objects in 1 - and 3 - dimensions was studied and applied to understand the distribution of stellar masses in the Hydes cluster. He established close connection between statistical mechanics and Ramanujan's results on partition of numbers. Among other topics investigated were hole theory of the liquid state, bounded harmonic oscillator, kinetic theory of rubber, Fermi's theory of particle production, Riesz potential, colour centres in solids, armour penetration, radiation and sensation of pain, etc.

He guided a number of teachers and research scholars in fields like plasma physics, magnetohydrodynamics, quantum electrodynamics, relativistic quantum statistics and encouraged them to publish their results independently.

He also wrote a numbe of papers of pedagogic significance. To mention a few : Three elementary examples of Uncertainty Principle; Momentum of a

photon inside a medium; Understanding the understood; How big is the moon and how far is the sky ?

The last paper he published in a journal devoted to physics *American J. Phys.* **48,** 335, 1980 was on,'Why Add Marks in Examinations ?'. He wrote : There is an inherent element of arbitrariness in grading or ranking of competing candidates by combining their marks in different papers or tests.....In determining the ranking of candidates by adding marks, ...the assumption is implicit that a given difference of marks ... implies the same difference in "merit" whether the difference in marks is at the lower end of the scale or at the higher end. If we take the view that difference in marks at the higher end of the scale should have a higher weightage than difference at the lower end of the scale, then it may be more reasonable to add marks after taking their squares...Thus, different procedures, seemingly equally plausible, for combining marks give, in gereral, different rankings. Whatever procedure is adopted is, to a degree, a matter of arbitary choice'.

He motivated school and college teachers who came in contact with him to deeply study and analyse some seemingly ordinary everyday events. These resulted in interesting publications. As examples one may mention : A note on parallax and the resolving power of the eye, Linear extension of reflected image produced by a surface traversed by waves, Evaporation from earthen jugs, Biot-Savart's law and Newton's third law of motion, etc.

One case of practical importance for everyday use, was the design of a desert cooler in early fifties. Using a table fan these were constructed in the Department Workshop for use by teachers during summers. Similarly, on observing that old safai karmacharies often had difficulty in bending, he advised a detailed physiological study for the design of broom - sticks.

Professor Kothari started publishing original research papers in 1928 and continued till mid sixties. After that, he devoted more of his time to problems of education. However, the significance of his research work can be gauged from the fact that his research papers continue to be cited even today.

His Thoughts - Excerpts from Some of his Lectures

Apart from his outstanding research work in physics, Dr Kothari wrote and lectured extensively on the interaction between Science and Humansim. (A list of his published lectures and writings is given at the end.) He had a deep insight of quantum physics and also of various ancient Indian philosophical schools of

thought. He could appreciate the close connection between these two apparently opposite view points, and in his lectures, he expounded this relationship. These lectures are unique in many ways and his thoughts will continue to live and inspire the younger generation.

One can fully understand his ideas only by reading his lectures. Here, we give a few selected excerpts from a few of these. It is natural that these quotations may appear disconnected, but there is an underlying unity in his thoughts.

In his Raj Krishan Jain Memorial Lecture delivered at Delhi University in 1977, he spoke on Science and Religion. He said :

'Both science and religion have their origin in man's basic urge and his deep aspirations. Science provides an understanding of nature. It tells us what is possible in the world of nature and what is not, but it does not and cannot tell us what we **should** or **ought** to do. Science deals with **"is"**, religion with **"ought"**. The two are not unrelated. "Science is lame without religion and religion is blind without science," Einstein said. Dr Kothari goes on to pose the mind-body problem. He writes 'As I write these lines, thousands of muscles coordinate to guide my pen. The muscle cells are controlled by electric pulses along nerve fibres linking the muscles with the brain. The brain with its more than ten thousand million neurons (nerve cells) is a fantastic, miraculous, network of electric currents. It defies all description. A basic question is : what or who controls the electric currents in the brain so that I just write these lines and not something else? One could say that, what guides my pen is my mind. But what is this entity called "my mind", or "your mind"?' Discussing moral consciousness he says,'it is to make a distinction between right and wrong, between good and evil. This is not a scientific distinction. It cannot be determined on the basis of science or reason. Science helps, but this distinction depends ultimately on something that goes beyond science. It is the "small voice within" that alone can tell us, in the end, what is "right" and what is "wrong".'

Concerning consciousness he asks the question "Is consciousness a property of the configurations or arrangements of chemical molecules composing our bodies (our brains), and nothing more than that? Or is it something more than a property of molecular patterns, something more than molecular architecture?" He goes on to say : 'The two realities, the "inner" world and the "outer" world are **not** reducible one to the other. The one is not accountable, explainable, in terms of the other. That this is not possible today, or in the near future, is

generally admitted. We believe that this irreducibility of one to the other is an inherent feature of reality.' In this lecture, he dealt at length on the central theme of independence and interdependence of the "inner" and "outer" worlds. He goes on to add that, 'Ahimsa (love and non-violence in thought, word and action) is the foundation and essence of religion. It is increasingly apparent that today man's progress depends crucially on the joining together, in mutual re-inforcement, of science and **ahimsa.** Without this man has no future, and his very survival is at stake..... We need desperately new knowledge and technology. But no less, perhaps even more, man needs wisdom, compassion, and strength and serenity of the human spirit. It is that which would determine ultimately the continuing advancement of science and its wise use for man's progress and well-being. **Science can make as also kill a civilization...** Ours may be called an age of science, but it is certainly not a scientific age. It is not an age of reason or rationality, not yet. That can only come when **science** and **ahimsa** equally find a place in man's thoughts and actions.'

In several of his lectures, Dr Kothari tried to explain the Principles of Complementarity and stressed that we must take the complementarity approach seriously not only in science but also in life. He argues that it should form an integral part of education. As he explains, 'The Principle of Complementarity, we owe principally to Niels Bohr, is perhaps the most significant and revolutionary concept of modern physics. The **complementarity approach** can enable people to see that seemingly irreconcilable points of view need not be contradictory. These, on deeper understanding, may be found to be complementary and mutually illuminating, the two opposing contradictory aspects being parts of a 'totality', seen from different perspectives. It allows the possibility of accommodating widely divergent human experiences in an underlying harmony, and bringing to light new social and ethical vistas for exploration and alleviation of human suffering.'

According to him 'the most profound, rich and fundamental of all complementarities is that of **matter** (brain) and **consciousness** (mind).' He argues at length to show that an understanding of complementarity existed in Indian culture. He says that, 'the core of the ethical-spiritual insights propounded in the Upanishads, Buddhism and Jainism rests essentially on the complementarity approach to the problems of life and existence. The unique and unsurpassed contribution of the Ramayana and Mahabharata is that they integrate these "insights" with the life and culture of the common people.

'Sri Aurobindo, the great exponent of the Upanishadic thought in our times, writes in his commentary on the **Isha Upanishad "The principle it follows throughout is the uncompromising reconciliation of the uncompromising extremes."** A number of pairs of opposites have been considered and resolved in the Upanishads, and these include :

Renunciation and Enjoyment

Being and Becoming, and

Vidya (knowledge) and Avidya (ignorance)'

This problem is also discussed in his Inaugural Address at the Intenational Conference on Conceptual Foundations of Quantum Theory (1989). In another article, Dr Kothari draws attention to the Jain formalism of complementarity approach, and says that it is 'based on the Syadvada dialectic ('Syad' means "may be"). The Syadvada logic is indispensable for the theory and practice of **ahimsa** (non-violence) in thought, word, and deed. Syadvada and ahimsa go integrally together. Syadvada asserts that the knowledge of reality is possible only by denying the absolutistic attitude. What is new is the fact that relativity and quantum mechanics embody the same line of thought as one finds in the Syadvada logic. Further, the Syadvada approach enriches our understanding of complementarity in physics. As pointed out by PC Mahalanobis and JBS Haldane, the foundations of the theory of probability are also in keeping with the Syadvada logic.' In this article, Dr Kothari goes on to correlate the best understood of all complementarities, the wave-particle duality in physics, with Syadvada logic.

Dr Kothari showed serious concern about the use to which science is put. At different forums, he gave lectures on topics like, Science and Community; Human Implications of Science; Science and Humanism, Science and Technology and Concern for the People; Science and Non-violence, etc. He said that science properly taught can contribute much and effectively to the incorporation of the moral component in education - central to man's progress and even survival in this atomic age.

In his GV Mavalankar Memorial Lecture(1965), Dr Kothari said : 'Science is hard work;.... It is a relentless and passionate search for truth. And bringing an uplifting experience, which comes from such pursuit, within reach of a large mass of people everywhere, science has contributed immeasurably - far more

than may appear at first sight - to strenghtening the commitment of man to free enquiry and to the quest of truth as its highest duty and obligation. By loosening the bonds of dogmatism, by providing a common and rapidly expanding stock of knowledge and by fostering an attitude of objectivity and true humility, by encouraging honest doubt and vigorous but dispassionate thinking, science is becoming a major force in reducing idealogical tensions and conflicts. **Science is also humanism.'**

He argued that science must think in terms of the millions and said : 'The vital role of science in India is to fight ignorance, poverty and disease, and function as a poweful instrument to bring about a social transformation, so that millions could live longer and happier lives.'

Elsewhere he said: 'The key to national development is science and technology (S & T) and building of character and concern for the people, particularly the poor. Character building and true S & T development go together, mutually reinforcing.

'....In a world dominated by sicence and technology, promotion of effective concern for the people, particularly the poor, should be the foremost task of education at all levels. It should inculde knowledge of the aspirations, needs and living conditions of the poor, productive work experience, and effective participation in community - social service.... Science and Technology and Production by themselves cannot generate and ensure national development.... In the world there was never so much STP as today; and never before in man's history so much greed, hatred and brutal violence as today. There is a growing dehumanization and decay of humanness. It is growing at a frighteningly rapid pace. There is almost a total disregard of human values and the suffering of the poor and the destitute.... In the atomic age national interests and of mankind are inseparable.'

Participation in INSA Activities

Professor DS Kothari was elected Fellow of the Indian National Science Academy (then called National Institute of Sciences of India) in the year 1936. He served as a member of the Council almost continuously from 1942 to 1963, and held the following offices : Foreign Secretary (1945), Secretary (1946-51), Treasurer (1953-56), Vice President (1957-58), Editor of Publications (1961-April

1962), Additional Vice President (1963) and President for 1973-74. As out-going President he again served on the Council for two years - 1975-76.

He was elected President of the Academy in the same year as his term as UGC Chairman came to an end. He could therefore devote full attention to INSA and brought to bear his rich experience to serve this institution. He devoted considerable time to the Library of the Academy. He interacted with the employees and often enquired about the welfare of their families. He inspired the Library staff to bring out periodically 'Science Information Notes,' which were distributed to the Fellows. During the birth centenary year of Einstein, he encouraged INSA staff to bring out, in mimeographed form, a collection of articles on and about Einstein. This was later published in a regular book form jointly by INSA and CSIR.

Dr Kothari had great faith in the youth of the country. To recognize and nurture young talent he wanted to introduce, at the national level, some awards for promising young scientists. Since no funds were available with the academy for this activity, he persuaded a private Foundation (Kothari Foundation of Calcutta) to donate funds for this. In 1974, the first awards were made to 21 scientists below the age of 32 years. This programme is now supported by INSA and Young Scientist Award is considered very prestigious.

Dr Kothari was keen that senior scientists and particularly the Fellows of the Academy should interact regularly with science students in schools and colleges. During his tenure as President, INSA arrangd several popular talks in schools and colleges and in INSA auditorium for science students. These were highly appreciated and were quite popular and well attended.

Professor Kothari, as a brilliant academician discussed with ease highly technical and current advancements with specialists. But what distinguished him was his ability to explain to non-specialists and young students, the deep significance of many difficult concepts of modern physics. For example, he would discuss at length, how our very existence depended upon the Planck constant or the great significance of taking the velocity of light to be absolute and given, or the implications of the quantum mechanical concept of complementarity (*NPL Technical Bulletin* No. 14, p. 5-12, 1989).

He took keen interest in the organization of National Science Day at the Academy, each year, on February 28. School students were invited to participate in competitions, and awards were presented. He also arranged to distribute interesting scientific literature to students.

INSA awarded him two Medals, Shanti Swarup Bhatnagar Medal in 1966 and Meghnad Saha Medal in 1978. While accepting the Meghnad Saha Medal he delivered a lecture on "Atom and Self" *(Proc. Indian Nat. Sc. Acad., Part A, Vol. 46, No. 1, 1980)*, which was highly acclaimed by all those who got a chance to read it. He spoke about the complementarity of mind and matter. He said : 'Mankind's very survival is at stake. That we need to know more about the atom, about the external world of space-time and matter-energy, is beyond question. But to ignore altogether the knowledge of the self can in the end only invite disaster. The foundation of duty and reverence is self-knowledge, and not the atom, not the external world. Even to decide to dedicate oneself to science, this decision, is not a part of science. It is outside science. It is akin to some kind of religious faith.'

Other Activities

Professor Kothari's deep concern for education led to his involvement in several related activities, which include National Council for Educational Research and Training (NCERT), Commission for Scientific and Technical Terminology and reform of the UPSC examination system, etc.

NCERT : From the inception of the National Council of Educational Research and Training (NCERT), Professor DS Kothari played a role of friend, philosopher and guide of this organisation. Beginning of his long association with the NCERT can be traced back to 1961, when he became a member of its Executive Committee. He was entrusted by the Executive Committee the task of recruitment of the faculty and the staff for this organisation, which he performed with highest distinction in the first ten years of the Council in his capacity as the Chariman of the Appointment Committee.

He conceptualised the role and functions of the NCERT and in the Report of the Education Commission 1964-1966 gave a blueprint for its future development. The blueprint was a masterpiece of architecture for building and academic institution of national importance. It provided guidelines for setting up of administrative and academic structures for the management of personnel and programmes. He visualised the need of constructing a campus of the NCERT in New Delhi for housing its secretariat and the National Institute of Education.

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* We are grateful to Professor AN Maheswari, Joint Director NCERT, for providing this write up.

The Government of India supported the development of this organisation along the lines suggested by Professor Kothari in the Report of the Education Commission. Even a cursory scrutiny of the history of the three and half decades of the NCERT would reveal that this organisation could grow from strength to strength because its foundations were strong and its development closely followed the Kothari blueprint. Today, this organisation has a staff of over 3000 persons of whom about 850 are academics.

To identify and support the education of talented students interested in science, the National Science Talent Search Scheme was introduced. (Now it is National Talent Search Scheme.) It proved very popular and children from all parts of the country eagerly participated in it. The initial scheme envisaged that 350 scholarships will be awarded to meritorious students who will join the BSc courses in Basic Sciences at different colleges and universities. He took perennial interest in this scheme and would make it a point to sit in the viva-voce examination of students. He was the Chairman of the Advisory Board for science education programmes of the Council. Under his guidance summer schools for science teachers were conducted for several years and many faculty members were sent to the USA for undergoing training in science education.

To make school children aware of the developments in the country in the fields of science and technology and also to encourage them in independent thinking and model building, national science exhibitions were planned to coincide with the birthday of the Late Prime Minister, Pt Jawaharlal Nehru—November 14. The exhibitions were to be organized in different part of the country every year. The first exhibition was organized on the National Physical Laboratory grounds, New Delhi and was inaugurated by the then Prime Minister, Smt Indira Gandhi. Ministry of Defence, CSIR, and other organizations took keen interest in it.

Dr Kothari encouraged NCERT to publish general science books for school children. A number of outstanding Indian scientists and mathematicians were persuaded to contribute, and the project was a considerable success. He was instrumental in starting the journal 'School Science,' which has gained international recognition as a quality periodical for dissemination of science news and articles on science, at a level relevant to teachers and students of secondary schools. At Professor Kothari's suggestion the NCERT made it compulsory for inclusion in all the text books published by it, the passages called Gandhiji's Talisman :

"I will give you a talisman. Whenever you are
in doubt or when the self becomes too much with
you, apply the following test :
Recall the face of the poorest and the weakest man
whom you may have seen and ask yourself if the step
you contemplate is going to be of any use to him.
Will he gain anything by it? Will it restore him to
a control over his own life and destiny? In other
words, will it lead to Swaraj for the hungry and
spiritually starving millions?
Then you will find your doubts and your self melting away."

Each year 30 million textbooks published by the NCERT carry Gandhiji's Talisman.

Professor Kothari emphasised to the NCERT the need to make education value based. He took advantage of each opportunity of Council's programmes for explaining to the Council's faculty his concept of value education. It would be difficult to identify major schemes and programmes of the NCERT from the period of his life that were not influenced by his direct involvement sometime or the other, or indirectly owe to some guidance from the Report of the Education Commission.

Commission for Scientific and Technical Terminology: India is a country with many languages, each with very rich heritage. However, science in its present form, was comparatively new to us and in the early decades of this century, was being taught only through English. After independence it was realised that science must reach the masses and a coherent policy had to be worked out to formulate and evolve suitable technical terms in regional languages. In December 1960 the Government announced the formation of a Commission for Scientific and Technical Terminology and Professor DS Kothari was appointed its first Chairman. He served as its Chairman till 1964. To produce modern scientific literature in any language, it is essential to have an extensive and well formulated glossary of technical terms. Before any new terms are coined and current terms adopted, the guidelines and principles for the evolution of technical terminology has to be formulated. Dr Kothari, realizing that science is essentially an international activity, helped to lay down guidelines and principles for the evolution of scientific and technical terminology in Indian languages. Following these guidelines, an exhaustive glossary of scientific and technical terms was compiled. In this monumental

task a large number of teachers, scholars, educationists, and learned people cooperated. It continues to be the officially accepted glossary.

Dr Kothari was convinced of the necessity of teaching science in the mother tongue of the child. His views are best expressed in the Education Commission Report : 'We are convinced of the advantages of education through the regional languages. We regard the development of regional languages as vital to the general progress of the country, and as an important step towards the improvement of quality in education. To avoid any misunderstanding we would emphasize that this does not mean the shutting out of English, or other world languages. In fact, we will profit from these languages all the more when our education becomes more effective and useful.'

UPSC : In February 1974, Union Public Service Commission appointed a committee on 'Recruitment Policy and Selection Methods' with Professor DS Kothari as the Chairman. UPSC had been selecting candidates for various All India and Central Services of the Government by holding various examinations, essentially according to the Macaulay Report which was based on the 1854 Report for the British Civil Service. For one thing, there was over-emphasis on History and other Social Science subject. Because of the tremendous expansion of the educational opportunities in the country after independence, a large number of candidates began to appear for the UPSC examinations and the system was coming under serious strain. This necessitated an in-depth study of the entire selection system for Government services.

The Kothari Committee, after a detailed study of the entire problem, submitted its Report to the UPSC in March 1976. The Committee realised that in a modern society based on science and technology, the development and progress of the country would require planners and administrators with adequate knowledge of these subjects. Therefore, technical subjects were also included amongst the optional papers. Besides this, the Report suggested some sweeping changes like :

(a) Single examination for IAS and other Civil Services,

(b) A much wider choice of optional subjects, including technical subjects, with equal weightage to each subject,

(c) Examination in three stages,

(i) Preliminary Examination (objective type) - to serve as a screening test
(ii) Main Examination (written and interview)
(iii) Post Training Test.

The present selection system is based essentially on this Report.

Other Organisations : (i) Dr Kothari was actively associated with a number of other organisations and Institutions in the Country. During his later years, he was deeply involved in generating awareness amongst students and teachers of Indian Institute of Technology at Delhi, for integrating Science and Technology on the one hand and Humanism on the other. He prevailed upon the IIT authorities to start a regular course on Science and Humanism and actively guided a group of faculty members in formulating this course and regularly teaching it. Consequently, a new awareness dawned and a number of related activities grew up. A book on Science and Humanism was completed just about a month before his death and he wrote an inspiring Foreword for it. On Professor Kothari's inspiration, a study circle was started at IIT, Delhi to regularly discuss the message of the Gita and the implications of the new literature arriving from the West on integration of Science and Humanism. This had a long term impact on the thinking, teaching and research activities of a number of faculty members. A 4-credit course on 'Technology and Community Development' was started in 1990-91. Apart from highlighting the inter-relationship between Appropriate Technology and Community Development, this Course has gradually matured to include a rational philosophy of integrated development. Under the guidance of Professor Kothari, a special National Seminar on 'Technology and Rural Development' was also organized in the Silver Jubilee Year of IIT, Delhi. Subsequently, a new channel for Industrial Training of BTech students in institutions like Gandhi Gram Rural Institute of Mumbai, People's Science Institute at Dehradun, etc was approved by the Senate.[1]

(ii) Dr Kothari was a member of the FICCI (Federation of Indian Chambers of Commerce and Industry) Awards Jury since 1968, when the Awards were instituted. Today, FICCI Awards are considered to be one of the prestigious awards in the country and the credit for this goes to Dr Kothari. He took very keen interest in each and every facet of the working of the Awards, be it for scientists, or for social responsibilities such as family welfare, or for training and placement of disabled persons or for women entrepreneur professionals or social

[1]Thanks are due to Professor RR Gaur of IIT, Delhi for providing material on this.

workers. It was at his suggestion that cash Awards for individual scientists in the area of Life Sciences including Agriculture, and Physical Sciences including Mathematics were instituted. Again, on his suggestion, an Environment Award was instituted so that the business community should give attention to environmental preservation and pollution control.[1]

(iii) Dr Kothari was closely associated with Bhartiya Vidya Bhavan, Mumbai. In 1983, it published his lecture on 'Atom and Self' in the form of a booklet and after his death, brought out a Special Issue of Bhavan's Journal (vol. **39,** No. 16, March 31, 1993). Writing in the Journal, the author of the article 'Dr DS Kothari : Scientist As Philosopher' says :

'Dr DS Kothari was closely associated with the Bhavan. He participated, as far back as May, 1968, in the week-long All-India University Teachers' and Students Camp organised by the Bhavan at the Bhavan's Andheri Campus. Over 500 people - Vice-Chancellors, teachers and students - attended the camp. It was perhaps the first of its kind to be held in the country under non-official auspices.

'Among the distinguished men who spoke at the camp included Lok Nayak Jayaprakash Narayan, Dr PB Gajendragadkar, Shri Achyut Patwardhan, Pandit HN Kunzru, Shri Jairamdas Daultram and Dr PV Cherian. 'Dr Kothari, who was then the Chairman of the University Grants Commission, inaugurated the camp. In the course of his address, he said : "This camp is a fine example of active participation jointly by students and teachers. There is need for increasing participation, deliberation and involvement of students in the formulation and implementation of development projects and programmes, especially those concerned with student residences, social sevice, and discipline and welfare generally. The Education Commission has recommended that conference of representatives of the student unions in universities and colleges may be convened once a year to consider amongst other things improvement of discipline and promotion of academic excellence. The university is a society in which all are, or at any rate should be, engaged in the pursuit of learning. Teachers are senior partners and students are junior partners in this great enterprise.

"In our country the basic role of Education should be (as urged by the Education Commission) to promote a sense of common citizenship and culture,

[1]Thanks are due to FICCI for providing the details about this.

and to further national integration; to make a direct contribution to national productivity; and to contribute (in howsoever modest a measure) to the world stock of rapidly expanding knowledge of technology." "For the purpose of our country, for it to attain its rightful place in the comity of nations, what we need is knowledge and commitment or to put it in simple Indian words, Gyan and Ram have to go together. Science and non-violence or atom and Gandhi must enter into a symbolic and creative synthesis. Towards this consummation, for the good of us and for the good of mankind, our country and especially the youth have a special responsibility and obligation."

(iv) He was also very closely associated for a number of years with Gujarat Vidyapith, Ahmedabad, an institution established by Mahatma Gandhi. The Vice-Chancellor of this deemed University, Professor Ramlal Parikh, after Dr Kothari's death, wrote : 'He was closest to the Gandhian ways of life and particularly Gandhiji's relentless pursuit of truth and non-violence. Myself as a person and the entire fraternity of the Gujarat Vidyapith owe to his inspiration, several innovative programmes in the Gujarat Vidyapith like Centre for Studies in Interrelation of Science and Non- violence, Science and Nai-Talim, Science and Rural Development, Gandhian Studies, Peace Research etc...'

(v) Dr Kothari was interested in Yoga and holistic medicine. He was closely associated with various expert committees of the Central Council for Research in Indian Medicine and Homoeopathy, which is the parent body of All Research Councils in Indian Systems of Medicine including the Central Council for Research in Yoga and Naturopathy (CCRYN). He played a key role in organizing the first ever All India Seminar on 'Yoga, Science and Man', sponsored by the Government of India. The Seminar was held under his Chairmanship and over 300 experts from various fields like medical science, yoga, and education participated, including Dr Karan Singh (the then Minister for Health and Family Planning), Professor Nurul Hasan (the then Minister for Education and Social Welfare), Dr BK Anand, Professor TR Anantharaman, Dr OP Jaggi, Shri Kireet Joshi, Maharshi Mahesh Yogi, and Swami Dhirendra Brahmachari. In his Welcome Address, Dr Kothari said : 'Ahimsa and Yoga represent our country's unique and dynamic heritage. The two go together. Ahimsa and Yoga are more relevant than ever to man's well-being and development, even survival, in the atomic age.' He goes on to add, 'Whatever may be the immediate or short-term goals of science, its long-term goal is to understand man. As Erwin Schrodinger, famed for his epochal contributions to modern physics, said : The answer to the question : Who are we?, is "not only

one of the tasks, but the task of science, the only one that really counts." This emphasizes the central importance of Yoga studies and research.'

Dr Kothari also gave the idea of introducing Yoga as an integral part of educational curriculum in schools, and the first attempt to formulate the outlines of Yoga syllabus for schools was made under his chairmanship.[1]

(vi) Though a man of very liberal views, he was a devout Jain and highly respected by the Jain community. He had made in-depth study of quite a few Jain Texts, particularly on Syadvada (Anekantavada) and tried to relate its teachings with the principles of modern physics. He was invited to contribute an article to the Commemorative Volume published in honour of Niels Bohr. He also worked to propagate (समणसुत्तं) Samansutam, published by Sarva-Seva-Sangh, Varanasi on the advice and insistance of Vinoba Bhave. Dr Kothari also served as President of Akhil Bhartiya Swetambar Sthanakvasi Jain Conference. In 1974, to celebrate 2500 years of Nirvan of Bhagwan Mahavir, Magadh University at Gaya, Bihar, organized a large three-day conference of Jain scholars and munis. It was inaugurated by Dr Kothari. He spoke about the close links between certain aspects of Jain philosophy and modern physics. People who attended the lecture still recall with pleasure the great impact his lecture had on the audience.

Anuvrat Organization, in 1989, honoured him with Anuvrat Award. It carried a cash prize of Rupees one lac. Declining to accept the Award he wrote : 'Ahimsa is an **absolute**, never failing instrument of truth, love and service of the community- indeed of all human beings. May the Lord grant us strength, faith and understanding to practise it, as best we can, in life. This alone counts.

'A word about the Anuvrat Award : In all humility and respect to the Organization I cannot accept it. I do not quite see - but I may be wrong- how there can be an 'Award' of this kind for any endeavour - and so feeble on my part - to practise Ahimsa. And I am aware that countless are far ahead of me, especially mothers and sisters.'

(vii) He was a member of the Jawaharlal Nehru Memorial Fund. He also served as Member of the Council of Advisers of the Jamnalal Bajaj Foundation.

In 1979, he was also appointed the Chaiman of a Committee, by the Minister of Education, to review the work of the National Adult Education Programme and suggest changes for better utilization of funds.

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[1] Thanks are due to Dr Naresh Kumar, Director, CCRYN, for providing information.

HONOURS

Professor DS Kothari received many honours in his lifetime. He was awarded **Padma Bhushan** by the President of India in 1962 and **Padma Vibhushan** in 1973.

Many universities awarded honorary degrees to him. These include Roorkee University, Aligarh Muslim University, Udaipur University, Guru Nanak Dev University (Amritsar), University of Leningrad (USSR). In 1948, when Sir Maurice Gwyer was the Vice-chancellor, Delhi University decided to award him DSc (**honoris causa**) along with DLitt to Pt Jawaharlal Nehru, Maulana Abul Kalam Azad and others. Dr Kothari politely declined to accept the degree saying that as a member of the University faculty, it would not be proper to accept the honour being bestowed on him. The Chancellor wrote back to Sir Maurice saying : I am sorry to hear that Doctor DS Kothari has asked for his name to be withdrawn from the list and I accept his request. I fully appreciate the reasons which have motivated him to make this request.' He also made it a point that as long as he was the Chairman of the UGC he would not accept any honorary degree from any Indian University.

He was invited by a number of universities from all over the country to deliver convocation addresses. He delivered more than forty addresses : from University of Jammu and Kashmir in the north to the University of Kerala in the south, Gauhati University in the east to University of Bombay in the west. He also delivered number of memorial lectures. Among them were **Ninth Pandya Memorial Lecture** (on 'Effect of high explosives on metals') at Indian Institute of Metals, Bhilai, **Krishnan Memorial Lecture** (on 'Nuclear Explosions') at National Physical Laboratory, New Delhi, **Dadabhai Naoroji Memorial Lecture** (on 'Education, Science and National Development I and II') **Ninth JN Tata Memorial Lecture** (on 'Science and Self-knowledge') at the Indian Institute of Science, Bangalore, **Shri Raj Krishna Jain Memorial Lecture** (on 'Some thoughts on science and religion') at Delhi University, **Siremal Bapna Memorial Lecture** (on 'Science and Ahimsa') at Devi Ahilya Vishwavidyalaya, Indore.

In his convocation addresses and momorial lectures, he covered very widely different topics. His presentation was always so engrossing that the audience listened to him with rapt attention. Addressing the students of Delhi University, in his Annual Convocation Address (1983) he said : 'The advancement of science and technology and its use for human welfare - economic, science and culture will be in jeopardy unless there is a moral advancement of man, a strengthening

of the human spirit. Science and technology without self-control and Ahimsa can only result in widening the frightening gap still further,widening beyond repair the gap between the poor and the rich countries, and the gap between the poor and the rich within a country....The survival of man depends on science and self-control, on 'Atom' and 'Gandhi'. That can be a road to a glorious future. And every step counts, no matter how modest.'

In 1977, delivering Shri Raj Krishan Jain Memorial lectures at Delhi University, he said 'Anti-science, negation of science, is to be totally rejected. It is most important to make an unequivocal distinction, even if it cannot be sharply made, between rational, beyond-rational (beyond-reason), and anti-rational (anti-reason). Anti-rational or anti-science has no place in the affairs of man. It is untruth. But beyond-reason is not anti-reason. And beyond physics is not anti-physics. It is not a negation of physics....

'Faith in the pursuit and value of science goes beyond science and reason. It is akin to a religious feeling : it goes beyond science. Faith in science, faith in reason is not anti-reason, but beyond reason. To suffer for the sake of science and truth is a moral quality. It depends on the strength of the spirit. Paradoxically, reason and faith, though opposed to each other, yet sustain and reinforce each other beyond measure.....

'Science is the search for truth. The practical value of science has been astonishingly great, beyond the most daring expectations. A passionate and unfaultering devotion to the pursuit of truth, and the use of knowledge for man's material and spiritual advancement is the ideal of all those who seriously dedicate themselves to science.

It is interesting to recall that after this lecture, the Vice-Chancellor of the University presented Dr Kothari a cheque of Rs. 10,000/-, this being the honorarium for the lectures. Dr Kothari declined to accept the cheque and suggested that the money be used to provide students and teachers with books like Gandhiji's Autobiography, The Gita, Upnishads, Shri Aurbindo's writings, etc. at one-third the price. The Vice-Chancellor liked the idea and added another Rs. 10,000/- from the University side. This encouraged many students and teachers to buy such books.

Similarly, he did not accept the honorarium of Rs. 5,000/- given to him for delivering Sri Aurobindo Memorial Lecture in 1982 at the University of Delhi and wanted the money to 'be used by the University for the scheme of supplying

selected books (not text/course books), at subsidized prices to students and teachers (and others in need and interested).'

He was elected President of the Physics Section of the Indian Science Congress Session in 1944 and the General President of the Indian Science Congress for the 1963 Session, held in Delhi.

He served as Chancellor of Jawarharlal Nehru University, New Delhi from 1982-1992. Earlier to him only Prime Ministers of the country had served as Chancellor of the University. It was Smt Indira Gnadhi, the then Prime Minister, who invited Dr Kothari to take up this appointment.

He also received the Award of National Federation of UNESCO Associations in India. He was awarded the first **Anuvrat Award** (carrying a cash award of Rs. 1 lac) which he politely declined. In 1991, he also received the Atmaram Award of Kendriya Hindi Sansthan, Agra for outstanding contributions to scientific and technical literature. He was a Foreign Member of the USSR Academy of Science and a Fellow of the Third World Academy, Trieste, Italy. He was also elected Fellow of National Academy of Science, Allahabad and of the Indian Academy of Sciences, Bangalore.

Some Personal Glimpses

The honours and recognition he received from different quarters, can hardly bring out the great impact he made on people who came in contact with him. His personality and the values of life he cherished, can be illustrated by recalling glimpses of his contacts with different persons. Though the incidents recounted here may appear disconnected, they reveal different aspects of his personality and his approach to problems of life.

As is well-known, he was a pure vegetarian and a teetotaller. Many of us who are vegetarians have, at one time or the other, particularly when abroad, faced question regarding this 'belief'. When Kothari was a research scholar in Cambridge in early thirties, his colleagues and friends often querried him about not eating meat even in the cold climate of England. He explained his position in his inimitable style. He enquired from his friend, why they did not eat human flesh or dog's meat, because after all it was all meat. On their showing great revulsion for such an idea, Kothari explained that every man draws a line as to what he eats and what he does not, and this line is quite arbitrary and varies from person to person. This ended all arguments.

Once he was asked a hypothetical question : If meat preparation were the only medicine for an ailment, would you still refuse to take it? His answer was, 'I would prefer to die than take any meat preparation.' Yet he never wanted to impose his views on others. After he assumed charge of the Chairmanship of the University Grants Commission, he discussed with the staff at different levels, about the type of food to be served in the UGC canteen. Everyone agreed that only vegetarian food should be served there. Even when distinguished visitors from abroad visited UGC, they were served lunch prepared at the canteen. He never took his visitors, however eminent they were, to expensive hotels, since he strongly believed that one should not be generous at public expense.

As Scientific Advisor to the Defence Minister Dr Kothari led a high level military delegation to the USSR. He hosted a dinner, where he was expected to propose a 'toast'. Knowing that Dr Kothari was a teetotaller, some very senior and experienced people advised him that while proposing the toast, though he may not actually drink, he should make a show of lifting the glass to his lips. When the occasion arose, everyone was surprised to see him fill his glass with water and while toasting he announced : Friendship between USSR and India is so pure that one can only propose a toast with "aquapura". Everyone present was highly pleased with this novel way of toasting.

Dr Kothari was an outstanding teacher. One of his students* has recorded the following : 'We liked him very much because he taught very well and quantum mechanics became very interesting. A glimpse of his human side, we got one day when he was taking our class in the Lecture Theatre in the old block. Both the doors were closed. Suddenly, the power failed and the room became completely dark. Immediately, there arose a loud howling sound made by boys at the back. Sir opened the front door and light entered the room. We could see his face staring at us and we held our breath thinking that the whole class would be scolded. His face was grim and his gaze was fixed on us. We waited for some admonishing words but he said : "If you had not made this sound today, then I would have thought that you are not normal human beings." Much relieved, the whole class burst into a laughter. He too joined in heartily.'

Soon after the Defence Science Laboratory started functioning at Metcalfe House, behind Old Secretariat in Delhi, he started getting complaints about a Safai Karamchari. This man was neglecting his work and could be found sleeping

* Ma Gurupriya (formerly Dr Ratnadeepa Mazumdar)

during office hours in odd corners. One day, Dr Kothari called him in his office. At first the man behaved stubbornly but when he saw that the Head was polite and sympathetic, he came out with his story. He said that he was a poor man, coming to office from a long distance. He had to walk the whole distance and by the time he reached the office, he was already very tired. He also told that while other officers could get loan from the Government to buy a motor vehicle, people in his category were not allowed a cycle loan from the Government. Dr Kothari called the Accounts Officer and asked him to grant the person cycle loan. He said, he would take up the matter with the concerned Ministry and if they did not agree, the loan may be treated as a personal loan from him. When the matter was taken up with the Ministry, it agreed to grant cycle-loan to Safai Karamcharies. The concerned person became one of the most efficient workers in the establishment.

As one knows, during his lifetime, Professor Kothari occupied many high Government positions which entitled him to many privileges. He was extremely careful not to misuse his position. One of us once asked him for advice, as to whether his wife could accompany him in the staff car, since rules were not very clear for the occasion. The advice he gave was almost like a 'mantra': Whenever in doubt about the applicability of a rule, put it against yourself.We noticed that he himself always practiced this. On one occasion, Dr Kothari went to Delhi airport to see off Dr Tringuna Sen, Education Minister in the Government of India at that time . He politily suggested to the Minister that while going to board the plane he should carry his own bag and not hand it over to someone else to carry it for him. Dr Sen greatly valued the advice.

Many Government officers frequently travelled to distant places, because the TA rules prevalent at that time permitted three first class fares for to and fro journey, in addition to other incidental expenses. This meant considerable personal saving to the individual and acted as an inducement to travel. Dr Kothari, who often met the Prime Minister, Pt Jawahar Lal Nehru, brought this to his notice and suggested that TA should cover actual return fare plus incidentals. The Prime Minister greatly appreciated the suggestion and immediately a Government order was issued changing the TA rules, to the great surprise of all Government officials.

Many of Dr Kothari's students and friends brought him gifts. He readily accepted them if they were inexpensive. He loved home-made jam presented to

him by one of us. He would accept kurta and pajama of khadi given to him as a birth-day gift. He extensively used transparencies for his lectures and when once someone brought felt-pens for writing on plastic sheets, which were not available in India then, he gladly accepted them.

Once, a professor came to pay a courtesy call, after returning from abroad, where he had gone to attend a conference on UGC grant. He presented Dr Kothari a costly Parker pen. Dr Kothari politely declined to accept the pen, saying that the pen provided by the UGC, along with the pen-stand, served his purpose very well. However, the person insisted on leaving the pen behind. Dr Kothari suggested that he will call his private secretary and the pen could be presented to him, who would value it, and make better use of it.

Dr Kothari himself presented books like Gandhiji's Autobiography, The Gita, Upanishads, etc to his friends and relatives on happy occasions like marriage, birthday or anniversary, with loving message written in his own hand.

Mr Madan Mohan, former Registrar of Delhi University has recorded some incidents from Dr Kothari's life. He writes:* 'I cannot forget the marriage ceremony of one of his sons at 5 University Road, to which the then President of India was also invited. Professor Zakir Hussain, President of India did attend the marriage and stayed in the Pandal for about an hour. To the surprise of everyone, Kothari Saheb spent hardly a few minutes with him and for the rest of the time he was busy enquiring after and exchanging greetings with other guests ranging from peons, malis, etc. to high officials in the University and the government. This is one of the many human qualities with which Kothari Saheb was bestowed.

'Once, when Professor Kothari was the Chairman of the University Grants Commission, a procession of the Delhi University and Colleges Karamchari Union went to the Commission at Bahadur Shah Zafar Marg to demonstrate in favour of some of their pressing demands. Just when the first slogan was shouted, Kothari Saheb came out and could recognise many of the union leaders who were old employees of the University and the colleges. Kothari Saheb's immediate reaction was that the employees of the University should not have taken the trouble of coming all the way from the University to the University Grants Commission. According to him, such a demonstration could have been staged at his residence at 5, University Raod in the University so that it could

* University News, May 2, 1994

save the karamcharis the inconvenience and expense of hiring private buses; the money so saved could be utilised for the welfare and well-being of the children of the low-paid staff. This shows his concern for the betterment of the karamcharis of the University, even at a time when he had no direct connection with the University.'*

Once a discussion started on the burning of public property e.g. buses and railway stations by mobs. He was asked for his view on how this could be prevented. In his typical sage like style, he said in measured tone, "No one burns his own property. The Government utilities do not serve the pepople so well as to make them feel that these belong to them. We must search our own hearts."

Dr Kothari was a very busy person, whether as Scientific Advisor to the Defence Minister or as Chairman of the UGC. Yet when someone met him, he would listen patiently and with sympathy and never gave the impression of being in a hurry. He used to say that those who work hard have time for everything - even playing with grand children.

One was amazed to see people coming to him for his advice, regarding all types of problems of life, viz., marriage of a daughter, whether to accept the offer of a particular job, etc. He once explained that when a person comes for advice, one should place oneself in his position and give advice from his point of view. Often many of us give advice from our own point of view.

While the Education Commission Report was being written, he would very often leave the UGC office early in the afternoon and go and sit on the lawns of India Gate. It is here in a relaxed and free atmosphere that major portions of the Report were written by him.

Dr Kothari was a devout Jain. Yet he had the highest regard and tolerance for other religions and beliefs. For example, whenever his car passed by the Buddhist Tibetian Temple on the Ring Road (Civil Lines) he would fold his hands in obeisance to Lord Buddha. He did the same while passing by Raj Ghat.

He was very fond of quoting Buddha : 'Learning is a good thing but it availeth not. True wisdom can be acquired by practice only. Practice the truth that thy brother is the same as thou. Walk in the noble path of rightousness and thou will understand that while there is death in self, there is immortality in truth'

* University News, May 2, 1994

He would say that though electrons do not know this truth, they behave as 'identical particles.' On the other hand, while man knows the truth, he fails to practice it. Dr Kothari would also quote Gandhiji about the necessity of reducing oneself to 'zero', and strived to practice it. For example, when someone touched his feet in reverence, he would do the same to the concerned person.

Among the people working for INSA there was one attendent, with the same name - Daulat Singh. Dr Kothari once remarked : 'We are both Daulat Singh. It is mere accident that I am here and he is there. It could have been just the other way round.' He shunned publicity. Many of us wanted to make a documentary on him, but he never encouraged the idea.

He retained a child like curiosity to learn and remained a diligent student all his life. Because so much appears in print these days, he would advise people to read only the 'Masters'. He could quickly grasp the main points in any article or book, and made extensive notes of what he considered to be important. After his retirement from the UGC he decided to read the Gita in the original. (In school he had learnt Urdu and Persian and could not write Hindi correctly). In a couple of years he was able to read and explain in depth the shlokas of the Gita and recite them also. Because of his deep understanding of quantum physics, he was able to see and appreciate its close link with ancient Indian thought. He wrote and lectured extensively bringing out this synthesis. Some of his typical articles in this field are : 'Atom and Self', Meghnad Saha Medal Lecture 1978 *(Proc. Ind. Nat. Sci. Aca.* **46 A,** 1-28 (1978); The complementarity principle and eastern philosophy, Niels Bohr, A Centenary Volume, Eds. AP French and PJ Kennedy, Harvard University Press, Cambridge, MA, USA, pp. 325-331 (1985); Complementarity Principle : physics and beyond, *NPL Technical Bulletin,* **No. 14,** pp 5-12 (1989); Some thoughts on Mind, Matter and Complementarity, *J. Phys. Educ,* **2** pp.13-16 (1974).

Many outstanding scientists and thinkers would come and meet Dr Kothari when visiting India. They would discuss philosophical and scientific questions and were impressed by his depth of understanding. They became his admirers and life-long friends. The long list includes not only physicists, chemists and mathematician but also medical men, psychologists, biologists, educationists, religious thinkers, etc. One may mention some of them : Nobel laureates PMS Blackett, P Kapitza, and S Chandrasekhar were among his close friends. Later

Prof I Prigogine, Nobel laureate from Belgium, visited him fairly frequently to discuss physics and philosophical question. It is interesting to recall that outstanding medical men like George Wald (Nobel laureate) and Larry Dossey MD found discussions with Dr Kothari very stimulating. Larry Dossey has authored several books and has dedicated his book 'Meaning and Medicine' (Bantam Books, New York 1991) to Professor DS Kothari. In his Acknowledgement he writes : "Dr Kothari had come across my book 'Space, Time and Medicine', which occasioned the beginning of a stimulating correspndence. An unforgettable experience for me was receiving his landmark paper 'Atom and Self,' published in an Indian scientific journal in 1980. It is one of the most profound discussions of the mind-body problem I have ever discovered. It was my great honour to meet Professor Kothari when I was invited in January 1988 to deliver the Annual Mahatma Gandhi Memorial Lecture at the Gandhi Peace Foundation in New Delhi. Dr Kothari spoke the languages of modern physics and the ancient Upanishads with equal profundity and grace. In his life and philosophy he has honoured the realities of the physical, mental, and the spiritual as few scientists I have known. Our conversations and the communication that has followed have for me been memorable and inspiring, and have contributed in no small measure to the ideas set forth in the volume.'

As a Man

Dr Kothari may be best described as a multifaceted personality, i.e., while he was a brilliant theoretical physicist he was also an inspiring teacher like ancient rishis or gurus. His contributions to modern Indian education cover almost the entire spectrum, from elementary school to university levels. He will always be remembered for organizing defence research and development in the form it exists today, aiming at self-reliance in the defence of the country. He also helped to reorganize the examination and selection process for Central Services of the Government of India, conducted by the Union Public Service Commission. This apart, he was also a deep thinker and a philosopher. In his unique way he attempted to synthesize ancient Indian wisdom with modern scientific thought. He was a great human being and left a lasting impression on almost all those who came in contact with him.

He regularly read from the Autobiography of Gandhiji - Story of My Experiments with Truth, and tried to practice his teachings. One may here just

mention one aspect of the influence Gandhiji had on Dr Kothari. It is well-known that Gandhiji talked of 'Ram Nam' as an infallible remedy for all ills. As Dr Kothari explained to some of us, this is the foundation of Mind-Body relationship. In other words Ram Nam taken from the depth of the heart will lead to removal of all evil thoughts from the mind which will consequently lead to a healthy body. This can be summarised almost as a mathematical formula as follows :

राम नाम → निर्विकार → निरोग

Dr Kothari has lectured and written extensively on the mind-body relationship. He himself was an embodiment of a healthy body with a pure mind. Dr Kothari had a lean and thin constitution but was essentially a very healthy person. Except for minor ailments for which he took home remedies, he was never hospitalized.

The life of Professor Kothari is an outstanding example for achieving excellence in human endeavour. Throughout his life, till he passed away in his sleep in the early hours of February 4, 1993, he was inspired by the "**mantra**" which is best expressed in his own words : "**The key to national development is science and technology and building of character and concern for the people, particularly, the poor. Character building and true science and technology go together, mutually reinforcing.**"

Dr Kothari deeply influenced most of the people who came in contact with him. Professor George Wald, NL, when informed of Dr Kothari's death by his grand-daughter, Vandana, replied back : 'It is very good of you to have let me know of your grand-father's death. He is a person I loved and enormously appreciated, more directly than any other Indian I came to know; a superb scientist with a warm soul. We were going to write some papers together; but I couldn't read his handwriting.

'I am myself 86, so it won't be long...'

In reply to his letter written on Professor P Kapitza's death, Mrs Kapitza wrote : 'Kapitza was always very interested in the development of science in India. You were one of the closest friends we had in India. We always remembered you then as a young student in Cambridge, and he was always proud of

your life and work in India.' Dr Samarendra Saraf, Fellow at Indian Institute of Advanced Studies, Shimla, wrote : 'He lived an enviable life and he died an enviable death. In his life-time he was a source of inspiration for those around him; after death he, as **lux et luce** (light that shines but dazzles not) has become a lighthouse for our future generations of natural-physical scientists..... Men of stature often overshadow or eclipse the younger generation of budding scholars, with their over bearing gestures; but I found in him true mirror replica of the Vedic sage or seer of yore who ever sang the prayer with his disciples in a coparcenary spirit... Let's walk together, let's speak together, let our minds be united in the pursuit of a common goal.... A truely great man is one who ennobles and elevates others without ever making them feel belittled and dwarfed. As such, the late Professor Kothari will always continue to stand before me as my ideal and my cynosure of scholarship.'

Remembering Dr Kothari

Soon after his death, a number of Institutions/Associations started different types of academic activities in memory of Dr Kothari. Some of these are : INSA established 'The Daulat Singh Kothari Memorial Lecture' in the year 1993 from the General Funds of the Academy. It is to be given every three years in any branch of science. The first award lecture was delivered in 1996 by Dr Krishan Lal of National Physical Laboratory, New Delhi.

In 1994, University of Delhi established, at its South Campus the 'Professor DS Kothari Centre for Science, Ethics and Education. (It has now been moved to the main, North Campus.) Among the many objectives, one may mention :

To work for integrating science, education and human values;
To facilitate in depth studies in areas of interest to the centre;
To organize courses for students, teachers and the general public.

The first Professor DS Kothari Memorial Lecture was delivered by Sir John Kendrew, NL and Foreign Fellow, at the Academy on November 18, 1995 and the Centre was formally inaugurated. Sir John spoke on 'Education and Changes in the Practice of Scientific Research.'

Dr Kothari delivered over forty-five Convocation Addresses at various universities all over the country. In these, he covered various topics. The Centre

is to shortly bring out a colllection of these. The University of Delhi has also named one of its hostels after Professor DS Kothari.

A number of Institutions/Organisations have started Professor DS Kothari Memorial Lectures. These include Department of Physics, Banaras Hindu University; Indian Institute of Science, Bangalore; Defence Laboratory, Jodhpur; Indian Science Congress Association, Calcutta; The Mathematical Association of India, Delhi Chapter.

One of the grand-sons of Dr Kothari, Vineer Bhansali, submitted his thesis entitled 'Symmetries, Anomalies and Effective Field Theory,' for PhD degree in physics to Harvard University, Cambridge, Mass. (USA) in 1992. In his Acknowledgements, he writes,' ...I am indebted to my grandfather, Professor DS Kothari, for attempting to explain length contraction by pacing rapidy on our floor when I was seven...' Dr Bhansali had his college education at California Institue of Technology, (Caltech) where Professor R Feynman was one of his teachers. He has established a Prize in his grand-father's name at Caltech and in May this year, he received a letter from Dr David Baltimore, President of Caltech, stating that, 'I am pleased to infrom you that we have recently established the 'Dr DS Kothari Endowed Prize in Physics, in honour of your grandfather. This prize will be awarded annually, to an outstanding senior in physics...' The first prize has already been awarded.

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1960 Effect of high explosives on metals, Ninth Pandya Memorial Lecture Indian Institue of Metals, Bhilai, Dec. 1.

1965 Science and the community, GV Mavalankar Memorial Lecture, Harold Laski Institute of Political Science, Ahmedabad, Apr. 9.

1966 Men, atoms and galaxies, Dr. Amir Chand Oration, July 30.

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— Education, science and national development, Dadabhai Naoroji Memorial Lecture: I and II.

— Universities and national development, First Dr VS Krishna Memorial Lecture, Andhra University, Waltari, May 30 and 31.

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1972 Some aspects of education, Motilal Nehru Memorial Lecture, Hyderabad (Feb. 28).

1974 Science and man, Zakir Husain Memorial Lecture.

1977 Some thoughts on science and religion. Shri Raj Krishna Jain Memorial Lectures I and II. Delhi Univ. Oct. 31 and Nov. 3.

1979 Science and self-knowledge, Ninth JN Tata Lecture, Inst of Sci Bangalore, March 20.

1981 BN Singh Memorial Lecture, Delhi Universty, March 3 and 5.

1982 Role of science in promoting social and moral values : Ramakrishna Memorial Lecture, Indian Institute of Technology, New Delhi, Feb. 15.

1983 Science and Values, Fifth Bhai Parmanand Memorial Lecture, Bhai Paramanand Smarak Samiti, New Delhi, Dec. 10.

1987 Science and Ahimsa-Siremal Bapna Memorial Lecture, DeviAhilya Vishwavidyalaya, Indore, Oct. 3.

CONVOCATION ADDRESSES

Year	Month & Date	Particulars
1962	December 10	University of Mysore
—	December 15	St. John's College, Agra
1963	January 14	Aligarh Muslim University, Aligarh
—	April 14	Gurukul-Kangri, Haridwar, **(in Hindi)**
—	September 21	Shrimati Nathibai Damodar Thackersey Women's University, Bombay
—	October 21	The University of Jammu & Kashmir
—	December 24	Visva-Bharati, Shantiniketan
1964	January 11	University of Jabalpur, Jabalpur
—	March 6	University of Burdwan, Burdwan
—	May 7	Indian School of International Studies, New Delhi
—	November 30	University of Roorkee, Roorkee
1965	January 4	Jadavpur University, Calcutta
—	January 28	Jodhpur University, Jodhpur

—	February 13	Nagpur University, Nagpur
—	March 9	Gauhati University, Gauhati
—	October 14	University of Madras, Madras
—	October 18	Gujarat Vidyapeeth, Ahmedabad
—	December 18	Panjab University, Chandigarh
1966	October 14	Gujarat University, Ahmedabad
—	December 3	Agra University **(In Hindi)**
—	March 8	Indian Institute of Technology, Kanpur
1967	October 27	Shivaji University, Kolhapur
—	December 15	Sardar Patel University, Vallab Vidyanagar
1968	January 9	Utkal University, Bhubaneswar
—	February 24	The Punjabi University, Patiala
—	February 27	Shrimati Bhagwati Devi Jain Degree College, Agra Cantt. **(In HIndi)**
—	March 17	Indian School of Mines, Dhanbad
—	August 20	University of Bombay, Bombay
—	October 12	Maharaja Sayajirao University, Baroda
—	December 14	Indore University, Indore (both in **Hindi** and **English)**
1969	February 16	Sri Venkateswara University, Tirupati
—	February 22	Rajasthan University, Jaipur
—	March 31	University of Calcutta, Calcutta
—	December 29	Karnataka University, Dharwar
1970	March 28	Magadh University, Bodh Gaya
—	November 18	Jawaharlal Nehru University, New Delhi
—	November 28	University of Kerala, Trivandrum
1971	January 23	Osmania University, Hyderabad
—	March 30	Banaras Hindu University, Varanasi (both in **Hindi** and **English**)
—	December 6	Saurashtra University, Rajkot*
1972	October 28	Marathwada University, Aurangabad
—	December 30	Indian Agricultural Res. Instt., New Delhi
1983	Aprl 16	University of Delhi, Delhi

Addresses (that were printed)

1958 Science and National Planning, Anniversary Address, National Institute of Sciences of India, Delhi (January)

1960 Address on the occasion of the opening of the Defence Science Laboratory, Delhi (April 9).

* Central Government declared a state of emergency and the function was cancelled. Dr Kothari could not come and the address was not delivered' VC Saurashtra University

1961 Inaugural Address, 24th Session, *Indian History Congress*, Delhi University, (28 December)

— Some aspects of secondary science education, *Sixth Annual Conf. of All India Science Teachers Assoc, Udaipur (26 December).*

— Education and the Universities,Vice-Chancellors Conf. New Delhi (28-29 October)

1962 Annual Day Address, SN Medical College, Agra (10 February).

— Nuclear explosions and their effects, *Anti-Nuclear Arms Conventon*, New Delhi (16-18 June).

— Some aspects of University education, Vice-Chancellors Conference, New Delhi (11-13 October).

1963 Science and the Universities, Presidential Address, *Indian Science Congress Association*, 50th Session, Delhi (7 October).

— Science and human progress, Inaugural Address, *32nd Annual meeting, The National Academy of Science*, Allahabad, (16 February)

— Address, 30th Annual meeting of Geological, *Mining and Metallurgical Society of India*, Calcutta (12 November) *Quarterly J. of GMMS of India*, **Vol. 34** (4) pp. 209-210.

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— Education and operational research, *Seminar on Operational Research in Universities*, Delhi University, Delhi (August 10-12).

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1968 Education and national development, Shrimati Nathibai Damodar Thackersey Women's University, Bombay, Golden Jubilee Commemoration Volume.

— Crisis in education, Ruparel College Annual Lectures Foundation, Bombay (November 23-24).

1969 Guru Nanak's main contribution - universalization of religion. Presidential lecture at Inter, *Seminar on Guru Nanak, Punjabi University*, Patiala (September 5).

— Higher education and national development, *Conf. of Vice-Chancellors*, New Delhi (April 2-23).

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Books

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1958 Nuclear Explosions and their effects (Revised Edition).

1963 विज्ञान और विश्वविद्यालय, साहित्य और संगम, आगरा।

1964 The problem of scientific and technical terminology in Indian languages, Ministry of Education, Government of India, New Delhi.

1970 Education, science and national development, Asia Pub. House, Bombay.

1975 Science and man, Indiana Publication, New Delhi.

1983 Atom and self, Bhartiya Vidya Bhavan, Bombay.