# B. M. Udgaonkar
# Eminent Scientist
# & Educationist

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# *Preface*

Prof. B. M. Udgaonkar is a many faceted personality. He is often labelled as a Science Educationist. Would that be appropriate? Well, he is certainly that but not only that. The injustice in confining him to this on compartment would be evident the moment we get to hear his erudite comments on various issues, some far removed from the fields of science education. Or even education, for that matter. His compass is indeed very wide. He is a hard core Scientist and earned a world wide reputation as a theoretical particle physicist. He is a teacher par excellence, having taught a variety of topics not the least reactor physics to a large group of original practitioners of that discipline in the country. .

He is an excellent science communicator. He is an international authority on Nuclear Disarmament, having been very active in the Pugwash movement that was awarded the Nobel prize for peace. He is a good orator and he writes very proficiently. He could be called agent provocateur in a different sense as he is able to provoke his readers. This comes out vividy when one reads his Physics News editorials. He is an institution builder and one does not have to go beyond the Homi Bhabha Centre for Science Education (HBCSE) . to be convinced of that. He is a good nurturer of talent both individual and institutional. This is apparent from a large number of students and disciples who have occupied prestigious positions both here and abroad. Besides the HBCSE, Institute of Physics (IOP), Bhubaneswar and Marathi Vidnyan Parishad (MVP) were put on firmer footing by him. He started several novel programmes in University Grants Commission (UGC) by establishing Programme Advisory Committees in different subjects to promote quality teaching and research at various universities in India. He has a unique knack of spotting the right person for the right job. Were it not for this extraordinary faculty of his one would not have seen scientists like Abhay Ashtekar, Mustansir Barma and Sanjay Limaye what they are today. His command of the English language is superb and he has taken pains to develop it right from his school days. He is a thinker with wide interests. He is just not a laboratory or armchair scientist but he has moved widely in the society and his thoughts on Science and Society are well appreciated. At a casual encounter one may find him to be a rather serious introvert. But once you get to know him one finds the witty, even mischievous side to his persona. Above all he is very honest and transparent in his personal and public dealings. So how would one finally describe him. Perhaps simply as a fine human being.

Prof. Udgaonkar has always shunned

publicity. He has preferred to do his work patiently and diligently away from the limelight. That is perhaps the reason he has remainded unknown to many and none of his anniversaries were publicly celebrated. The National Centre for Science Communicators, has benefited from his advise right since its inception. So the Centre along with Homi Bhabha Centre for Science Communicators ,which is a brain child of Prof. Udgaonkar , decided to felicitate him on his completion of 80 years of very fruitful and accomplished life by organising a national seminar on, 'Science Education-Challenges in Quality'. We are indeed grateful that he readily gave his consent. Heartfelt thanks to you. Prof. Udgaonkar.

On this occasion, we are also publishing a Souvenir comprising three sections. The first contains a total of 29 articles from his students, colleagues and admirers. A series of rather rare photographs taken on various occasions adorn the second section and a small number. just four, selected from a large written output forms the third. Besides ,his brief biodata and a list of his papers-articles and books can also be found in the souvenir.

We thought of bringing out this Souvenir and requested all the probable contributors rather late. just in the middle of July. But I must acknowledge the instant and heartwarming response. I sincerely thank them all Mr. Laxman Londhe, a science and science fiction writer is also an artist and has drawn a water colour sketch of Prof. B. M. Udgaonkar which graces the front cover of this Souvenir. Dr. Bal Phondke along with Dr. Parul Sheth and Mr. Suhas Naik-Satam have edited the souvenir.

**A. P. Deshpande**
Chairman
National Centre for Science Communicators

# My Brother

*Dr. Wijaya Altekar*

Those who know Bhalchandra M. Udgaokar know that he had a brilliant academic career. But only a few may know that very early in his life he must have decided to make a career in science and was highly motivated. A sense of overall perseverance in overcoming personal challenges during early phases in his career helped him achieve his chosen end. We were six siblings and "Dada", as we brothers and sisters call him, is the eldest. Our father was a doctor. Besides practicing medicine he was a dedicated social worker, working for the uplift of downtrodden women. He had a very firm belief in the value of education, which he imbibed into his children. Dada's sharp intellect and dedication to studies was obvious right from his school days, He was a student of the King George High School, as it was known then. It had a large number of students and every standard usually was divided in four or five divisions with a total of close to two hundred students. He always used to secure first rank among them all. Consequently, he won a scholarship throughout his school career. It was a matter of great pride for my sister and me, to be recognised as 'Sister of that scholar'!

Realising the importance of English language in higher education he paid special attention to its study. He and his friend made it a point to practice speaking only in English. In those days of mainly vernacular schools and just a few convent schools, mastering the English language was a great achievement for a boy coming from a middle class Maharashtrian family. Though equally adept at all school subjects his forte was Physics and Mathematics. So much so, that he would solve all the questions in a Mathematics paper and challenge the examiner to correct any ten out of the twelve answers! His college career was also embellished with a first class with distinction throughout.

It was a moment of tremendous joy for the entire family when Dada cleared the matriculation examination of the Bombay University with flying colors. He came first in the city of Mumbai and second overall in the University, which then included the erstwhile Sindh province with Karachi as its capital and parts of the present day Kamataka. He joined the science course in Elphinstone college. Since our father was a doctor everybody thought that he would study medicine, but he chose Physics and Mathematics. After Inter Science also he surprised everybody. In spite of obtaining a first class first position, instead of going for engineering he decided to go for B.Sc.! Of course he knew what he was doing.

Next year when he was still a teenager studying in the Junior B.Sc. class our parents, not yet even fifty, died unexpectedly. We were all very young, shocked, helpless and bewildered. The month was January. However Dada kept the company of his books and

appeared for the B.Sc. examination in just two months time and finished with usual credits. In another two years he obtained the M.Sc. degree with his accustomed first class with distinction. At this stage, with his record-breaking career he could have secured a cushy job anywhere but that was not his aim. Many a person's careers are thwarted owing to the responsibilities of younger siblings. But he never let his courage and aim falter or leave him. In fact he appeared for an interview for the post of an officer in Imperial Bank of India (now, State Bank of India). During the interview Mr. Chandaverkar asked him knowingly "Mr. Udgaonkar, do you think you would really take up this job with the Bank"? Of course Dada refused the offer! Within few months he was selected in the Tata Institute of Fundamental Research by Dr. Homi Bhabha himself and the rest is history.

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# Professor Udgoankar, An Exceptional Mentor

*Prof. Abhay Ashtekar*

My interaction with Professor B.M. Udgoankar was limited to just a year and half, from about February of 1968 to August of 1969, during which I was an undergraduate at the Institute of Science in Bombay. However, it left a deep mark on my inner attitude towards physics and scientific research. I write this tribute with a deep sense of gratitude.

During the academic year 67-68 I was a junior B.Sc. student and one day Professor Udgoankar walked into our class and suggested that those of us who had a National Science Talent Scholarship could go to TIFR once a week for physics discussions. We were overjoyed that someone of his stature was taking such keen interest in our careers. Four of us from the Institute of Science and two from other colleges then started meeting at TIFR once a week. Each meeting lasted a couple of hours. Professor Udgoankar introduced us to Professor Yash Pal and his then student Ramnath Kaushik, who later became the Director of the Indian Institute of Astrophysics. At least two of the three of them participated in each meeting. Generally they asked probing questions and made us think in ways we were not used to. They also suggested problems which we tried to solve there and then, often with hints from Ramnath. This was a novel way of doing Science for us and for the first time I got a taste of how to think 'from scratch,' and began to understand why certain problems and issues were more interesting than others, although at face value they all seemed equally deep or mysterious.

Towards the end of that academic year we started reading Feynman's Lectures. This became the primary activity during the first semester of my senior B.Sc. year, 68-69. Professors Udgoankar and Yash Pal insisted that we also do problems given in the books. Some of them were hard for us and took a lot of time and energy. There was one, in particular, where I first got the same result as the answer at the back of the book, but then realized that I had done something conceptually sloppy. When I redid it more carefully, I got only half the answer in the book. This was puzzling and disturbing and so I reported it in our next meeting. After some discussion Professor Udgoankar concluded that the person who had given the answer in the book probably did the same conceptual error that I had first made. This gave me confidence and I decided to write to Feynman, telling him the whole story. Feynman actually replied (see attachment) saying that the book was wrong! This little episode bolstered our confidence enormously.

Newton's gravitational constant has the same dimensions as the second time derivative of inverse density. During the summer vacation of 68 I started thinking about cosmological implications of a possibility that Newton's constant was not a true constant but related to the mean density of the universe in this way. Using simple mathematical formulas describing

the evolution of the universe that I found in semi-popular articles, I then worked out consequences of this rather ad-hoc hypothesis. Some of them seemed interesting. So when the academic year began, I gathered courage and showed them to Professor Udgoankar. To my pleasant surprise he took it rather seriously and introduced me to

Professor S.M. Chitre. He in turn went through my calculations and made constructive, critical comments. Although my manuscript was far from being a publishable paper, Professor Chitre thought that the ideas were interesting and the reasoning showed a knack for doing original research. This reaction of seasoned scientists gave me clarity as well as a big psychological boost. The episode also solidified my interest in cosmology and general relativity.

Soon after, therefore, I went to the United States Information Service in the Bombay consulate and looked at brochures on Ph.D. programs in physics. I found just two which specialized in these areas: Maryland and Austin, Texas. I applied to both. Mary-land replied saying that did not consider students from India unless they had a M.Sc. But, as I later learned, largely because of recommendation letters from Professors Chitre and Udgoankar, Austin took a risk and offered me graduate admission and assistantship. Throughout the application process Professor Udgoankar took time to discuss career paths with me, weighed the pros and cons of joining TIFR versus going to Austin, and finally advised me to go, largely because he thought I needed solid graduate course work, which was not readily available in TIFR at the time, and because I showed keen interest in general relativity which was not represented at TIFR. As it turned out I stayed only briefly in Austin and transferred to the University of Chicago to work with Professor Geroch in the new Relativity group that Professor Chandrasekhar had just created. I then had the good fortune of seeing Professor Udgoankar again, albeit briefly, when he came to a particle physics conference in Chicago in 72-73.

I have always felt tremendously fortunate that Professor Udgoankar decided to take interest in undergraduates at Bombay University precisely the year I went to Bombay from Kolhapur to join the Institute of Science. As years pass, I find it increasingly incredulous that he was so generous with his time for undergraduates of me. Three others from our group of six have gone on to lead productive scientific careers - Ajit Kembhavi, an astro-physicist; S. Krishnan, a biophysicist and Sanjay Limaye, an astronomer/ meteorologist. So the 'yield' was high. To all of us, the TIFR sessions Professor Udgoankar arranged were precious; they exposed us to exciting frontiers and gave us a taste for creative thinking which, alas, was all too rare in our undergraduate education. These stimulating contacts came just at the right time. They let us take our first flights into the exciting frontiers of physics. They taught us how natural and simple it is to spread one's wings, and what a great joy it is to fly high over intellectual landscapes of Science. Not surprisingly, that thrill and joy has been addictive. Although nearly four decades have passed, it still continues to bring the deepest joy and satisfaction.

A million thanks, Professor Udgoankar!

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# My Recollections of Professor B. M. Udgaonkar

*Prof. Mustansir Barma*

It was some time in the second half of the 1960s, and I was a student enrolled in the B.Sc. course in Physics at St. Xavier's College, Mumbai. Several of my classmates and I had recently bought the bright red 3-volume 'Lectures in Physics' by Richard Feynman. We would make sporadic attempts at trying to really understand what Feynman says — a task that proved quite difficult, despite the deceptively informal and chatty style of the author.

It was some time in our penultimate year in college, I think, that we learned about an informal study group being formed at the Tata Institute of Fundamental Research, for interested students to come and discuss the Feynman lectures and accompanying exercises, on Saturdays. We had heard that the discussions would be organized by a couple of professors at TIFR, and a bunch of us students, from various colleges, showed up. This was the first time I met Prof. Udgaonkar, who, along with Prof. Yash Pal, conducted the discussions (most ably assisted by Kailash Rustagi and P. K. Babu, who were then graduate students at TIFR). I did not explicitly recognize it then, but I was a beneficiary of Prof. Udgaonkar's long-standing engagement with physics education and pedagogy.

The discussions went well, and we students (who included Adi Bulsara from St. Xavier's, Madhav Marathe from Ruia College, and Abhay Ashtekar from the Institute of Science) got a lot out of it. Prof. Udgaonkar made sure that all of us participated. I remember that I was sent up to the blackboard by him, and was asked to make a binomial expansion with a small parameter x. I was very nervous, but managed to write down the first couple of terms, under the firm but friendly gaze of Prof. Udgaonkar. The strongest impression that remains in my memory of these discussions, four decades later, is that Prof. Udgaonkar would always guide the discussion towards trying to get to the essence of the phenomenon under discussion, behind the mathematical formalism. In retrospect, these discussions were very important for me — not only from the point of view of solving the exercises that go with the Feynman lectures, but also, more importantly, to get a glimpse of how physics works, and how a physicist thinks.

My next encounter with Prof. Udgaonkar happened about a decade later, towards the end of 1976, when I first joined TIFR as a postdoctoral fellow. I joined the Theoretical Physics Group at the Institute, which was headed by Prof. Udgaonkar. An important activity of the group was the Theoretical Physics Seminar, held every Friday at 4 p.m., and Prof. Udgaonkar was always present, seated in the front row. During this time, his engagement with physics education continued, and I remember refresher courses for college teachers organized by him, held in the ground floor lecture halls of the Institute. Within TIFR, he initiated several new programmes. These included the Visiting Students' Research Programme (VSRP) in which

students from all over the country visit TIFR for several weeks during summer, and get a hands-on idea of research by doing projects, in addition to attending lectures. This programme has been a great success, and continues till today. He also initiated a joint teaching programme in collaboration with the University of Poona. Although this programme did not continue for many years, it did produce some outstanding students who have gone on to make a mark.

During these years, I came to know Prof. Udgaonkar rather well, through the following circumstance. I lived off-campus, and would wait every morning to catch the TIFR bus from the stop near the Naval Canteen. Very often, Prof. Udgaonkar (who lived further away) would be driving in to work, and would honk, stop and pick me up on the way. In the 10 minute ride that followed, we would talk about various subjects. I learned a lot during these drives — as the subjects ranged over a large number of topics, including new developments in physics, students and education, Pugwash conferences and more.

Another capacity in which I, and many other academics at TIFR, benefited from Prof. Udgaonkar's perspicacity, was in the establishment of a co-operative housing society in Vashi, in Navi Mumbai. Prof. Udgaonkar was the driving force behind the founding of the society in the early nineteen eighties, where many ex-TIFR members now live. He was the first chairman, and his guidance was invaluable, both in the formative stages and in the years that followed.

Prof. Udgaonkar's interest in physics education continues unabated even today. Earlier this year, I met him at the Homi Bhabha Centre for Science Education at a function organized at the end of a camp organized by the centre to train and select students for the International Physics Olympiads. Over the years, all of us in the TIFR family have benefited enormously from Prof. Udgaonkar's clear thinking, commitment and wisdom. Personally, I greatly value my association with him over the past four decades starting from my college days, and would like to wish him all the very best on the occasion of his eightieth birthday.

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# Handcrafting a future for tomorrow

*Prof. Prabuddha Ganguli*

Reminiscing on the decades gone by, I fondly recall my first meeting with Professor B. M. Udgaonkar, as an undergraduate student. We were a handful of students in Mumbai keen to explore the facets of science beyond our formal curriculum. An obvious option was to form a science study group with a mentor who would show us the path to tomorrow. "You should meet Professor Udgaonkar in TIFR and he is only a phone call away", said one of our teachers. What followed then is irreversibly etched in our minds.

A warm and encouraging voice at the other end of the phone invited us to visit the enchanting TIFR campus for a discussion. Then came the moment of truth... we were in Professor Udgaonkar's office engulfed by his calm reassuring warmth - a feeling that runs through me even as I re-live that exciting moment. Within minutes was born our National Science Talent Scholars' Science Study Group with an umbilical link to Professor Udgaonkar! Despite his intense academic pursuits and commitments in national S&T activities, he excavated time for the young hungry minds. His unstinting support and guidance in our most formative years when it was needed and mentoring us with the involvement of several faculty members in TIFR, gave us the unique platform to glimpse the exciting scientific landscape and chart our paths to the future. No words of gratitude are adequate to express our gratefulness to this man who has silently and continually been responsible for kindling the spark and fueling the curiosity flame in several hundreds of juvenile minds.

Years later I was one of those privileged few to have joined the graduate school in TIFR to pursue a PhD programme in the School of Physics. The TIFR campus opened floodgates of opportunities to proximate with Professor Udgaonkar. He steered our enthusiasm to contribute to developing science curricula and teaching materials and methods for implementation in diverse institutions in Mumbai. During the early 70's several catalysing factors were created in TIFR, which matured in an environment that was conducive for the evolution of science teaching programmes with intense involvement of many. Interestingly these efforts especially the passionate involvement of Dr V.G. Kulkarni's team in Mumbai's Municipal Schools, and astute visionary leadership of Professor Udgaonkar, went into fruition with the establishment of the Homi Bhabha Centre for Science Education.

The decade of the 70's also experienced the start of innovative activities in science education with TIFR connections, such as "Kishore Bharati" one of its activities being christened as The Hoshangabad Science Teaching Programme, The Satellite Instructional Television Experiment (SITE), and The Bombay Association for Science Education (BASE). For many of us who got involved with such

programmes, derived a lot of energy and vigour from Professor Udgaonkar, in addition to establishing viable infrastructure, the challenge was to garner appropriate resource persons and Professor Udgaonkar's contributions in this direction are noteworthy.

Professor Udgaonkar's innovative skills broke new grounds in the creation of innovative options within the University Grants Commission (UGC). He was able to break away from traditions and introduce a scheme in which faculty members from the Delhi University could go on a sabbatical for extended periods under the UGC to participate in the Hoshangabad Science Teaching Programme thereby creating a sustainable and formally recognised conduit for University partnering an educational programme in Rural India. This was the first step of its kind then in India. These initiatives have paved the way to a host of national schemes that followed.

The hallmark of a thought-leader and reformer is when he is able to seed his thoughts, nurture, grow and harvest them in irrigated and un-irrigated minds. Working with him closely on several occasions was a treat as we were able to experience his insight into situations as he saw them, strategies as he crafted them, implementation plans as he sewed them in place and above all giving all he did a soft but determined human face.

An ignited mind continually radiates to influence the environment. Professor Udgaonkar is a legend with a difference - man so kind and approachable ever willing to give everything from his garden of choicest thoughts and experience to anyone with a mission.

The world of science and education has been enriched with his immeasurable contributions and we pray to The Almighty to continue showering him with good health so that our world continues to derive inspiration from Professor Udgaonkar for all the years ahead.

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# My Colleague

***Dr. P. K. Iyengar***

Udgaonkar and I were colleagues at TIFR in the early 1950s. That was the time when Homi Bhabha recruited non-PhD holders in Physics each year, to be trained in to research and form the backbone of the work of the DAE. This was in contrast to the concepts in higher education practiced by the university system at that time. It is therefore not surprising that Prof. Udgaonkar who joined TIFR with an M.Sc degree, has shone so well in theoretical physics, elementary particle physics, physics education and in promoting new applications of science in social life. It was a unique opportunity for many of us to freely discuss, take lecture notes from highly qualified visiting professors at TIFR, and start working in experimental physics with a modern emphasis on local instrumentation, and try to do everything we can, for the first time in the East of the Suez!

I have personally known that Home Bhabha liked Prof. Udgaonkar and respected his abilities. He sent him abroad on several missions, the first one being to Saclay in Paris, to the French AEC. Here he became an expert in theoretical reactor physics and built up a group in that area. This group eventually, under B.P. Rastogi, moved to Trombay and became the Theoretical Physics group in BARC.

It is a pleasure to remind oneself that this familiarity, steadfastness in pursuing the interests of the country in the field of atomic energy has continued and Prof. Udgaonkar has supported BARC immensely in every instance of major events. He had, of course, wider interests, which resulted in the seeding of the Homi Bhabha Centre for Science Education, and activities in the UGC and in the Planning Commission. I want to remind people that it is the quality of pure science that enables one to rationally analyse situations and take the right decisions that makes one's life worthy of emulation.

I am happy to contribute this small reminiscence on the occasion of the 80$^{th}$ birthday of Prof. Udgaonkar.

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# My Reminiscences of Professor B. M. Udgaonkar

*Dr. S. K. Joshi*

It is a satisfaction and pleasure for me to go down the memory lane and record here some recollection of time spent with Professor B. M. Udgaonkar over a period of four decades. The memories of times spent in the company of friends and scholars like Udgaonkar are a harvest of old age for me.

When did I first meet Udgaonkar? The first time I saw him was in the summer of 1966 at the Argonne National Laboratory (ANL) in Chicago. I had gone to Argonne as a summer visitor from the University of California (UC) at Riverside. I was a visiting lecturer at UC Riverside during 1965-67. In summer of 1966 I saw an announcement of a seminar by B. M. Udgaonkar at Argonne. Udgaonkar was then heading the Theoretical Physics group of the Tata Institute of Fundamental Research, Mumbai, a national centre for basic research. The topic of Udgaonkar's seminar (Regge Poles Phenomenology) was quite outside the domain of my interest (Solid State Physics), but I went to the seminar because Udgaonkar whose name I heard back home was the speaker. His seminar was well received and after the seminar there was prolonged discussion. Because of my shyness I did not go to him and introduce myself, and most probably he did not notice me also.

Our next meeting was some four years later at the University of Roorkee (UOR). I had joined Roorkee University in 1967 straight from University of California, Riverside as Professor of Physics and Head of at the Department at a relatively young age of thirty two years. Due to the dedicated effort of young faculty members of the Department who were a motivated lot, the Department very quickly earned quite a reputation for research and teaching. The department hosted the 1969 Nuclear Physics and Solid State Physics Symposium of the Department of Atomic Energy from December 28 to 31, 1969. Professor Udgaonkar also came to Roorkee during the symposium because he was already interested in problems of higher education. He wanted to visit universities and understand the problems faced by them. He organized an evening session in Roorkee symposium for a discussion on how to strengthen Physics research in India. The session was successful and participants suggested the formation of an Indian Physics Association (IPA) to deal with issues of research and education in Physics. The Indian Physics Association was finally formed in 1971 and Professor Udgaonkar was the obvious choice for leading it as the founder President. The Association started publication of Physics News, a quarterly with Udgaonkar as editor. Frontier fields of physics were presented in a simple language for students. Editorials of Physics News written by Udgaonkar touched on national issues, and were popular with the readership. The Indian Academy of Sciences, under the leadership of

Professor S. Ramaseshan had improved the content and quality of journals brought out by it. The Indian Academy of Sciences in collaboration with Indian Physics Association and Indian National Science Academy decided to publish a journal of physics called Pramana.

Udgaonkar started writing and lecturing on education and development, and challenges of higher education. It was in the fitness of things that he was appointed a member of the University Grants Commissions (UGC) in January 1973 for a period of three years. He came to the commission as a member from the best centre of fundamental research in India, that is TIFR, Mumbai, and he had had extended stays at the topmost institutions in the world like Institute for Advances Studies, Princeton, Lawrence Radiation Laboratories, Berkely, Centre d' Etudes Nuclear, Paris etc. He, therefore, persuaded the Commission (UGC) to constitute Programme Advisory Committees (PAC) for different disciplines, whose mandate was to promote quality teaching and research, in universities and to sanction research projects to teachers with speed.

The first Physics PAC was chaired by Udgaonkar and I was a member. Thus started our close and lasting affinity. Working with him in the PAC was an education for me. A large number of schemes for promoting research and quality teaching were introduced by Udgaonkar . Whenever I came with good suggestions, he encouraged me and implemented them through a Commission decision. Udgaonkar very actively participated in setting up of Homi Bhabha Centre for Science Education (HBCSE) at TIFR. Today this centre is serving the cause of promotion of science education in an admirable way.

I got an opportunity to work with Udgaonkar again from 1983 to 1990, first in the Department of Atomic Energy (DAE) Committee which recommended the take over of Institute of Physics (IOP) Bhubaneswar by the DAE, from the State government. Udgaonkar was the first Chairman of the Council and I was a member from 1985 to 1990. His chairmanship and Professor Trilochan Pradhan's leadership of IOP put it on the way to becoming one of the leading centers of research in physics in India.

I learnt a lot from the meetings he chaired. He showed how it pays to be a patient listener. He was always soft spoken and persuasive, critical and analytical. He was friendly but firm. He was objective in his decisions. He expressed his opinions clearly and honestly but with a spirit of courtesy and humility.

I shall always cherish my association with Professor Udgaonkar during the seventies and eighties. May God Almighty make him live a 100 years and we pray for his health and happiness.

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# Our Dear and Revered Senior Colleague

***Prof. (Dr.) S. S. Kapoor***

Prof. Udgaonkar was my teacher of Quantum Mechanics in the training school of the then called AEET-Atomic Energy Establishment Trombay. But the memory of those lectures is still quite vivid in my mind, which speaks amply about how good and influential a teacher he is. It is then not surprising to me that he has distinguished himself not only as an eminent scientist, but also as an outstanding educationist by making a mark on science education in the country through his innovative contributions.

During these last five decades I have had many occasions to talk and interact with Prof. Udgaonkar. In particular, during the period of 1983-89, when Prof. R. P. Sharma and I were engaged in the setting up of the BARC-TIFR Medium Energy Heavy- Ion Accelerator (MEHIA) facility at TIFR, I had more frequent interactions with him, and had greatly benefited by his encouragement and guidance. In those days, he was providing us much motivation to see that the super-conducting LINAC booster, which was being set up indigenously is successfully completed. I am sure he will be very happy to see that today the MEHIA facility has become a world class heavy-ion accelerator facility, and the TIFR has become a renowned centre of heavy-ion accelerator based research.

Prof. Udgaonkar has not only been a distinguished research scientist in theoretical physics, but has also left a deep impact in the field of science education by his valuable contributions to the cause of improvement in the quality of science education in the country. Of course, taking a lead from his work, there is a lot which yet needs to be done to improve the quality of education in the country. I hope the upcoming conference will also address itself to these issues to arrive at some concrete suggestions for the future.

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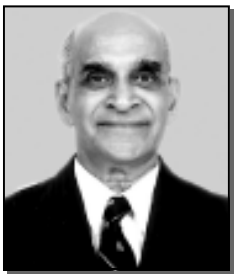
# Professor B M Udgaonkar – An Erudite Educationist at Heart!



*Dr. P. J. Lavakare*

I came to know Prof. Udgaonkar first at the Tata Institute of Fundamental Research (TIFR), when I started my research career in the sixties. At the time he was already a recognised authority in theoretical particle physics at the institute. Not being a theoretical physicist myself, I never had the opportunity of working with him. But over the years, I noticed that apart from his research activities, he had started taking a lot of interest in teaching, particularly at the postgraduate level. It is this aspect of his personality that attracted me to him much more and I started interacting with him more in this area where I found a common wavelength with him.

It was rather unusual, if not appalling, for a research scientist from TIFR to be taking interest in University education, where unfortunately research was not the focus of the academic life. Prof. Udgaonkar took a lead in trying to bring TIFR scientists closer to the higher education scene in Bombay University. He fought a long battle to bring TIFR closer to education in India. This surely would have affected his concentration in research. But in the end his concern for education was recognised by the management. TIFR took a bold step in setting up the Homi Bhabha Centre for Science Education. Efforts of Prof. Udgaonkar and late Dr. V. G. Kulkarni, who spearheaded the Centre, came to fruition with the setting up of this Centre. The Centre is now playing a major role in encouraging science talent and science teaching in the country. We owe to Prof. Udgaonkar, our sincere gratitude, for this unique contribution to the country.

Over the years, as I left TIFR, I continued my association with Prof. Udgaonkar in an altogether a new facet of his career. His interests in Science had by now expanded beyond Research and Education. He was looking at Science and Technology as a tool for national development. He got deeply involved in the International Pugwash Movement of world scientists who were concerned about the misuse of Science and Technology that had threatened world peace. This movement was initiated by great men like Bertrand Russell and Albert Einstein, who appealed to humanity to look at science as the means for promoting peace and advocated disarmament at global level.

Prof. Udgaonkar was attracted to this new implication of Science and took active part in the Pugwash Movement together with several other Indian scientists from the country. He was always very outspoken at these Pugwash conferences and often criticized the western world for showing a sense of hegemonic attitude

towards the ownership of science and not showing adequate concern for the developmental needs of the third world countries. He took the Pugwash agenda beyond the disarmament issues and highlighted the importance of development of the third world countries through Science and Technology. He pointed out the inadequacies of the methods of collaboration, between the developed and the developing countries in the field of Science and Technology. In his strong commitment for international collaboration, he wanted the world to follow guidelines that would be equitable to all. He went ahead and involved some of us in formulating and convincing the western world to adopt the now well-known "Pugwash guidelines for international collaboration in Science and Technology".

Prof Udgaonkar has been very erudite and forceful in his writings, which could not be easily ignored by the western world. I do hope that the spirit of 'Science Education with Research' that Prof. Udgaonkar has evoked on the Indian Science scene will continue and I am sure he will have a lot more to contribute to this field as he enters a new stage of his life in his eighties.

Without his knowing perhaps, he has been my 'guru' when it comes to Science Research, Education and Development. On my birthday today, I have the pleasure in writing these few words and accepting this role that Prof. Udgaonkar has so beautifully outlined.

I wish him a long life and hope he will continue to write many more of his forceful treaties on various issues related to Science.

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# Thank you Prof. Udgaonkar for your investment in the students

*Dr. Sanjay S. Limaye*

Sometime during early 1968, I was called into the office of Prof. V.T. Chiplunkar at the Institute of Science in Mumbai. Although I had no reason to worry, being called into the office of the Head of the Physics Department was somewhat unusual. Not entirely immune from the age appropriate tendency for mischief, I was nevertheless a good student, and so I walked into his office wondering what the reason could be. Prof. Chiplunkar, in his calm steady voice explained that he had received a visit from Prof. Udgaonkar of the Tata Institute for Fundamental Research (TIFR) in Colaba to invite bright students for a once week opportunity to interact with the physical scientists and engage in Physics projects, and would I be interested in going. This was such a wonderful chance to visit TIFR not just once, but weekly was so exciting, that I immediately said yes. After almost forty years, I can see that this impacted my own career in a way that I would have not predicted myself then.

Unlike most other students of the time, I had a somewhat different, perhaps fortunate background. I had joined the Institute of Science through a happenstance that was in itself, somewhat unusual. Having been schooled in Delhi, I was not able to enter Delhi University or any other engineering colleges (e.g. the IITs) after Higher Secondary for technical reasons. Having been selected for a National Science Talent Search Scholarship offered by the Govt. of India, my parents allowed me to leave home and enroll in Bombay for college to pursue science instead of engineering when I was barely sixteen. Coming from a scientifically literate family (both my father and grandfather were research chemists), scientific research was not new to me, but Physics was. The culture of research had changed in the years since the grand days of Physics, from being more individual to group oriented as the required facilities were expensive to build and maintain. And in the previous summer, I had attended a Summer School for Science Talent Scholars in Bangalore, which had further raised my curiosity in Physics, particularly Radio Astronomy – a topic, which was being researched at TIFR.

The weekly visits soon started – there were just a few of us – a few from the Institute of Science, and S. Krishnan from Ruparel College. We would board the white (BARC-TIFR) shuttle bus near Oval Maidan and ride to the institute, or take the BEST Route 123 to R.C. Church and go to Navy Nagar. The first visit to TIFR was quite memorable – first arriving at the Guard Cabin by the road – who must have wondered what four young lads were doing there, and then entering the beautiful well kept grassy open space by the sea – it was visually very attractive indeed. The building itself presented itself an example good architectural design with visual appeal contrasted with the grand somewhat gothic stone building that housed the Institute of Science. I don't recall much of the

first session with Prof. Udgaonkar, and Prof. Yash Pal, but remember them introducing to the staff and informing us that we could visit the cafeteria, attend seminars at TIFR and could participate in some small projects on our known with their guidance. We were mostly interacting with the High Energy Physics Group, which was undertaking high altitude balloon flights for detection of cosmic rays. Then young scientists, S.V. Damle, later a Professor at TIFR and R.K. Manchanda were two with whom I had many encounters much later at conferences in my career.

One of the problems that I initially tried to solve was an optical one – the geometry of particle tracks imaged at close distance in a glass cylinder from two orthogonal directions. The cylinder was one of two identical glass chambers with aluminium plates at each end and an outlet on the wall, to become a bubble chamber (first developed by Luis Alvarez, who later was awarded the Nobel Prize in Physics for it. Later, he became more famous along with his geologist son, Walter Alvarez and other colleagues for the discovery of the Iridium layer at the cretaceous-tertiary, or KT boundary that led to their suggestion of an asteroid impact nearly 65 million years ago). The particle tracks created from elementary particle interactions with the fluid in the chambers would leave bubbles, which would be photographed by two cameras, and the task was to re-construct the three-dimensional path from images of the bubbles along the track. I recall having intense discussions with Abhay Ashtekar about the impact of parallax, being somewhat more experiment oriented, whereas he preferred far theoretical problems. We had an opportunity to experience the "lab culture" bay having to work with the technical staff in the workshops located in the basements as well as attending the scientific seminars – (one the more challenging and tedious seminars I recall attending in the packed auditorium was one given by Sir Fred Hoyle, which in itself was somewhat educational, although in ways he would not have guessed!).

While there was no formal program, these visits exposed me to many aspects the culture of research in physical sciences and had the opportunity to observe closely the dedication, the persistence and the joy of success. Experiences that even having grown up with access my grandfather's chemical research laboratory, I was not able to experience as I was a mere child then. These experiences were useful in my career in exploring the solar system through space exploration.

The foresight of Prof. Udgaonkar and his colleagues in investing in the youth was extra ordinary indeed at the time in what was after all, a government laboratory. Given the present greater need for capable scientists for India's numerous research laboratories, such efforts are essential for attracting young, talented students to the field so that the investment in them produces a tangible return that will impact the country. The contribution of their expertise, knowledge and time was very valuable indeed, and I am grateful for the opportunity. There was certainly no hesitation on my part to impart similar opportunities to high school students when it became possible for me to do so. Beyond that, the communication of exciting research and exploration results and working with teachers for professional development has become routine for me. I find it inspirational that Professor Udgaonkar is still engaged active at the Homi Bhabha Centre for Science Education. It is a pleasure to thank him on the occasion of his 80$^{th}$ birthday.

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# My Greetings to Bhal...

*Dr. Jayant Narlikar*

I am happy to associate myself with the happy occasion when friends and admirers of Bhalchandra Udgaonkar are celebrating his eightieth birthday. I am proud to count myself as one of them. As I will be abroad at the time of celebration, I am sending my greetings to Bhal in advance of the occasion.

My association with Bhal dates back to the late sixties. I had seen his name on the scroll of honour at Mumbai's Institute of Science, in a list that carries names of my father and Homi Bhabha. But the chance to meet him arose when I dropped in to see him at the Tata Institute of Fundamental Research (TIFR), on one of my visits from Cambridge. I was then contemplating joining TIFR, and had found that a discussion with a scientist already working there might be useful. Indeed I found the chat useful in forming my overall picture of what life in Mumbai, working in TIFR would be like.

When I joined TIFR, I was given an office on the fourth floor next to Bhal's and it was always a pleasure to drop in on him for some advice or other. For, I found him to be a fountainhead of experience and wisdom. In his views he was quiet but firm: not offering them unless specifically asked for. We discovered an older link. I was trained in the campus of Banaras Hindu University and there my family knew Bhal's in-laws. His father in law was the distinguished historian A. S. Altekar, and Shreedhar, ASA's youngest son had been my school-mate.

As I got to know TIFR better, I began to appreciate the role Bhal was playing as a senior faculty member. Whereas most of our colleagues were concerned only with their own research, very few of them realised or appreciated the importance of teaching. Bhal was one of the latter. He took interest in the graduate school programme, planning courses, interacting with research scholars, and also in the initial interviews that selected them. Sadly, the then constitution of TIFR did not permit interaction with undergraduates. But still Bhal kept in touch with the bright physics students from Bombay University. Even today I meet (now distinguished) scientists who had interacted with Bhal as undergraduate students.

As a member of the University Grants Commission, Bhal had to deal with important policy issues of universities. There he brought to bear on the problems the inputs from working in a research institute like TIFR. In the UGC, such inputs are always valuable whether in matters of degrees, courses or syllabi.

He was always trying to build bridges between universities and TIFR. I was associated with the teaching collaboration between Pune University Physics and TIFR in the mid-1980s. This involved selection of some bright students for the Pune University M. Sc. Physics course, awarding them scholarship and also having some TIFR scientists teaching courses in the M. Sc. programme. I believe Bhal

lectured on dynamics while I took the course on electromagnetic theory. This involved spending 3-4 days in Pune each week, staying on the university campus and interacting with the students. I found the experience exhilarating and was sorry that the programme did not continue for various reasons. I think one of the reasons was that the TIFR faculty did not share enough enthusiasm for such teaching.

I think it was Bhal's active encouragement at the other end of the student spectrum that led to the flourishing of the Homi Bhabha Centre for Science Education. Aimed at school education, the Centre concentrates on teacher training in science, the writing of good textbooks and enhancing the role of experiments. With Bhal on the Governing Board, the Director of the Centre, V. G. Kulkarni could reach out for higher and higher aims.

I end this tribute to BMU by recalling his successful presidency of the Marathi Vidnyan Parishad, when he introduced several new programmes and diversified the scope of activities of the Parishad. This was one instance of his concern for bridging the gap between the ivory-tower scientist and the common man. Although he worked a lot for enlightening the general public he himself shunned publicity and was more comfortable working from sidelines.

I wish him many years of active and satisfying life ahead.

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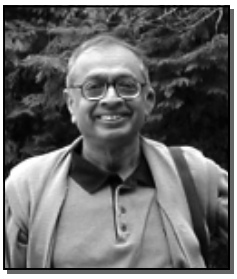
# Prof. B. M. Udgaonkar - A "Live Wire" personality



*Prof. S. B. Patel*

It was the year 1966. Some of us at the Ramnarain Ruia College had fallen in love with Physics and took admission to the M.Sc. class, with Nuclear Physics as our special subject. One day, our teacher, Prof. R. D. Godbole, called some of us aside and told that we shall be meeting Prof. B. M. Udgaonkar, Head of Theory Group at the TIFR, to discuss aspects of our M. Sc. programme in physics. There was no University Department of Physics then and we had to run from one college to another to attend the lectures….. and sometimes all the effort would be wasted as for some reason the lecture could not take place. We met Prof. Udgaonkar at his Anand Bhavan residence and unburdened ourselves! His charming personality captivated us and from that day he became our friend and mentor. He took our "outburst" (read opinions) very seriously and his positive attitude filled us with a sense of hope for the future.

Prof. Udgaonkar around that time was also a member of the UGC and played a very active role in the commission. I remember once when in the UGC office in Delhi, I had an opportunity to talk to Prof. Rais Ahmed who was then the Vice Chairman of the UGC. At the mention of Prof. Udgaonkar's name his face lit up and he said spontaneously "Prof. Udgaonkar is the most live-wire personality I had ever come across!" As I saw more facets of Prof. Udgaonkar's personality, I realized how true the words of Prof. Rais Ahmed's were!

Prof. Udgaonkar's contributions to the functioning of the UGC were enormous. The FIP (Faculty Improvement Programme) for college Teachers was essentially his baby. As a precursor to the FIP, he introduced the Sabbatical Programme for college physics teachers in Mumbai, under the UGC umbrella. A college physics teacher could thus get an opportunity to spend an year or more at the TIFR and get involved in frontline research. The UGC would pay salary of the substitute teacher appointed by the college, during the entire programme. Some of us, thus got an opportunity to earn a Ph. D. in physics from the TIFR graduate school and we could feel an academic breeze blowing in the corridors of colleges affiliated to the University of Mumbai. I must add here that Prof. Udgaonkar insisted on completing all the course work requirement of the TIFR graduate school, before even thinking of getting registered for the Ph. D. programme! This clearly shows his penchant for quality.

Prof. Udgaonkar realized that the quality of education depends critically on two pillars: one quality of the teachers and two the degree of autonomy given to the teachers and institutions. He pushed the idea of "Autonomous colleges" through the UGC. This great step gave an opportunity to many colleges to raise the standards of their academic efforts through the academic freedom given to teachers to be innovative and responsible.

Many teachers could achieve their full potential. Unfortunately, so far, colleges in Mumbai have not been able to take advantage and academic initiatives, in this visionary effort, pioneered by Prof. Udgaonkar and his colleagues at the UGC.

Another very exciting activity initiated by Prof. Udgaonkar, in which many of us got involved, was the "Wednesday meetings" at the TIFR. Every Wednesday, many of us—mainly college teachers—visited TIFR and after attending the colloquium, Prof. Udgaonkar conducted a session in which we discussed quantum mechanics. Each Wednesday, one of us would prepare a short presentation on a topic from the "Quantum Mechanics" by Merzbacher and our group of about 15-20 would discuss it with Prof. Udgaonkar, who also could persuade some of his colleagues at TIFR to participate in the discussions. These discussions were exciting and some time would even go on for 2 or more hours. Everyone enjoyed this activity and looked forward to Wednesdays. Even senior teachers like, Prof. R. D. Godbole, Prof. V. M. Palekar and Prof. Madhu Dandavate (who became the cabinet minister for railways in the Janata Govt.), participated in these Wednesday meetings with great enthusiasm. Prof. Udgaonkar, strived hard to raise standards, wherever he went. It is due to his encouragement, I could get involved in post-doctoral research at the Lawrence Berkeley Laboratory, University of California at Berkeley. My research involvement at TIFR and later at Berkeley, changed my entire outlook towards research and teaching.

Later in 1972, he could persuade his colleague, Prof. M. C. Joshi to join the newly formed University Department of Physics at the Kalina Campus of Mumbai University. In fact he was the moving spirit behind the launching of the Department. How some of us wish that the University had accepted all his suggestions at that time by showing academic flexibility—by capturing his vision, we could have reached far greater heights!

Prof. Udgaonkar is a great, highly motivating teacher. In the second year of our M. Sc. programme he taught us some aspects of particle physics, and I vividly remember his beautiful exposition of the "boot-strap" idea, a frontline topic in those days. He could motivate many of his colleagues from TIFR and BARC to participate in teaching, e. g. Dr. Ajay Divetia, who designed and headed the Cyclotron project at Calcutta, taught us a course on experimental physics. The establishment of the Homi Bhabha Centre for Science Education is another testimony of Prof. Udgaonkar's relentless efforts in the field of education.

On the occasion of his 80$^{th}$ Birthday, I would like to salute Prof. Udgaonkar and wish him and his family a very good health and active life ahead.

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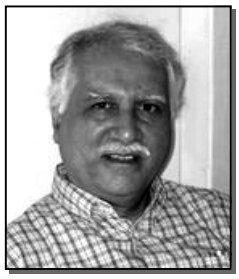
# Fine Human being

*Dr. Bal Phondke*



I distinctly remember when I first met Prof Bhalchandra Udgaonkar, though I am not sure he does. But then how could he? For I was one among some fifty odd Physics trainees from the fourth batch of the Atomic Energy Training School whom he had come to teach Reactor Physics. He was to give a series of lectures on that topic which was new to us. We were a mixed bunch drawn from all over the country, some from renowned universities others from newly established ones in the hinterland. While most of us had already acquired a master's degree some others had joined straight after their B. Sc. Still. none of us had studied Reactor Physics till then. This was because the discipline was so new that it had not yet been included in the university curricula. Even on the world stage it was still being developed.

Yet, Prof Udgaonkar made it all sound very simple. His talks were very lucid and easily comprehensible though he had not compromised on the rigour anywhere. He captivated us all and the topic soon acquired an aura of enchantment. He was able to convey to us all the thrill of this still emerging discipline and its utter charm. He was able to infect us with his own enthusiasm and excitement. I did not realise it at the time but with the benefit of hindsight I now see that he was able to achieve what he did because he enjoyed studying the field himself. More importantly he took pleasure in teaching. When the series of lectures came to an inevitable end I was at once glad and sad; glad because I had just experienced how a true master can inspire his disciples and sad because that dream-like experience was over. It is entirely due to his teaching that I have not forgotten the elements of Reactor Physics theory even after almost fifty years when I first learnt them. Nor have I forgotten that enthralling experience.

It was only later that I learnt that it was not his field of active research that being theoretical particle physics. Had I chosen that I would have continued to meet him from time to time. But after graduating from the Training School I opted for Biophysics and went away from TIFR as also from interaction with Prof Udgaonkar.

Interestingly our paths crossed again when I had left BARC and active research to take up journalism. My decision to leave BARC and accept the invitation to become Chief Editor of Science Today was one of the most difficult one in my personal life and professional career. It had not gone down well with my scientist colleagues. To a man everyone had warned me that I was committing professional harakiri. That was because most scientists then looked down upon science popularisation. They thought that it was demeaning of a scientist to stoop down to that level.

Prof Udgaonkar was among the very few who actively encouraged me and complemented me. He said that he wished more would follow. For, he considered science popularisation as

science education by other means. It was a non-formal form of education according to him, He said that everyone thinks that boys and girls in the class rooms alone are students to whom science has to be taught. Nothing can be further from the truth. Science, he said, has to be a way of life. Its constituency, therefore, extends far and wide. Planners, policy makers, legislators, industrialists, entrepreneurs, bankers, housewives, man in the street and scientists too, just about everyone needs that education. His encouragement and advice helped me chalk out a new and different profile for the magazine and take it to a wider readership. Throughout all this his love for science and science education became very apparent.

Prof Udgaonkar is one of those rare persons who has shunned the limelight and has preferred to do seminal work quietly and by remaining in the background. Thereby, he has made those whom he gave his unstinted support excel and give off their best. I hope that he would be around for a good many years more to build another generation of thinkers and intellectuals.

There are a number of qualities that he possesses that have remained unappreciated due to his unassuming and humble disposition. But above all he has always impressed me as a very transparent and fine human being, a species that is seriously threatened with extinction.

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# Professor B M Udgaonkar and HBCSE

*Prof. H. C. Pradhan*

It was between 1965 and 1970, in the middle of a thriving research career, that Professor Udgaonkar started taking active interest in education. This, I believe, arose out of his deep social commitment, which was moulded as he was growing during the days of India's freedom struggle. This commitment combined with his experience at the leading institutions in the U. S. , where universities are the main seat of research, and hence research and higher education are integrated, propelled him. Prof. Udgaonkar was responsible for the growth of the graduate school and the Visiting Students' Research Programme (VSRP) at TIFR. It was natural that this interest soon extended to development of graduate studies at the University of Bombay, where he had studied for his B. Sc. and M. Sc. I was a M. Sc. student at the university around this time and I distinctly remember how excited and thrilled my fellow students and I were, when at the behest of our teachers, Prof. Udgaonkar gave two lectures on elementary particles for us. I also recollect the conversation we had with him about our M. Sc. course at the university and the surprise and dismay he felt when he came to know that even twenty years after independence the university of a premier metropolis of the country did not have an independent Department of Physics and that M. Sc. courses at the university were being run by affiliated colleges with students hopping from one college to another for their lectures, just as they did when he himself was a M. Sc. student almost two decades earlier. Thanks to his efforts, a Department of Physics did get established at the university four years later.

His restless and ever-questioning mind led Prof. Udgaonkar to think of the comprehensive problem of improvement of science education in the country, and this drew him to school education. With the help of Prof. V. G. Kulkarni and Dr. R. G. Lagu, colleagues at TIFR, he began organizing innovative teacher-training programmes for municipal schools of Mumbai. The Homi Bhabha Centre for Science Education (HBCSE) grew out of the need for institutionalizing these efforts. Sir Dorabji Tata Trust generously supported the new venture. Prof. V. G. Kulkarni decided to forsake his burgeoning research career in nuclear physics, gave up an impending visiting position in Canada and became the founder-director of the Centre. This is the genesis of HBCSE. The Centre owes its existence to Prof. Undgaonkar's vision and efforts. Established in 1974, the Centre was supported as a project by the Sir Dorabji Tata Trust until 1981, when the Department of Atomic Energy, Government of India took it over and it became a part of TIFR. Over the years HBCSE has grown to be a unique centre in the country devoted to the cause of science and

mathematics education. Acclaimed nationally as well as internationally, it has diverse activities, principal among which are teacher-training, student talent nurture, curriculum development and research. These activities are guided by the twin principles of equity and excellence cherished life-long by Prof. Udgaonkar.

To complete the story one must add that Prof. Udgaonkar was, while setting up and nurturing HBCSE, simultaneously pursuing his interest in higher education. He was a member of the University Grants Commission (UGC) and was responsible for the establishment of many teacher and student training and other need-based programmes at the UGC including the setting up of the Western Regional Instrumentation Centre at the University of Bombay.

Professor Udgaonkar was the Chairman of the Homi Bhabha Centre from 1975 to 1991. He was the mentor to Prof. V. G. Kulkarni, who continued to be HBCSE's Centre Director up to 1994. At every stage when HBCSE took a major initiative, be it an academic project or be it setting up a new campus, Prof. Kulkarni sought Prof. Udgaonkar's guidance and counsel. He helped Prof. Kulkarni to move to a new location at Nana Chowk when HBCSE's activities grew up beyond what could be accommodated in three rooms of TIFR. Similarly, when at the next stage of expansion of activities, HBCSE dreamt to set up its own new campus, without Prof. Udgaonkar's active intervention the dream could not have became a reality. The search of a site for the new campus went on for almost five years. HBCSE's impressive campus at Anushakatinagar stands as a testimony to the untiring efforts Prof. Udgaonkar and Prof. Kulkarni took for all these years.

One of HBCSE's major projects in the initial years was the language project. Under this project, textbooks of science for classes V, VI and VII prescribed for Marathi medium schools by the State Government of Maharashtra were rewritten with only their language simplified and nothing else changed. These rewritten books were printed and used in a large number of municipal schools of Mumbai covering about 15, 000 students. The results of this educational experiment proved beyond doubt the merits of simplified language in textbooks: Not only did it improve students' comprehension of the subject in a major way but also, it changed for the better the classroom communication between students and teachers which substantially depends on the textbook. Prof. Udgaonkar was the inspiration behind the project. He was instrumental for the initiation of another project concerning an issue close to his heart. This was the SC/ST project, in which three successive batches of about 40 SC/ST students from municipal secondary schools of Mumbai were given academic and motivational inputs for a few hours once a week, over an extensive period (three years for every batch). The result convincingly demonstrated that if those inputs, which are available form their homes to students from privileged sections of the society, are given to the SC/ST students. They do equally well.

It was again Prof. Udgaonkar who suggested a then young member of the Centre, now Prof. Jayashree Ramadas, to take up research in learning, in particular, study of the

work of the famous cognitive psychologist, Jean Piaget. HBCSE today has a very active research programme in cognitive science. Prof. Arvind Kumar, the present Director of HBCSE, conducted for thirteen years without a break a unique talent nurture programme for undergraduate students in physics, the Homi Bhabha Study Circle, in which the students used to meet for a 4 -hour session per week to discuss and solve problems in core areas of physics such as quantum mechanics, classical mechanics, electromagnetic theory and thermodynamics. The study circle was a precursor to the later eminently successful student talent nurture programme of HBCSE like the Olympiad programme and the National Initiative in Undergraduate Studies (NIUS). The idea of the study circle came from similar efforts of Prof. Udgaonkar. He had conducted a similar programme earlier at TIFR.

Prof. Udgaonkar has an innate sense of moral responsibility, which he has meticulously guarded throughout his life. Even during his long tenure as Chairman of HBCSE, since he was not a member of the staff of HBCSE, he never interfered with HBCSE's day to day activities. After his retirement from TIFR in 1991, he handed over his Chairmanship to Prof. Virendra Singh, Director TIFR. Prof. Udgaonkar maintains regular contact with HBCSE and is always available to us for advice and discussions. We all seek his counsel and considered opinions on a variety of matters, academic and non-academic. Yet till today Prof. Udgaonkar's principle of non-interference has operated unfailingly and immaculately.

His eminence as a distinguished senior scientist and educationist of the country has lent all HBCSE's activities a kind of credibility. But this has never found expression in his behaviour, not even in any casual conversation. In fact, it is his eminence combined with his sense of social commitment and moral responsibility and his genteel manner of expressing them, that attracted Prof. V. G. Kulkarni and Dr. R. G. Lagu earlier and Dr. Arvind Kumar later to the endeavour of science education. This charisma, if I may say so, continues even to date, though without ever being explicitly evident. Younger members of HBCSE regularly keep discussing and consulting Prof. Udgaonkar about their projects and research, and this includes diverse topics such as history and philosophy of science, theories of learning, activities in school science and mathematics laboratories and Olympiads. We, all members of HBCSE, feel fortunate, proud and privileged to have Prof. Udgaonkar with us. We wish him continued fulfilling, active life for many many more years.

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# In Support of Reason
# A Tribute to Prof. Udgaonkar

*Dr. Vinod Raina*

The lament in Pete Seeger's persuasive song of the 60's – 'Where have all the flowers gone?' – continues to nostalgically haunt many who plunged head first in support of peace at the height of the cold war's frightening portents of violence that exemplified soon after the second world war, by insane deaths in Vietnam. The lingering feeling of the imminence of brutal use of science that continued to persist post August 1945 when Hiroshima and Nagasaki became the indelible symbols of the destructive power of technology stirred many to seek sense and restraint within the scientific enterprise. Prof. Udgaonkar and his involvement with Pugwash symbolised that.

The proponents of the use of science for improving the conditions of the poor and marginalised, and as a source of 'reason' that had the potential of countering bigotry, prejudice, superstition, hatred, intolerance and religious violence were most forcefully voiced by Meghnad Saha. Unsurprisingly this came to be known as Nehruvians rather than Sahaites given the fierce support Nehru had for the scientific enterprise, and of course his exalted stature. In this first decade of twenty first century, as science has advanced as never before, we are witness to a bewildering phenomenon, of the undiminished brutality of science in support of war – in Bosnia, Iraq, Afghanistan and elsewhere. Also the increasing retreat of reason in a World is dominated by religious fanaticism, and the commodification, privatization and marketisation of science for personal profit rather than for public good. Reason enough, perhaps, to turn to that pro-reason lyricist, Javed Akhtar, to pen a new song – 'Where have all the Nehruvians gone?'

Well not quite 'all' since we have Prof. Udgaonkar amongst us. This conference in his honour signifies that an endangered species the Nehruvians might have vanished. Perhaps not! He, along with Prof. Yash Pal would perhaps rank as two infectious 80+ 'young' romantics who in spite of all the destruction and violence that engulfs us; a lot aided by advancements in science, have refused to part with the hope that science can benefit, both in improving the conditions of the deprived masses, and as a fountainhead of reason, to confront irrationality and injustice. If some find their romanticism naïve, so be it, since the World would seem to have a great deal of need for precisely such naiveté.

The advances in Soviet science were conclusively demonstrated by it winning the space race with the launch of the Sputnik in 1957. In spite of having many tiers of cordial relationships, many of these advances did not travel to India directly from the USSR, perhaps because of language barriers and came through the West. One of them was to spread reason, rationality and the method of science at the grass roots through science education. After the initial attempts in Bombay municipal schools,

the effort took roots in the far away Hoshangabad district of Madhya Pradesh through a series of coincidences to which Prof. Udgaonkar was central. A generation, or more, younger than Prof. Udgaonkar, I was initiated into the Hoshangabad Science Teaching Program (HSTP) from its beginning in 1972, while pursuing research. Since I was working for a physics Ph. D. , he, as an established physicist in fields similar to what I was working in was already like a distant guru to me (I was at Delhi University while he and Yash Pal were both at TIFR in Bombay). Summer courses in theoretical physics were an avenue for distant gurus and chelas to come together during those days.

But I got to know him more closely because of the HSTP. As a staunch supporter of the initiative, he along with the other pro-reason 'Nehruvians' like Yash Pal, P. N. Haksar, Obaid Siddiqui, M. G. K. Menon, Arjun Singh, Rais Ahmed, D. Balasubramaniam, Pushpa Bhargava amongst others, played a key role in the evolution and expansion of HSTP. For many of them, who may not otherwise have been involved at the grassroots on a day-to-day basis as many of us were, HSTP was perhaps much more than a school science program. It was more like the fulfillment of the nationalistic dream of spreading reason and rationality across rural India. Perhaps unknown to him, Prof. Udgaonkar's unflinching support to what we were doing, many a time in hostile situations, was a source of immense strength and inspiration. This was because often the oceans of irrationality and prejudice, at the governmental and societal levels would depress us and yet we had to wade through.

His most active support, however, came at the time of founding Eklavya. By 1980, eight years after the programme was initiated, a small group of us were prepared to resign our jobs and give up science research careers to work full time to spread the HSTP beyond Hoshangabad, and bring reason and rationality in teaching social sciences and language too. For this it was decided that a new group, later on called Eklavya, should be set up. But we had no clue where we would get funds and other support. There were other doubts too. Would expansion greatly reduce the quality of HSTP, rendering it ineffective?

We went around the country meeting supporters to seek their advice. I distinctly remember some of us meeting Prof. Udgaonkar for this purpose in a room where he was staying at the CSIR Guest House next to the scenic Lodhi Gardens in Delhi. As for the fear of dilution, his advice was candid – "Till the slope of the quality of the effort is even marginally greater than that of the mainstream system, go ahead. Don't clamour for higher slopes in the beginning, you can't work on that premise in large systems". And he energetically helped in the effort to raise funds and other support – from the DST, UGC and other agencies. Finally, through an initiative of M. S. Swaminathan, who was a member of the Planning Commission then, and M. G. K. Menon, the then Secretary, Department of Science and Technology, DST agreed to provide founding finances to Eklavya in 1982, using the logic that since Madhya Pradesh did not have a State Council for Science and Technology then, the new Institute would temporarily fulfill that gap.

As I said earlier, most of the Nehruvians looked at HSTP in a much larger perspective than a school science programme. As a consequence they were prepared to fund from the Government; an institution none of the

Government bodies would have any administrative control over! Such faith in autonomy was soon to be tested in 1984 when the gas disaster claimed thousands of lives in Bhopal, where Eklavya was headquartered. While being funded by the DST and working in collaboration with the Madhya Pradesh government, Eklavya took on the science establishment and the MP Government openly for their professional, administrative and legal lapses in the biggest science-society issue ever faced in peace time. Later, Eklavya exposed the technical flaws in another major National initiative, the Narmada dams. All this while HSTP was running in the government schools of MP! It is people like Prof. Udgaonkar, who must be given tremendous credit for creating, nurturing and supporting an environment where differences based on reason and logic were encouraged, and hypocrisy, intellectual dishonesty and sycophancy were shunned.

Because of such positions that Prof. Udgaonkar held in relation to science-society issues, it was not a matter of dispute when twenty six people's science organisations came together in the aftermath of the Bhopal gas disaster to invite him to become the National Convenor of the Bharat Jan Vigyan Jatha in 1987. This was the biggest event since independence for linking up with the masses throughout the country on issues of development and reason. When the five national Jathas converged at Bhopal in November that year, with 7, 000 science activists in a historic assembly, it was the leadership of Prof. Udgaonkar and his insistence on inclusiveness that encouraged the various organisations to look beyond a loose and friendly tie-up. Consequently, the All India People's Science Network, a formal federation of science groups of the country was formally inaugurated next year in 1988 at its first Congress in Cannanore (now Kannur), with Prof. Udgaonkar as its founding President.

The pre-independence nationalist scientists like P. C. Ray, Mahendra Lal Sarkar, Meghnad Saha, amongst others, laid the foundation for viewing science as something beyond a laboratory pursuit, an ivory tower preoccupation. In post-independent India, Prof. Udgaonkar would rank amongst the foremost, a person who not only dreamt but also worked to utilise the political independence from colonial rule in order to create a self-reliant and rational India. As the twenty-first century progresses, with science advancing in leaps and bounds but getting divorced from human progress and with definite signs of retreat from reason, the value and contributions of persons like him appear greatly amplified.

A true tribute to him would be to work harder to reverse the current trends in the relation between science and society and strive for human progress based on equality and democracy, the precondition for both being a society based on reason and logic.

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# A Devoted Educationist

***Prof. Rama***

Bhal Udgaonkar had already been at TIFR for a couple of years when I joined. At that time, the Institute was small, and every body knew every body. My interaction with Bhal was minimal initially, both professionally and socially. But 40 years together in a small place is indeed a long time. Gradually, things became better, we developed general interest in each other's work and social gatherings became more frequent. I observed that Bhal, unlike some other friends, was not used to dramatising. He was not quite the quiet type either. His utterances were sober and well researched.

Towards the later part of his career, he developed interest, I should say; devotion in matters of wider national importance where even a small contribution means a lot.

I would like to point out one incident for which I should be grateful to him. One afternoon, he called me and said, "We have initiated a programme aimed at providing research exposure to bright young college students during their vacation time. Would you like to take one student?" And I said, "Yes". I was thinking of developing a new type of Neutron Moisture Gauge at that time.

Within fifteen minutes after the call, a boy named Palekar came to see me. I explained to him what I was planning, and gave him some literature on the subject. Next morning, he came with the drawing of the apparatus. It was good. I told him to go to the workshop and get it made and let me know if he required any help. After five or six hours he came back with a nice looking housing ready to take the components in. How he managed this, I do not know and I never asked. I was amazed and much impressed; ready to proceed further but Palekar did not turn up for a week. Instead, there came an envelop containing the papers that I had given him and a letter of apology that he will not be able to carry out the project since he was sick and was advised bed rest for six months. By then a bond of understanding and affection had already developed between the two of us. I made some suggestions /offers which he declined. He studied at home for six months and still he topped the M. Sc. (Prev) exam of the University and again topped the M. Sc. (Final) exam the following year. Our association continued for about two decades. Thanks to that call from Bhal Udgaonkar. I wish Bhal well. And also Palekar wherever he is.

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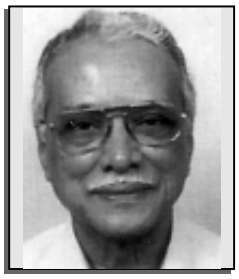

# The Doyen of Science Education in India

*Prof. Abbas A. Rangwala*

I first met Prof. Udgaonkar in 1963 when he came back to TIFR from USA. Prof. Udgaonkar's reputation had preceded his return and I was hoping that I would be able to pursue my Ph. D. degree under him. I approached him with some trepidation but he put me at ease and agreed to be my guide. He was more than my Ph. D. guide; I consider him as my mentor. He was always accessible and considerate, even affectionate. I got my degree under him in 1968-69.

During the period I was working for my Ph. D. , he often discussed teaching in the universities and University of Mumbai (then University of Bombay) in particular. At that time there was no University Department of Physics in the University of Mumbai and there was some talk of establishing one. The teaching at master's degree in the University was carried out by pooling together teachers from various affiliated colleges; the theory classes being conducted in the evenings and at different colleges on different days. I have some recollection that Prof. Udgaonkar was one of the persons the University authorities were consulting for the creation of the department. But for some reasons the University was dragging its feet, which used to annoy him. Finally, the University Department of Physics came into existence in early 1971 with Prof. M. C. Joshi of TIFR as the Head of the Department. The first set of recruitment of teachers was carried out in October 1971 and three of us who joined, Prof. Arvind Kumar, Prof. H. C. Padhi and I, all had done their Ph. D. work at TIFR.

Prof. Udgaonkar's interest in teaching at the university level was there almost right after his return from USA. Often he would quite seriously ask questions like, "Why can't we have universities like Harvard, MIT, Stanford or Berkeley? What prevents us from creating such universities?" He was also concerned about the kind of physics textbooks and ask, " why can't we have a course like Berkeley Course in Physics?" I remember his once telling me that he would consider J. D. Jackson's book on Classical Electrodynamics as equivalent to 20 research papers. I believe it was in the early 1970's that he was on UGC's planning committee and there he was instrumental in getting funding for various universities for research and teaching. I also believe that he was the prime mover in the introduction of University Leadership Programme (ULP) instituted by the UGC under which University Departments would get funding both for training teachers in the colleges as well as creating faculty positions in the University Departments which were to be regularized in the next five year plan. Our Department was one of the early beneficiaries.

There are two events of that period that stand out in my memory in which

Prof.Udgaonkar was one of the central figures. The DAE had sanctioned money (10-15 crores) towards creation of a Pelletron facility. Prof. M. C. Joshi was keen that this facility be housed at the Mumbai University campus at Kalina. Prof. Udgaonkar and others, from their experience of dealing with the University, were skeptical about the University's capability of handling this kind of project in view of its rigid bureaucratic structure and outmoded accounting procedures. The Pelletron finally came up on the TIFR campus and the University lost its bid.

The second event of 1970 was of more academic nature. The falling standards of teaching and research, which have recently attracted considerable attention in the elite scientific circle, was realized by Prof. Udgaonkar and some others way back in the 1970's. In an effort to improve these, TIFR approached University of Pune and the TIFR-Pune University joint teaching programme in physics was initiated. At that time I had asked Prof. Udgaonkar as to why TIFR by-passed University of Mumbai which was in the same city. His reply, based again on his familiarity with the academic bodies of the University, was that the University of Mumbai lacked the academic flexibility required for such a programme and that, he thought, University of Pune was more flexible in its academic outlook. Thus though Prof. Udgaonkar had close association with both the Mumbai University and the Department of Physics, he never let his emotions overtake the rational; he always kept in mind what was in the best interest of a project or a goal.

In the year 1981 our Department celebrated Decennial Year of its establishment and, among other activities, the Department planned a series of ten lectures. The first speaker in this series was none other than Prof. Udgaonkar. In this lecture he ranged widely over roles of universities, research institutions and the UGC in teaching and research; a cause to which he had very ardently devoted his time and energy since early 1970s.

The crowning achievement of Prof, Udgaonkar in the area of education, in my opinion, is the establishment of the Homi Bhabha Centre for Science Education. I believe he put all his weight and authority behind its establishment and the Centre is now the premier institution of its type in the country. It has provided sterling service primarily in the field of school education. But there are others who are better placed to write about this glorious achievement of Prof. Udgaonkar.

Prof. Udgaonkar's concern for science education and research has spanned over 40 years and I salute him for his unwavering enthusiasm and tireless pursuit to follow his dream and vision.

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# A Hundred Years of Particle Physics

*Dr. D. P. Roy*

It all started with the Rutherford scattering experiment of 1911, bombarding á particles on gold atom. While most of them passed through straight, occasionally a few were deflected sharply. This is like shooting bullets at a hay stack and finding that one of them deflects sharply to hit a bystander or to put in Rutherford's own words - 'deflects back to hit you on the head'. This would mean that there is a hard compact object hiding in the hay stack. Likewise this experiment suggested that there is a hard compact nucleus inside the atom, surrounded by the electron cloud. Later, in the thirties the nucleus was found to be made up of protons and neutrons. They are bound together by the strong nuclear force mediated by the exchange of ð meson, just like the nucleus and electrons are bound in an atom by the electromagnetic force mediated by the photon. Now, one can easily see from the energy-momentum conservation that the exchanged mass between the interacting particles has to be imaginary ($m^2 < 0$), while of course photon and ð meson have real mass. But such exchanges are possible in quantum theory, thanks to the Uncertainty Principle, ÄE ~ h/Ät, which allows nonconservation of energy over a limited time scale. Quantum field theory gives an equivalent prescription, preserving energy-momentum conservation but changing the mass-square of the exchanged particle continuously from positive to negative values, which is called its virtual mass. Prof. Bhabha was one of the pioneers in this field. In fact he is responsible for giving the name meson, since the ð had an intermediate mass between the electron and the proton or neutron. These latter ones are called by the generic Greek names lepton and baryon, meaning light and heavy particles respectively. He started the tradition of particle physics in India in the late thirties and continued it into the fifties along with his experimentalist colleague, Prof. Menon.

This tradition was carried forward by Profs. Udgaonkar and Virendra Singh into the sixties. This was the era of hadron physics. Hadron is a collective name for both types of strongly interacting particles, mesons and baryons, having integral and half integral spins respectively. Several dozens of mesons and baryons with various masses and spins had been discovered by then. It was clearly not tenable to describe them all as fundamental particles. Nor was it possible to identify a few as fundamental ones, of which the others would be composite states. Even the mass hierarchy was not relevant, since for strong interaction the binding energy can be as large as the rest mass energy, so that a relatively light particle can be a bound state of two heavy ones. This lead to a new paradigm, which their mentor and the leader of this school, Prof. Chew from Berkeley, called "Particle Democracy". That means there is no distinction between constituent, composite and exchange particles; each hadron plays all the three roles. Thus in contrast to atomic and nuclear physics, where one uses the masses of the constituent and exchange particles along

with their couplings to compute the masses and couplings of the composite states, one could determine here all these masses and couplings in terms of one another using a set of consistency conditions. This was the Bootstrap principle. Of course in practice one had to make certain simplifying approximations, which determined its range of applicability. Both Profs. Udgaonkar and Singh had achieved international distinction in this field.

When I joined Prof. Udgaonkar as a Ph.D. student in 1964, I had already published a paper in this area. But he explained to me that this is a well explored area, whose merits and limitations are pretty clear by now. So he suggested me to work instead on Regge poles, which was still relatively new and hence potentially more interesting. The basic idea of Regge poles is as follows. We have seen that the exchanged particle has a negative mass-square, which varies continuously with the kinematics of the interacting particles. The spin of the fundamental particles, however, remain unchanged. In contrast, for composite objects the spin increases with mass as we know from atomic or nuclear physics. The same should hold for hadrons. So the spin of the exchanged hadron should go down continuously with its virtual mass-square and eventually become negative. This object of simultaneously varying spin and mass-square is called Regge pole. The Regge poles provide a simple and predictive model for high energy scattering of hadrons. Prof. Udgaonkar had done an elegant analysis of high energy scattering cross-sections using Regge pole exchange in the previous year with Prof. Gell-Mann from Caltech. But having suggested me this field he left it entirely to my own devices to explore it to find suitable problems and solve them. However, he used to sit down with me to go through the drafts to appraise himself of the results and help me in improving its presentation, highlighting the main points with precision and clarity (without ever consenting to put his name on them of course). I am indebted to him on all the three counts. Firstly, Regge poles became a thrust area of particle physics for a decade. And independence in research gave me confidence to move into the new era of particle physics, which took over the field thereafter. Finally the presentation skills I learned from him were essential in an intensely competitive field like ours, in order to get one's works read and taken notice of, particularly from a far off place like India.

The new era of particle physics was triggered by the electron-proton scattering experiment of Stanford in 1968, which was similar to the Rutherford scattering experiment, but at a much higher energy. And the result was also similar. While most of the electrons passed straight through the proton, occasionally a few were deflected sharply. This suggested that the proton itself consists of three hard and very compact particles called quarks. The name quark was adopted from a James Joyce novel by Prof. Gell-Mann, who had envisaged these constituents only as a mathematical device to simplify the description of hadrons. But this experiment showed them to be real physical objects. This was followed by many other experiments of this kind, which showed that all the hadrons are composed of quarks. In other words they are simply "quark atoms". Moreover the basic strong nuclear force binding these quarks is a long-range force mediated by a massless particle like photon, called gluon (for its binding property). The short-range ð meson exchange force, binding protons and neutrons in a nucleus, is similar to the residual Van der Waals force between atoms, which binds them in a molecule.

We know now that there are three pairs of quarks: up, down, strange, charm, bottom and

top. Similarly there are three pairs of leptons: electron, ì and ô along with their associated neutrinos. The lightest pair of quarks, up and down, are the constituents of proton and neutron. So together with the electron they constitute all the visible matter of the universe. The heavier quarks and leptons decay into the lighter ones via the weak nuclear force and so do not occur freely in nature, just like the heavy trans-uranium elements. But they can be seen in cosmic ray or particle accelerator experiments. The neutrinos are stable and come from many sources - accelerators, cosmic rays, atomic reactors and the sun - but are relatively hard to detect because they have only weak interaction. All these particles have spin half and are collectively called matter fermions. We have seen them all by now, the last one being the top quark, which is about 200 times heavier than the proton. Likewise we have seen the carriers of all the three basic forces, which are all spin one particles called gauge bosons. While the photon and gluon are massless particles, the carriers of the weak nuclear force, called W and Z bosons, are about 100 times heavier than proton. These matter fermions and gauge bosons constitute what is smugly called the Standard Model of particle physics. But the picture is not complete yet. A consistent theory of their masses requires a spinless particle in the mass range of W, Z and top called the Higgs boson. We hope to find it at the large hadron collider (LHC) nearing completion at CERN, Geneva. Moreover it is widely believed that one needs a Supersymmetric extension of the Standard Model in order to control the Higgs boson mass in the above range. This predicts a host of Supersymmetric particles in the same mass range, which could also be found at the LHC. But this prediction is less compelling than that of the Higgs boson.

Finally we have seen one clear evidence of physics beyond the Standard Model. It comes from the neutrino oscillation experiments, showing that the neutrinos have tiny but nonzero masses, over a billion times smaller than the other fermion masses. A simple and elegant explanation of this comes from the so called See-Saw model. It assumes the neutrinos to have both left- and right-handed chirality states like the other fermions. However as the latter ones carry charge, their left- and right-handed states have the same mass because of charge conservation. But since the neutrino has no charge, the right-handed neutrino can acquire an ultraheavy mass from a lepton-number violating interaction, which is over a billion times higher. This in turn pushes the left-handed neutrino mass over a billion times lower. This is why it is called See-Saw model. There is a lot of current interest in studying the ultralight neutrino masses because they provide indirect evidence of physics at an ultraheavy mass scale, which could not be probed directly in any foreseeable future. Moreover the lepton number violating interaction, operating at this mass scale, can explain one of the longstanding mysteries of nature, i. e. why is there such an excess of baryons and leptons in the universe over their antiparticles. This is evidently a very important matter as it underlies our very existence in the universe.

Let me conclude with a popular saying that the only way you can repay your debt to your parents is by passing on the same care and guidance to the younger generation. I have tried to repay my debt to Prof. Udgaonkar through my humble contribution in carrying forward the national tradition into this new era of particle physics, in collaboration with the younger generation. How far I have succeeded in this will be judged by the latter.

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# Learning with BMU

*Prof. Kailash Rustagi*

It is with great pleasure that I recall my association with Professor Bhalchandra M. Udgaonkar. For over 40 years he has been and continues to be a role model. Although my 'job' at TIFR was over when I finished my Ph. D. in 1970 my association with BMU has continued and I have never hesitated to seek his advice or even take up an issue with him. He has been a teacher, a mentor, a very patient and sympathetic listener – someone you could always count on! Somehow one knows that one will be taken seriously and straightforwardly. Sometimes after a meeting you may come back with a broader perspective even if not wiser! There was always that other possibility that you might have overlooked. I first met Professor B. M. Udgaonkar some time in July 1965 when we were looking for placement options after completing the one year course at the Atomic Energy training school. Then as now he inspired confidence. To put things in perspective, then, as now, this is an important time in a career in DAE except that in those days TIFR also took their young researchers from the Training school. When I first met him I wasn't quite sure what I wanted do, but an apparently easy and serious discussion with him was enough for him to ask me to see Professor S. S. Jha, who equally thoughtfully explained to me what this "new" field of nonlinear optics is. I think both had received sort of good reports about me from Prof Sengupta, who had taught us in Training School. Both were very open minded and precise, offering no career inducements except a good chance to become a good physicist. Yet it inspired confidence that you would be cared for and that you were with excellent teachers. It felt good joining. TIFR building was then new, very comfortable and posh! To keep our feet grounded the hostel was equally bad, much better for the pigeons who shared the rooms with us! In the next few years, I saw BMU some times as head of the theory group mostly with some "student" complaint and always had a feeling that I have been listened to and something will be done even if no promises were made! In retrospect, it is clear that you were "guided" without appearing to. He taught us an excellent course on Relativistic quantum mechanics giving glimpses of the high standards in clarity and depth. As a physics teacher he was incisive and provided great insights without the hype. Today, many of us feel we have been lucky to get this feeling of quiet confidence and high standards that these early years in TIFR gave us and BMU was very much one of those who transmitted this feeling! Perhaps, the most interesting interaction with BMU was an initiative that he took in 1968 or so. He had some bright young students from Mumbai colleges come to TIFR once a weak for Physics discussions. Quite like what Prof Arvind Kumar has been doing in the last two decades or so. We, i. e. these B. Sc. students and some of us, the Ph. D. students,

and BMU would sit in the seminar room AG80 and solve some problems from Feynman lecture notes. Some of these students, Abhay Ashtekar and Mustansir Barma among them, have since made a name for themselves! Personally I think it was wonderful in enhancing our vision because the discussions were forever probing. BMU would intervene only to point out yet another implicit approximation or another twist to the problem or to clarify or emphasize the point made by one of us. Among other things, this was also when I learnt that teaching and learning are two sides of the same coin. Surely, it was a model for conducting tutorials! Nearly four decades have passed and still when I met BMU in a seminar recently there was a chit from him with a penetrating question! Same smile and the same incisiveness. Some things never change and we are indeed grateful for that.

In between I sought his advice once every few years, read with great interest his editorials in Physics News and had many discussions with him on the tea table and elsewhere. Preparing for a talk some time ago, I read these editorials again. It is striking how much of good sense there was in those editorials- thoughtful, honest and provocative. Also there was no hidden agenda and no give-me-this !

To sum it, thank you very much Professor Udgaonkar for being what you are. Here is wishing that you may continue to enjoy good health and continue to inspire new generations of scientists, students and teachers for many years to come!

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# Prof. B. M. Udgaonkar – My Dada

*Dr. Virendra Singh*

When I joined the theoretical physics group at TIFR in 1957, as a young research student, the institute was located at the Old Yacht Club at the Gateway of India. Bhabha was the only Professor of theoretical physics but he was much too preoccupied with setting up Atomic energy establishment laboratories to directly interact with young students. I first met Kundan Singwi, who was looking after the group, and, at his suggestion, I met Udgaonkar. He immediately decided to take my studies in hand. To begin with, he asked me to go through the delightful Yale lectures of Enrico Fermi on "Elementary Particles" which were full of his special "back of the envelope" calculational tricks, of which he was a master, to get the order of magnitudes estimates of physical quantities. Thus began our long fruitful association.

Udgaonkar next asked me to calculate pion angular distribution in hyperon decays. I found that the distribution does depend only on the hyperon spin but not on its parity, a result he had himself derived few months earlier but where others had scooped him. All the same it made me feel that I was getting into the current research. I then undertook a systematic study of elementary particle physics and of quantum field theory. By the end of two years in the group, I had published two independent research papers; one on pseudoscalar meson theory in Nuovo Cimento and the other on ground state energy of a Bose gas in the Physical Review. Udgaonkar felt that the time was ripe for me to go to a research group, active at the frontiers of the field, in USA to do my Ph. D. for further development. I was sent to Berkeley, where Geoffrey Chew was the leader of a very dynamic S-matrix research program, to work in his group.

Udgaonkar also came to Berkeley, after about one year, to work in the same group. We soon collaborated on a paper on pion-nucleon scattering and thus began a phase of collaborative research. He also published some papers by himself and one of these on high-energy total cross sections became quite well known. Apart from writing many joint research papers we also enjoyed a number of other activities. We, together with his family, took a number of memorable car trips to visit various nature parks on the west coast of U. S. A. including Yellowstone, Mount Zion and Bryce Canyon and Yoshemite. In a lighter vein I recall a culinary experiment by him. He emptied a can of "cream of mushroom soup" into some rice and let it bake in the oven. It turned out delicious. It was at Berkeley that started calling him Dada (and his wife, Padma, as jiji). I also became attached to his two young children. Eventually many others also came to address him as Dada as it somehow seemed appropriate to do so.

From Berkeley he went to Institute for Advanced Study, Princeton, while I went to join Gell-Mann's group at Cal. Tech. Pasadena

for one year so that we were exposed to different research atmospheres. After that he came back to TIFR, while I did that after spending one more year at Princeton in 1964. During our stay in U. S. A. we had innumerable discussions on how to develop a strong and leading theoretical physics group at TIFR. After coming back we devoted our energies fully to this task. Within three to four years he passed the responsibility of looking after the theoretical physics group to me. I did that for some twenty years. Our active phase of research collaboration extended over 1960-66 and was very fruitful. It covered Regge Pole theory, bootstraps and symmetries and other S-matrix topics.

Around mid sixties, Udgaonkar started getting involved with the problems of science education and science development in the country. Later his interests further diversified to include problems of world peace. As member of University Grants Commission of India, and as a member of Pugwash committee he played influential role in these new areas as well. Prof. Udgaonkar analysed the problems of science and society also with the same kind of rigour as needed in any other scientific research problem. He has always tried to live a rational life. He also has an unusual talent to spot and assess future potential in young persons and did all he could to encourage them and realise their full potential.

Prof. B. M. Udgaonkar has been a teacher, philosopher-guide, research collaborator and a friend to me for about half a century. I am happy to pay my tribute to him and wish him and his family all the best in coming years on his 80th birthday.

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# Professor B. M. Udgaonkar

*Dr. Bikash Sinha*

I first met Professor B. M. Udgaonkar while visiting TIFR in the early seventies from King's, London. To some of us he was a bit of a legend. He was a student of Homi J. Bhabha in theoretical physics; particle physics in particular, and of course a collaborator of Murray Gell Mann, the legendary "discoverer" (if that is the right word) of quarks. Of course there are no free quarks. At the time, however, he was already deeply committed to science education and dissemination of science to common people. However, all I remember of the brief encounter during my visit to India is his charming smile and inquisitive eyes.

Around 1976, I joined Bhabha Atomic Research Centre and almost immediately got very excited about Indian Physics Association and more specifically Physics News. I always enjoyed editing and seeking out articles for this kind of journal, at the Presidency College, Calcutta; at Cambridge, U. K. and now, I thought what a wonderful opportunity this was, IPA and Physics News.

Of course Professor B. M. Udgaonkar (BMU) was the central inspiration for such an "Indian" adventure for me, new and delicious. Together, we used to collect articles with great deal of persuasion and difficulty, trying to make Physics News more attractive and interesting.

If the lights down my memory lane haven't faded totally, BMU and I, once in a while used to go to the Printing Press in Sassoon Dock, cutting through the stench of Bombay Duck by sheer will power. None of us complained. I learned the tremendous joy of setting the press in tiny little metallic words (remember 1970's) making dummies and then ultimately the journal. BMU made me feel that the whole business is not only worthwhile but also exciting and very important.

I came to Calcutta in 1984 and lost touch with BMU. Curiously enough, my friends, if I can call them were actually of that age group, B. V. Sreekantan, BMU, young S. M. Chitre and so on.

During my frequent visits to Bombay from Calcutta once in a while I used to participate in those very intellectual coffee sessions on Sunday at the Jehangir Art Gallery with BMU, Professor Pandit and other TIFR faculty members – a most wonderful experience with a degree of intense spontaneity which I do not encounter today, just sheer joy of informed and intelligent conversation with no particular motivation.

Slowly but surely BMU faded away from TIFR to retire in Vashi, I hardly saw him except in occasional conferences at TIFR. I was delighted when I heard that his brilliant son got a good position at NCBS, Bangalore. The memory of the cruelest blow that Udgaonkars had to bear when their only daughter suddenly passed away in the U. S. flashed through my mind. It must be a source of satisfaction for both of them now that the son is in Bangalore and in a good faculty position, erasing somewhat the grief they bore all along.

I recall and will always remember Professor B. M. Udgaonkar as a person of sharp intellect and perception, charming yet tremendously persuasive, a man with a shy and engaging smile.

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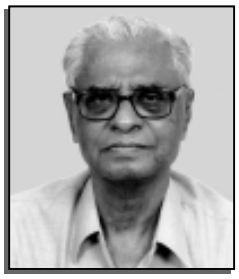

# Bhal Udgaonkar and the Pugwash movement

*Dr. K. Subrahmanyam*

Shri Ashok Parthasarathi, then convenor of the Indian Pugwash Society in August 1974, inducted me into the Pugwash Movement. I was then the director of Institute for Defence Studies and Analyses and he asked me to attend the Pugwash workshop on nuclear deterrence in Kyoto in Japan. Bal Udgaonkar was a much earlier entrant into the Pugwash Movement. In January1976 Madras Pugwash Conference, I did not come across him since he was perhaps in a working group dealing with development and technology transfer while I concentrated on the nuclear issue.

It was in August 1976 that I met him along with Ashok Parthasarathi as we travelled together to Muhlhausen in East Germany with an overnight halt at Amsterdam. As a severe diabetic I suddenly developed hypoglycemia on arrival at Amsterdam airport hotel. I remember the extreme solicitude displayed by both Ashok and Bal to look after me. They did not leave my side till I regained normalcy and had enough to eat. After Muhlhausen I met him in successive Pugwash Conferences and stuck up a strong friendship with a top ranking scientist who was by nature very amiable, a good conversationalist and radiated natural friendliness. Ashok, Bal and myself shared a common worldview on nuclear weapons. We were for total nuclear disarmament but so long as the weapons were in the hands of a few dominant powers Indian security imperatives demanded that India should keep its nuclear option open.

This view was anathema to the leadership of the Pugwash Movement. In those days they considered the Nonproliferation Treaty as their major contribution to international nuclear peace and stability. Contrary to the popular impression, the Pugwash movement at the time considered nuclear disarmament as utopian and arms control and mutual deterrence as the most pragmatic paths to global stability. I remember in 1982 in the Pugwash Conference in Budapest raising the issue of nuclear disarmament and one of the senior most leaders of Pugwash told me sternly "Subrahmanyam, for next fifty years there can be no talk of nuclear disarmament. " Most of Pugwash discussions on the nuclear issue took place within the framework of bipolar deterrence.

On this issue, there was significant agreement between US-led Western bloc and the Eastern bloc led by the Soviet Union. In such circumstances the Indian group often found itself as the lonely opposition. However, that did not dissuade us from expressing our views on the global nuclear hypocrisy. Ashok and Bal were from the scientific community and therefore had a wide-ranging interest in many subjects. Since I was the strategist, expressing opposition to the cartelised nuclear dominance, it became mostly my area of responsibility. By nature I am an assertive person and I usually call a spade a spade. The same is true of Ashok. Bal, on the other hand, was a person who never raised his voice, was always smiling and put across even the most controversial things in very low key.

Ashok as the convenor of the Indian Pugwash Society was represented in the Pugwash Executive Council. Again he used to play the role of one-man opposition in a largely like-minded group. When Ashok handed over the responsibility of the convenorship to me in 1980, I took his place in the Executive Council. I attended a couple of meetings of the Executive Council. It was at Budapest in 1982 that Dr Morton Kaplan the then Secretary-general of Pugwash approached me and suggested that they would like the Indian representative in the Pugwash Executive Council to be a physicist and whether they could have Bal. I jumped at the idea and readily agreed. What he was telling me was whether they could have the gentle, soft-spoken Bal instead of an assertive person like me. I also knew that Bal, in spite of his gentility was no pushover and could hold his own. So Bal became a member of the Pugwash Executive Council.

Even within Pugwash things began to change. There were people like Joe Rotblat, one of the signatories of the Russel-Einstein manifesto who always had a more progressive and flexible view on the doctrine of nuclear deterrence. By 1985 came the Gorbachev-Reagan declaration that a nuclear war cannot be won and should not be initiated. In 1986 Gorbachev joined Rajiv Gandhi to call for a nuclear weapon free and nonviolent world. By 1988 Rajiv Gandhi submitted his comprehensive Disarmament Plan to the UN Special session on Disarmament. Still, the mainstream opinion among the Pugwashites especially among those from Europe and North America was that nuclear deterrence was existential and the world had to live with nuclear weapons.

However, a major change took place by 1990 when the leading members of the Pugwash, Professor Joseph Rotblat, Professor John Steinberger and Professor B M Udgaonkar joined together to edit the book "A Nuclear Weapon Free World - Is it desirable or feasible?" It was brought out in 1993. Through this monograph the Pugwash joined the debate on the desirability and feasibility of a nuclear weapon free world, I am not privy to the discussions that took place among the contributors to the volume. But Udgaonkar argued the case vigorously for a nuclear weapon free world. Professor Rotblat also came out in favour and formulated the concept of societal verification to monitor a world free of nuclear weapons. This monograph will be a lasting contribution of Udgaonkar to the Pugwash Movement. It was also a recognition of long and patient arguments of Bal over the years within the Pugwash Executive council.

After the end of the Cold War and reduction of nuclear weapons in the arsenal of major powers international interest on a nuclear weapon free world diminished and the Pugwash itself was more focussed on Nonproliferation than elimination of nuclear weapons. Recently, however, in the light of the disclosures about A Q Khan's nuclear walmart and the possibility of nuclear weapons and materials falling into the hands of terrorists, interest has revived in nuclear weapon free world. Four well-known American Statesmen, Secretary of State Kissinger, Secretary of State George Schulz, Defence Secretary William Perry and Senator Sam Nunn, wrote an article in the Wall Street Journal on 4th January 2007, exhorting the US to take the initiative to move towards elimination of nuclear weapons. Bal Udgaonkar can recall with satisfaction his own plea some 14 years back.

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# Professor BM Udgaonkar – on his 80th Birthday

*Prof. Vijaya S. Varma*

It was the summer of 1967. I had just joined the Department of Physics of the University of Delhi as a CSIR Pool Officer after finishing my PhD in theoretical physics. I had also just got married. When I learnt that the Department was organising a summer school in theoretical physics in the salubrious climes of Dalhousie, I thought it would be a great opportunity for combining a honeymoon with learning new physics - escaping the horrors of a Delhi summer to boot. I therefore decided to enrol as a participant.

I have many happy memories of that summer school - making new acquaintances and reviving old friendships as I had been away from Delhi for 5 years working on my PhD. For a young Pool Officer, the high powered physics community that had gathered at Dalhousie was very intimidating company. Professor Udgaonkar was part of the group of participants from TIFR. It was his quiet, gentle manner which attracted my attention and among all the participants it was to him that I went for advice on a paper I was working on then on N/D relations. I had submitted it to the Physical Review Letters and it had been returned with the referees' comments which I didn't know quite how to handle. I decided to ask Professor Udgaonkar for his advice on what to do as he seemed to be the most non-intimidating participant of the summer school. Even though we had met for the first time at Dalhousie, he nevertheless carefully read through my manuscript. After two or three days he gently informed me that he thought the referees' comments were valid and that instead of contesting them I should carry out the program they were suggesting if I wanted the paper to be accepted for publication. In the event, I never actually published that paper, but that incident marked the beginning of my friendship with Professor Udgaonkar.

The next occasion on which we met was a few years later at another summer school, this time organised by TIFR. The then famous duo of Chew and Low were lecturing and I decided to attend. Professor Udgaonkar was again one of the participants and it was a pleasure to renew my acquaintance with him and get to know him better despite his quiet reserved ways. The school itself was relatively uneventful except for a cricket match between the TIFR crowd and the rest. It was played with a tennis ball on the forecourt of the hotel we were staying in, on what was a small shingle-covered clearing, probably meant for knocking a ball around. The TIFR team were determined to show the rest that they were the best but we of course had other ideas. The match was closely contested. When it came to my turn to bat, I found that the leg side boundary was invitingly close. So when

Professor Udgaonkar, who was one of the TIFR team's star bowlers, came on with his gentle spin, it was too big a temptation to resist hoisting him over square leg for a succession of sixes. I thought I was well on the way to scoring the first century of my life when Sharat Patil, the umpire chosen for the game, gave me out thinking the ball had hit the rock face at the back of the crease which was serving as the wickets, whereas it had only spun off the edge of my bat. Such unfortunately are the ways of life and I still dream of the century that ought to have been. The nice thing about the episode was that although Prof Udgaonkar's bowling, of which I think he was secretly very proud, received such harsh treatment at my hands that day, he did not allow it to affect our friendship in the slightest.

Since those days we kept running into each other at seminars and conferences either in Delhi or Bombay and I always made it a point to keep up my contact with him. Our association has been long but always low-key. We never spent any great deal of time discussing our research interests and we met not so much as professional physicists but as fellow practitioners of a shared discipline. We spoke more about the teaching of physics, particularly in schools, than about research in theoretical physics. Professor Udgaonkar was aware of my involvement with the development of the Physics curriculum for the Hoshangabad Science Teaching Programme and whenever we met he was always eager to learn about what had happened since our previous meeting. Although many of my colleagues thought it a waste of time and energy for research physicists to be involved in school education, Professor Udgaonkar by his reactions and his own interests clearly was of the opposite view. He certainly felt that professional physicists must engage with the problems of teaching science properly in schools, with adequate room for experimentation in the curriculum, so that one could attract and retain the best young minds to the practice of the discipline. In all my interactions with him, I always found him to be polite, unassuming and humorous — in fact the epitome of the perfect scholar gentleman. He was ever the unassuming academic and talking to him you were never made aware of the fact that he was a respected professor at one of the renowned centres of physics research in the country. It is only now that I realise that he is actually 14 years older than me because never in our meetings did he assume the mantle of the senior academic, always interacting with me on an equal footing. It has been a pleasure to recall and record my memories of our interactions stretching over so many years of our lives and I wish him all the very best on this occasion celebrating his 80$^{th}$ birthday. I am sorry not to be present at the celebrations on account of previous commitments that have meant that I will not be in the country at the time.

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# Prof. B. M. Udgaonkar

*Prof. Balu Venkatraman*

It is a pleasure to reminisce my association with Prof. B. M. Udgaonkar on his eightieth birthday. We had similar ideas on many aspects of scientific research and science education.

Prof. Udgaonkar and I were associated with our several colleagues in TIFR and the then AEET, during lecturing times at the Training School, which was started in 1957, the year I joined AEET, but placed in TIFR just as Prof. Udgaonkar was. Eventually both of us were transferred to TIFR. I believe he provided the leadership in the AEET training programme, and was chosen by Dr. Ramanna to do so, as even then he evinced keen interest in educational activities.

Though our fields of expertise were quite different, we shared many common interests, especially with respect to the young people who were joining TIFR. Those of us led by Prof. Udgaonkar were strong votaries of the graduate school programme in TIFR; it was a long struggle since many experimental programmes needed a large number of scientific assistants who were keen to attach degrees to their qualifications. Many of us felt that such needs can be taken care of by special recruitment and different types of recognition. The graduate school styled on the US model, with senior scientists participating in giving advanced courses, was felt by many of us to be a necessity in maintaining a constant flux of young minds, whose precociousness and vivacity would be a catalyst to maintain the institute at the frontiers of research.

Some of us were advocating that only a few of the successful graduate students should continue to be in TIFR and this was most unacceptable to many. We believed that inbreeding was detrimental for an institute like ours. Many experimentalists felt that this way their programmes, which by their very nature had long gestation periods, would not be viable. It took several years for the graduate school programme to stabilise. As a corollary, the TIFR-Pune University joint programme in physics also began and Prof. Udgaonkar was the main mentor for that. . In both, the TIFR and Pune University joint programmes the real problem was to find teachers – many were not willing. Some amongst us gave courses almost every year but I know a few who have never given a single course. Unfortunately the Pune programme had to close down mainly due to logistic reasons. Prof. Udgaonkar also played a catalytic role in placing some good TIFR scientists at the universities and IIT.

Prof. Udgaonkar, Prof. R. Narasimhan, Prof. R. R. Daniel, Prof. Yash Pal and a few more were invited by Prof. M. G. K. Menon to form a discussion group, which would meet every Wednesday evening. There was no fixed agenda but we used to discuss many aspects dear to us: education at school, college and higher levels; whether India should develop and test a nuclear bomb (Dr. Bhabha had then just made an announcement that India could test a nuclear device in a short time after a green signal was

given), population control etc. Both Prof. Menon and Udgaonkar were part of the Pugwash movement. We used to prepare position papers and Prof. Udgaonkar prepared one on the nuclear issue. One should recall that Prof. Udgaonkar was in the Reactor Physics group of AEET before he switched over to the theory group at TIFR.

We worked together for a few years as members of the Board of Research in Nuclear Sciences of the Department of Atomic Energy with him as Chairman. I was the Chairman of Basic Sciences Committee 1 of the Department of Atomic Energy. Again we found ourselves on the same wavelength and it was this committee, which initiated the Sir K. S. Krishnan career awards of the DAE. Late Dr. N. Satyamurthy and I were asked to review the existing scheme of DAE fellowships at the Universities which seemed to be not fulfilling their stated goals, and come out with fresh proposals to rejuvenate the existing system or replace it with a more purposeful one. After extensive discussions with many scientists including Prof. Udgaonkar, we came out with the career award scheme now in operation, and Prof. Udgaonkar supported it warmly.

Both, Prof. Udgaonkar and I participated in many of the activities of the Nehru Centre. Dr. H. N. Sethna was instrumental in roping us into this. Both of us were involved in organising a seminar on education in 1976. He also contributed a few articles to Science and Society, a monthly published by the Nehru Centre.

Finally I come to his contribution to School Science Education, which is dear to both of us. Many of us felt that unless school education is improved considerably, for all sections of the community, the real potential of the young mind would go untapped. We realised that it was a stupendous task; but that should not deter us from the little that we could do on a voluntary basis using TIFR's status as the focal point. After some discussions, a group of us decided to organise school exhibitions, lecture demonstrations at TIFR etc. and then BASE (Bombay Association for Science Education) with teachers from various schools and a few members from TIFR was formed.

Prof. Udgaonkar, Prof. Yash Pal and a few others like Dr. V. G. Kulkarni felt that we should get more directly involved in the educational planning and development of many aspects of the curricula of the school educational system. They were encouraged to do so by Dr. Madhuri Shah, the then dynamic Education officer of the Mumbai Municipal Corporation. She later on became Vice-Chancellor of SNDT University and Chairman of UGC. She gave the group led by Dr. Kulkarni and Prof. Udgaonkar an office in their Grant Road complex and this was the start of the Homi Bhabha Centre for Science Education. I do not remember when this name was given – from the beginning or later. Thanks to Prof. Udgonkar's strong patronage and Dr. Kulkarni's dynamism we now have a full-fledged educational research centre well supported by the Department of Atomic Energy. This is a fitting tribute to the abiding interest and the proactive role Prof. Udgaonkar has played in the cause of education, especially science education at all levels.

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# An Eminent Teacher

*Prof. G. Venkatraman*

My inability to contribute a written tribute in no way diminishes my profound respect for Prof. Udgaonkar, especially as a teacher, for I still recall vividly the extended series of lectures. He delivered them in the only auditorium TIFR had (in the OYC) at the time. I particularly recall his exposition of the way the graphite moderator is arranged in a graphite reactor. The particular point Prof. Udgaonkar made was that there were many corners where one could use less than ultra nuclear pure graphite and get away with it, because these corners had less weightage in contributing to neuron moderation. This was a very subtle point, not found in any book.

I do not know whether others attending those lectures appreciated this salient point, but as I was then closer to reactors than many, the exposition made a deep impression on me. All of which goes to show, professor's deep commitment to teaching, among other things. Apart from this, I also recall the mutual concern we shared over the years about the need to advance physics in India in a highly structured and integrated way, rather than in terms of merely impressive personal flashes. Prof. Udgaonkar understood better than many that a large part of the advances come through massive and highly structured collaborative efforts, as one sees best in CERN.

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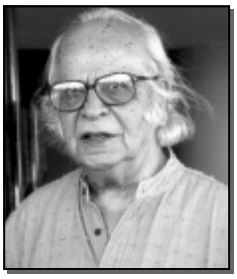
# Bhal Udgaonkar

*Prof. Yash Pal*



When I think of my science friends at the TIFR with whom I have enjoyed communing, the name of Bhal Udgaonkar pops up quite often. Bhal was a theoretical physicist while I worked with instruments and my theory was mostly confined to phenomenology. Having had exposure to a decent level of theory I enjoyed conversing with Bhal, but with little worthwhile contribution from my side. We had joined TIFR the same year and very soon our time was taken up with concerns for growing good science in India.

Bhal pointed out and I agreed that science in any discipline does not grow in a university department because viable groups of size beyond a critical level are not established. We thought that some concentrations of expertise were essential. This is one of the notions I later came to moderate and modify when I sought criticality not in a single department but in conglomerations like the Interuniversity Centres. But holding such discussions was an intense preoccupation for both of us.

Under Bhal's initiative we set up a continuing interaction with students and some teachers of Bombay colleges on a continuous basis. Students used to come to TIFR or, sometimes, we went out to give a set of lectures. It was very rewarding, many years later, to get the news that one of the student participants who had later become a very distinguished scientist recalled that these interactions had played a seminal role in developing his interest in doing deep physics.

Bhal was always engaged, a bit like me but with better capability of working out details. As head of the theory group he has to be congratulated for creating one of the best schools in theoretical physics. He sought out talent and nourished it. I often attended the theory seminars in which new emerging talent became visible. I found that one could spot talent irrespective of whether or not you fully understood what was being said. It seems amazing to say this but you have to develop a taste for excellence. This is very much the way that one can often recognise musical talent without fully understanding the Raga being elaborated. Many of the members of that group such as Virendra Singh, S. N. Biswas, Lalit Pandit, Rajasekaran, Chanchal Majumdar, N. Mukunda, Sudhanshu Jha and several others became much sought after and respected friends. Special culture of TIFR at that time created this possibility. Bhal was an important ingredient of that culture. Walking up or down a floor in the TIFR building to the third floor inhabited by the theory group and just to chat with any of them became a way of clearing cobwebs in the brain or borrowing excitement of new thoughts just emerging.

I will not talk of the basic science that Bhal did because I do not feel qualified in this regard. But I would like to remember a number of his other engagements.

Bhal was very active in discussions related

to the United Nations Conference on Science and Technology. His interventions on behalf of the developing world were heard with great respect. He was also a very active participant in the Pugwash Conferences.

Considering the depth of his knowledge and understanding and the intricacies involved in a field where science, technology and political and social matters were simultaneously operational I would consider him one of foremost experts to handle matter like the nuclear deal with the United States. It is a pity that his advice has not been sought.

For some years Bhal was a member of the University Grants Commission. It is my impression that it was on his insistence that UGC for the first time introduced a budget head to support science in universities. I was a beneficiary of his efforts when I went later to head the UGC.

Many working scientists felt that India lacked science Journals that were properly peer reviewed. Udgaonkar worked hard along with Ramaseshan and Indian Academy of Sciences, to launch the Physics Journal "Pramana". Several others followed.

Science education occupied our discussions perennially. In late sixties some of the activities in which Udgaonkar and I were involved along with several others, like V. G. Kulkarni, began to move forward. I had moved away but Kulkarni and Udgaonkar pursued this effort with singular dedication. It was primarily due to the efforts of Udgaonkar, assisted by VG, that "Homi Bhabha Centre for Science Education" was established. This has by now become an important and well-recognised world centre in this area.

I should not forget the fact that Udgaonkar was the Chairman of first major Science Jatha conducted in this country. This significant event was followed by a much larger effort in 1992 in which I was centrally involved. The role of these Jathas as scientific social movements has been important and many of the voluntary workers in this area were molded and honed in this activation, first led by Udgaonkar.

I cannot think of much of my life in science, particularly the area of science-in-society without entangling with the life and work of B. M. Udganokar.

I wish him many years of happy and active life.

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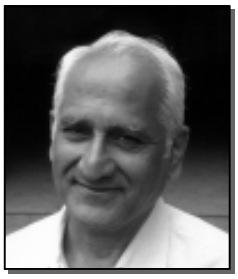
# तैलबुद्धी लाभलेले प्रा. उदगावकर



अ. पां. देशपांडे

भारताच्या प्राचीन काळात वसिष्ठ, वाल्मिकी, भारद्वाज असे अनेक ऋषी होऊन गेले. या ऋषींनी एकेका विद्येत पारंगत होण्यात आणि ती विद्या आपल्या वनातील आश्रमात विद्यार्थ्यांना-शिष्यांना मुक्त हस्ताने देण्यात आपले आयुष्य व्यतित केले. शिष्यही आपल्या गुरूची सेवा करून विद्या हस्तगत करीत. वसिष्ठ, वाल्मिकींचा काळ खूप जुना झाला तरी या विसाव्या शतकातही संगीत, आयुर्वेद, चित्रकला, शिल्पकला, मल्लविद्या या क्षेत्रांतील गुरुशिष्य परंपरा आपल्याला माहीत आहे. अशाच एकाग्रतेने विद्येच्या अनेक क्षेत्रात लीलया फिरणारे, आपले शिष्य तयार करणारे आधुनिक ऋषी म्हणून भालचंद्र माधव उदगावकर यांचे नाव आपल्याला बिनदिक्कतपणे सांगता येईल.

14 सप्टेंबर, 1927 रोजी प्रा. उदगावकर यांचा जन्म कराडला झाला तरी त्यांचे सर्व शिक्षण आणि आयुष्यभराचे कार्य मुंबईतच झाले. मुंबईला त्यांचे प्राथमिक शिक्षण महानगरपालिकेच्या शाळेत झाले आणि माध्यमिक शिक्षण हिंदू कॉलनीतल्या राजा शिवाजी विद्यालयात (किंग जॉर्ज हायस्कूल) झाले. तेथून पुढील महाविद्यालयीन शिक्षण एल्फिस्टन कॉलेजात आणि नंतर इन्स्टिट्यूट ऑफ सायन्स (पूर्वीची रॉयल इन्स्टिट्यूट ऑफ सायन्स) येथे झाले. तेथून ते भौतिकी विषय घेऊन एम.एस्सी झाले. इन्स्टिट्यूट ऑफ सायन्सच्या प्रवेशद्वारापाशी तिथे शिकलेल्या विद्यार्थ्यांची एक श्रेयनामावली लावली आहे. ज्यांनी मुंबई विद्यापीठांच्या परीक्षेत प्रथम वर्गात पहिला क्रमांक मिळवला. त्यांची यादी त्या फलकावर लावली आहे. त्यात होमी भाभा, एम.जी.के. मेनन, वि. वि. नारळीकर आणि भा. मा. उदगावकर अशी 8-10 नावे आहेत. आश्चर्याची गोष्ट अशी की उदगावकरांच्या नावानंतर तो फलक 2006 सालापर्यंत कोरा होता. नंतर त्या संस्थेत गेल्या 50-60 वर्षात अशी मुले झाली नाहीत की अन्य काही कारण घडले ते समजत नाही.

प्रा. उदगावकर मॅट्रिकच्या परीक्षेत विद्यापीठात दुसरे आले होते. 'होय तेव्हा एस.एस.सी. नव्हते. शालान्त परीक्षेला मॅट्रिक म्हणत आणि ती परीक्षा मुंबई विद्यापीठ घेत असे. 'बी.एस्सी.' आणि एम.एस्सी.ला विद्यापीठात ते प्रथम वर्गात पहिले आले होते. एम.एस्सी. झाल्यावर पुढे काय करावे हा प्रश्न होता. बँकेत जावे असा एक पर्याय तेव्हा होता. बँकेतले पगारही तेव्हा चांगले होते. पण पगाराचे आकर्षण उदगावकरांना केव्हाही नव्हते, अगदी त्या तरुण वयातही आणि बुद्धीचा पल्ला असा होता की ते कोठेही तळपले असते. पण त्यांच्या काही शहाण्या सुरत्या नातेवाईकांनी 'तू भौतिकी घेऊन एम.एस्सी. झालास, विद्यापीठात पहिला आलास, तेव्हा बँकेत न जाता तुझ्या शिक्षणाचा उपयोग होईल अशा विषयातील शास्त्रीय संशोधनाकडे वळ' असे सांगितले. बँकेत जावे की शास्त्रीय संशोधनाकडे अशा दोलामयमान मन:स्थितीत असलेल्या उदगावकरांना एकदम मार्ग सापडला आणि त्यांनी त्यापूर्वी 3-4 वर्षे स्थापन झालेल्या टाटा इन्स्टिट्यूट ऑफ फंडामेंटल रिसर्च ऊर्फ टी.आय.एफ.आर.मध्ये अर्ज केला. त्यांना मुलाखतीसाठी बोलावण्यात आले आणि खुद्द डॉ. भाभांनी त्यांची मुलाखत घेऊन निवड केली. त्यानंतर मात्र उदगावकर अविचल निष्ठेने पुढील पन्नास वर्षे टाटा इन्स्टिट्यूटमध्येच राहिले. एवढेच नाही तर आज 2007 साली वयाच्या 80व्या वर्षीही ते आठवड्यातून एकदा-दोनदा मानखुर्दच्या होमी भाभा विज्ञान शिक्षण केंद्रात जात असतात.

प्रा. उदगावकरांनी भौतिकीमध्ये मोलाचे संशोधन केले. पदार्थ हा काही मोजक्या मूलकणांचा बनलेला असतो. इलेक्ट्रॉन, न्यूट्रॉन, प्रोटॉन इ. मूलकणांचे गुणधर्म, विविध मूलकणांतील आंतरक्रिया, मूलकणांचे स्वरूप इत्यादी विषय गहन आहेत. भौतिकशास्त्रातही ते गहनच समजले जातात. कारण या क्षेत्रात प्रयोग करायचे तर कोट्यावधी रुपयांची गुंतवणूक करून अजस्त्र आणि सुसज्ज प्रयोगशाळा बांधायला हव्यात आणि सैद्धांतिक संशोधन करायचे तर उच्च गणितावर पूर्ण प्रभूत्व

हवे. उदगावकरांनी उच्च गणिताचा अभ्यास करून त्यावर प्रभुत्व मिळवले, ते आत्मसात केले आणि मोलाचे संशोधन केले. त्यांच्या संशोधनाचे वर्णनही गणिताचा आधार घेतल्याशिवाय करता येणे अवघड आहे. पण तरीही त्याबद्दल एक-दोन गोष्टी सांगता येतील. निरनिराळ्या क्षेत्रांतील संकल्पनांचे एकत्र कलम करून अगदी अनोखी अशी नवीन संकल्पना त्यांनी निर्माण केली अशी गोष्ट फार अवघड असते. पण उदगावकर ती करू शकले. 1950 सालाच्या सुमारास भारतात अनेक परदेशी शास्त्रज्ञ होते. भारतासारख्या गरीब देशाने संशोधनाची महागडी क्षेत्रे न निवडता तात्काळ उपयोगी पडतील अशी संशोधने हाती घ्यावीत, असा त्यातील काहींचा सल्ला होता तर भारतासारख्या दरिद्री आणि उपेक्षित देशात मौलिक संशोधन होणे अशक्य आहे असे आणखी काही जणांचे म्हणणे होते. परंतु त्या तरुण वयातही उदगावकरांनी आपल्या उच्च संशोधनानेच अशा लोकांना उत्तर दिले. 1910 च्या सुमारास एका नव्या शोधपद्धतीची माहिती पुढे आली. जलदगतीचे मूलभूत कण एखाद्या ॲल्युमिनियमच्या किंवा सोन्याच्या पातळ पापुद्र्याकडे सोडले तर त्यातले काही कण उलट्या दिशेने परत येतात असे आढळून आले. हे असे का घडते, कोणते कण परत येतात यावर संशोधन सुरू झाले. वर्ष दीड वर्षे हे गूढ उलगडत नव्हते. 1911 च्या सुमारास हळूहळू माहिती मिळू लागली. आता 112 मूलद्रव्ये आहे. हीसुद्धा त्या मूलकणांची आहेत. यातील काही मूलकणांवर डॉ. होमी भाभांच्या मार्गदर्शनाखाली उदगावकरांनी काम केले. 1953 ते 60 या अणुशक्ती प्रकल्पाच्या सुरुवातीच्या काळात त्यांनी अणुभट्टीच्या तात्विक भौतिकीचा पाया घातला. त्यानिमित्त 1953 ते 55 या काळात फ्रान्समधील सावले केंद्रात आणि 1960 ते 62 या काळात अमेरिकेच्या बर्कले येथील लॉरेन्स रेडिएशन लॅबोरेटरीत आणि पुढे प्रिन्स्टन इन्स्टिट्यूट फॉर ॲडव्हान्स स्टडी या संस्थेत करीत असलेल्या संशोधनाची कीर्ती परदेशी पसरू लागली होती. 1963 साली त्यांना स्कॉटिश युनिव्हर्सिटीच्या उन्हाळी वर्गात सैद्धांतिक भौतिकीवर भाषणे देण्यासाठी बोलावले. त्याच वर्षी त्यांना टोकियोच्या समर इन्स्टिटयूट मध्येही, रेगे पोल फिनॉमिनॉलॉजीच्या विकासावर भाषणे देण्यासाठी बोलावले होते. भाभा अणूसंशोधन केंद्रात नवीन भरती केलेल्या संशोधकांना वर्षभराचे व्यवस्थित प्रशिक्षण देण्यासाठी प्रशिक्षण केंद्राची स्थापना करण्यात आली. त्या केंद्रात जाऊन उदगावकर 'अणूभट्टी भौतिकी'वर भाषणे देत. पुढे अणुभट्टी विभागात संचालक पदापर्यंत पोहोचलेले अनेक शास्त्रज्ञ 'उदगावकरांनी आम्हाला शिकविले' असे अभिमानाने सांगत.

उदगावकरांना ज्येष्ठ पदे मिळत गेली आणि हळूहळू संशोधनाबरोबर व्यवस्थापनाचीही काही जबाबदारी त्यांच्याकडे आली. अणुशक्ती मंडळाच्या जागोजागच्या वसाहतीत असणाऱ्या शाळांचे अध्यक्षपदही त्यांच्याकडे चालत आले. टाटा इन्स्टिट्यूट आणि बी.ए.आर.सी.मध्ये चालू असलेल्या संशोधनाची नाळ महाविद्यालयीन शिक्षणाशी, विद्यापीठीय शिक्षणाशी जोडली जाणे गरजेचे आहे, असे उदगावकरांना सातत्याने वाटत असे. 1950-55 च्या सुमारास विज्ञानात नवी क्षेत्रे उदयाला आली होती. भौतिकशास्त्राचा सापेक्षता सिद्धांत, पूंज भौतिकी (क्वांटम फिजिक्स) अशा नव्या सिद्धांतविना अभ्यास पुरा होत नसे. आज अशा विषयांवर लिहिलेली कितीतरी पुस्तके उपलब्ध आहेत. मात्र त्या काळी अशी पुस्तके अभावानेच होती. दुसऱ्या महायुद्धात गरजेप्रमाणे विज्ञान वाढले, परंतु पुस्तके निघाली नाहीत. अशा परिस्थितीत हे नवे विषय शिकविणाऱ्या प्राध्यापकांची कुचंबणा होई. यातील काही उत्साही विद्याप्रेमी प्राध्यापक उदगावकरांच्या भोवती जमा झाले. टाटा इन्स्टिट्यूटमध्ये दर बुधवारी त्यांची बैठक होई. अवघड आणि अगम्य वाटणाऱ्या संकल्पनांवर येथे चर्चा होई. प्राध्यापक आपल्या अडचणी विचारत. कितीही कामे असली तरी उदगावकर हा बुधवारचा वर्ग चुकवत नसत. पुढे रेल्वेमंत्री आणि अर्थमंत्री झालेले प्रा. मधू दंडवते त्यावेळी सिद्धार्थ महाविद्यालयात भौतिकी शिकवीत आणि या बुधवारच्या वर्गाला न चुकता हजेरी लावत. या बुधवारच्या वर्गामुळे प्रा. उदगावकरांच्या लक्षात उच्चशिक्षणातील समस्या आल्या. देशपातळीवरील शिक्षणात त्वरेने सुधारणा घडवून आणण्याची निकड त्यांना जाणवू लागली. जगात खूप नवे शोध लागले. नवे सिद्धांत उदयाला आले पण 1857 साली स्थापन झालेल्या मुंबई विद्यापीठाच्या अभ्यासक्रमात त्यांना काहीच बदल दिसेनात. जुनेच विज्ञान जुन्या पद्धतीने शिकवले जाई. नोव्हेंबर 1966 मध्ये तत्कालीन कुलगुरू निवृत्त न्यायमूर्ती प्र. बा. गजेंद्रगडकर यांना पत्र लिहून त्यांनी दोन सूचना केल्या. अभ्यासक्रम सुधारणे ही पहिली सूचना आणि मुंबईत अनेक शास्त्रज्ञ आणि तंत्रज्ञ उपलब्ध आहेत. त्यांचे सहकार्य घेऊन जगातील सर्वोत्कृष्ट

असा विज्ञान विभाग विद्यापीठात स्थापन करणे ही दुसरी सूचना.हा विचार त्यांनी टाटा इन्स्टिट्यूटमधील आपल्या सहकाऱ्यांना पटवून दिला आणि विद्यापीठाला टाटा इन्स्टिट्यूटची मदत देऊ केली. परंतु विद्यापीठासारख्या संस्था म्हणजे टाटा इन्स्टिट्यूट नव्हे. त्या फार धीम्या गतीने पुढे जाणाऱ्या. त्यामुळे फार मुश्किलीने अभ्यासक्रम बदलण्यापर्यंत प्रगती झाली. मुंबई विद्यापीठ 1857चे. पुणे विद्यापीठ 1949 चे म्हणजे 92 वर्षानंतर स्थापन झालेले. पण पुणे विद्यापीठात पहिल्या दिवसापासून भौतिकी, रसायन, वनस्पती, गणित, संख्याशास्त्र असे विभाग होते. उलट खूप ढोर मेहनत करून 1972 साली उदगावकर मुंबई विद्यापीठात भौतिकीचा विभाग सुरू करून देण्यात यशस्वी झाले. विद्यापीठाच्या स्थापनेनंतर चक्क 115 वर्षांनी!

मुंबई विद्यापीठाच्या या अनुभवानंतर उदगावकरांनी असे पाहिले की, अशी अनास्था ही मुंबई विद्यापीठापुरतीच मर्यादित नाही तर भारतातल्या सर्व विद्यापीठांची अशीच परिस्थिती आहे. म्हणजे यासाठी दिल्लीच्या विद्यापीठ अनुदान मंडळालाच हलवायला हवे हे त्यांच्या लक्षात आले. तोपर्यंत भारतात विज्ञानाच्या अनेक प्रयोगशाळा झाल्या. पण त्यात संशोधन कोण करणार? मनुष्यबळ तयार करण्याचे कार्य विद्यापीठांनीच करायचे असते. विद्यापीठे जर कमकुवत असतील तर प्रयोगशाळांतील संशोधन कसे होणार? उच्चशिक्षणात मूलगामी बदल केल्याशिवाय देशातील विज्ञान वाढणार नाही, 1970 साली विद्यापीठात संशोधन करायला प्रकल्पासाठी 700 रुपये मिळत, ते 1980 साली प्रा. उदगावकरांच्या प्रयत्नांमुळे एक लाखापर्यंत मिळू लागले. पुढे उदगावकर विद्यापीठ अनुदान मंडळाचे सभासद झाले आणि नियोजन मंडळावरही सदस्य म्हणून नेमले गेले.

उच्च शिक्षणात एवढा रस घेणाऱ्या उदगावकरांचे पाय जमिनीवरून सुटले नव्हते. 1967-68 साली मुंबई महानगरपालिकेने शालेय शिक्षणात सुधारणा करण्यासाठी टाटा इन्स्टिट्यूटचा सल्ला घेतला. शिक्षणाचा सार्वत्रिक प्रसार व्हावा, सर्वांना शिक्षणाची समान संधी मिळावी असे सगळेच बोलतात. पण मागासवर्गातील विद्यार्थी शाळेत टिकून का राहत नाहीत, त्यांची गुणवत्ता कशी वाढवता येईल यावर उदगावकर आणि वि. गो. कुलकर्णी चर्चा करू लागले. यातूनच होमी भाभा विज्ञान शिक्षण केंद्राची स्थापना झाली आणि उदगावकरांना त्याचे 1975 ते 1991 अशी 16 वर्षे अध्यक्ष नेमण्यात आले. होमी भाभा संस्थेने पहिले काम मुंबई महानगरपालिकेच्या शाळांवर केले आणि उदगावकरांच्या आयुष्यातील एक वर्तुळ पुरे झाले. उदगावकरांचे स्वत:चे प्राथमिक शिक्षण महानगरपालिकेच्या शाळेतच झाले होते. त्यामुळे त्या शाळांतील विद्यार्थ्यांसाठी आपण काही केले पाहिजे ही ऊर्मी होतीच. आणि ती या निमित्ताने पुरी झाली.

अनुसूचित जातीच्या विद्यार्थ्यांसाठी शिक्षण संस्थांत आणि नोकऱ्यांत राखीव जागा ठेवल्या जातात. शिक्षणापासून आजवर ते वंचित राहिले म्हणून असे करणे ठीकच आहे. परंतु त्यांची गुणवत्ता वाढविण्यासाठी प्रयत्न केले नाहीत तर ते कायमचेच असे मागास राहतील. बुद्धी, प्रतिभा, सर्जनशीलता ही कोणा एका जातीची मिरासदारी नाही यावर त्यांचा पुरा भरवसा होता. म्हणून होमी भाभा शिक्षण केंद्रात त्यांनी असा प्रकल्प घेतला. अभ्यास करायचा म्हणजे नेमके काय करायचे, वाचलेल्या मजकुरातून निष्कर्ष कसा काढायचा, परीक्षेत उत्तरे कशी द्यायची, आपल्याकडून नेमकी काय अपेक्षा आहे याची काही एक कल्पना या वर्गातील मुलांना नसते आणि पालक अशिक्षित असल्याने घरातूनही त्यासाठी काही मदत मिळत नाही. या गोष्टींवर होमी भाभा संस्थेने योग्य मार्गदर्शन केल्यावर हीच मुले 80 टक्के गुण मिळवू लागली. उदगावकरांना सवड मिळे तेव्हा ते स्वत: येऊन विद्यार्थ्यांशी चर्चा करीत.

प्रा. उदगावकरांचे क्षेत्र विज्ञान आणि तंत्रज्ञान प्रयोगशाळा, विद्यापीठे, महाविद्यालये, शाळा यांच्या पुरतेच मर्यादित राहिले नाही. हळूहळू विज्ञान आणि समाज हाच त्यांच्या चिंतनाचा विषय झाला. विद्यार्थ्यांच्यात वैज्ञानिक दृष्टिकोन निर्माण करण्यासाठी जसे शिक्षण त्यांच्यावर संस्कार करू शकते तसेच पालक आणि समाजातले इतर घटकही ते संस्कार करू शकतात. तर मग या घटकात जाऊन काम करण्याची निकड त्यांना जाणवू लागली. 1975 सालच्या मराठी विज्ञान परिषदेच्या हैदराबाद येथे भरलेल्या मराठी विज्ञान संमेलनाचे उद्घाटन त्यांनी केले होते तर 1980 साली संगमनेरला भरलेल्या मराठी विज्ञान संमेलनाचे ते अध्यक्षच होते. या अध्यक्षीय भाषणाचा विषय 'मूलभूत गरजा, विज्ञान आणि समाजव्यवस्था' असा होता. या भाषणात त्यांनी अनेक मूलगामी विचार मांडले. जगातल्या एकूण दरिद्र्यरेषेखालील 31 टक्के लोक भारतात असून अन्न, वस्त्र, निवारा, पिण्यालायक पाणी याच त्यांच्या मूलभूत गरजा आहेत. याशिवाय स्वच्छता, सफाई, आरोग्य,

शिक्षण, रोजगार या गरजाही मूलभूत म्हणाव्यात अशाच आहेत. पण या गरजा भागविण्यासाठी भारताला खूप वाटचाल करावी लागणार होती. उदगावकरांचे हे भाषण 1980 सालचे होते आणि 2007 साली, 27 वर्षे उलटून गेल्यावरही त्यात फार मोठा फरक झाल्याचे जाणवत नाही. म्हणजे या मूलभूत गरजा तशाच आहेत. 1947 साली 33 कोटी लोकसंख्या असलेल्या या देशात 2007 साली तेवढेच लोक मध्यमवर्गीय आहेत. पण तेवढेच लोक दारिद्र्यरेषेखालीही आहेत. कुपोषणामुळे होत असलेले बालमृत्यू रोज आपण वर्तमानपत्रातून वाचत असतो. अशा परिस्थितीत सर्वच समस्या जैसे थे आहेत. वस्तुत: पूर्वी हे प्रश्न सोडवायला विज्ञान आणि तंत्रज्ञान उपलब्ध नसल्याने सर्वांनी सुखी राहावे एवढी प्रार्थना करणेच लोकांच्या हाती होते. पण एकविसाव्या शतकात विज्ञान आणि तंत्रज्ञान खूप काही करू शकते. औद्योगिकदृष्ट्या पुढारलेल्या देशात या गोष्टी शक्य झाल्याचे दिसते. औद्योगिक क्रांतीपूर्वी सुखवस्तू राहणीमान फार थोड्यांना लाभे. पण आता ते समाजाच्या 33 टक्के लोकांना लाभले आहे. हीच विज्ञान आणि तंत्रज्ञानाची फलश्रुती आहे. पृथ्वीवरील नैसर्गिक संपत्ती मर्यादित आहे. दिवसेंदिवस जगाची लोकसंख्या वाढत आहे. तरीही विकसित देश आपल्या पोळीवर जास्तीतजास्त तूप ओढून घेत आहेत आणि इतरांना काटकसरीचे उपाय सुचवित आहेत, ही चिंतेची बाब वाटते. यासाठी संयुक्त राष्ट्रसंघाने मध्यस्थाची भूमिका पार पाडणे गरजेचे आहे. भारताने 1957 सालीच विज्ञान धोरण स्वीकारले आहे. भारत सरकारने 60 वर्षात बरीच प्रगती केली आहे. भारत गरीब असला तरी तो विज्ञान-तंत्रज्ञानाच्या बाबतीत गरीब नाही. 1980 च्या परिस्थितीनुसार उद्योगधंद्याच्या क्षेत्रात जगात भारत दहावा होता. विज्ञान तंत्रज्ञान पदवीधरांबाबत जगात तिसरा होता. आपण आपल्याला लागणाऱ्या सर्व वस्तू बनवू शकतो. एसएलव्ही 3 उपग्रह आपण उडवला आहे, पोखरणला 1974 आणि 1998 मध्ये शांततामय कारणासाठी अणुचाचणी केली आहे. बॉम्बे हायचे तेलक्षेत्र विकसित केले आहे. विज्ञान तंत्रज्ञानात भारताची प्रगती प्रशंसनीय असली तरी सामाजिक प्रश्न हाताळण्यात आपण यश संपादू शकलो नाही. त्यासाठी अशक्यप्राय वाटणारी उद्दिष्टेही जर राजकीय उद्दिष्टे बनवली तर वैज्ञानिक ते साध्य करू शकतात. त्यासाठी उद्दिष्टांची सुस्पष्टता, उत्कृष्ट व्यवस्थापन, योजनेनुसार क्रमबद्ध वाटचाल आणि आवश्यक त्या आर्थिक आणि भौतिक सामग्रीची वेळेवर उपलब्धता या गोष्टींची आवश्यकता असते आणि त्यासाठी ते उद्दिष्ट संपूर्ण समाजाचे उद्दिष्ट व्हायला हवे.

1982 ते 1991 प्रा. उदगावकर मराठी विज्ञान परिषदेचे अध्यक्ष होते. त्यावेळी परिषदेत अनेक शैक्षणिक कार्यक्रम सुरू झाले. परिषदेच्या पत्रिकेला उत्तम स्वरूप आले. 1987 साली केंद्रसरकारने भारतभर विज्ञान प्रसार करण्यासाठी घेतलेल्या भारत जन विज्ञान जाथेचे ते अध्यक्ष होते. त्यातून नंतर निर्माण झालेल्या पीपल्स सायन्स नेटवर्कचे ते अध्यक्ष झाले.

भारतीय स्तरावरून उदगावकरांची कक्षा आंतरराष्ट्रीय स्तरापर्यंत वाढली. 1955 साली बट्रांड रसेल यांनी जगात अणुयुद्ध होऊ नये म्हणून एक समिती स्थापन झाली. या समितीची पहिली सभा भारतात व्हायची होती पण काही कारणाने हे होऊ शकले नाही आणि ती इटालीतील पग्वाश गावी झाली. त्यामुळे या समितीला 'पग्वाश समिती' असे नाव पडले. उदगावकरांचा या समितीशी 20 वर्षे संबंध होता. त्यातील दहा वर्षे ते 10 सदस्यीय कार्यकारी मंडळाचे सभासद होते.या समितीतर्फे त्यांनी समितीचे अध्यक्ष जोसेफ रॉटब्लाट आणि दुसरे सदस्य जॅक स्टाइनबर्गर यांच्याबरोबर 1993 साली 'ए न्यूक्लिअर वेपन फ्री वर्ल्ड - डिझायरेबल? फिजिबल?' असे पुस्तक लिहिले. या समितीने 40 वर्षे केलेल्या यशस्वी कामगिरीसाठी 1995 सालचे नोबेल पारितोषिक मिळविले. हे पारितोषिक घेण्यासाठी प्रा. उदगावकर इतर समिती सदस्यांबरोबर ऑस्लोला गेले होते.

या अशा अनेक प्रकारच्या कामगिरीसाठी उदगावकरांना विद्यापीठ अनुदान मंडळाने हरिओम पुरस्कार दिला आणि भारत सरकारने पद्मभूषण किताबत दिली. असे पुरस्कार मिळावेत म्हणून उदगावकरांनी कधी प्रयत्न केले नाहीत. ते टोकाचे प्रसिद्ध पराङ्मुख आहेत. कमालीचे नम्र आहेत. निगर्वी आहे, प्रामाणिक आहेत आणि दुर्मिळ अशी तैलबुद्धी त्यांना लाभलेली आहे.

'विद्वज्जन' (नोव्हेंबर 2004 मनोविकास प्रकाशन, पुणे - लेखक : अ. पां. देशपांडे) या पुस्तकावरून साभार.
संदर्भ : एक ऋषीतुल्य व्यक्तिमत्व - प्रा. वि. गो. कुलकर्णी
सकाळ दि. 4 ऑक्टोबर, 1987

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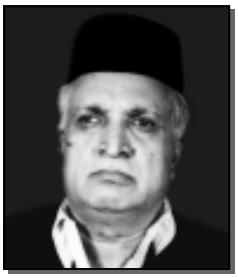
# शिक्षकांचे मनोगत



## ग. त्र्यं. खरवंडीकर

''भा''लचंद्र उदगावकर हा एक अत्यंत हुशार विद्यार्थी होता. त्याने शाळेच्या कोणत्याही परीक्षेत आपला पहिला नंबर कधीच सोडला नव्हता.'' हे उदगार आहेत श्री. ग. त्र्यं. खरवंडीकर यांचे. किंग जॉर्ज शाळेतील निवृत्त मुख्याध्यापक श्री. खरवंडीकर यांनी वयाची शंभरी नुकतीच पार केली आहे.

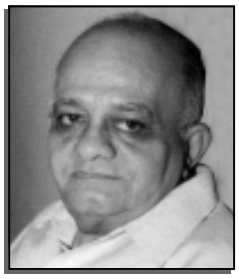
डॉ. भालचंद्र उदगावकर हे दादरच्या किंग जॉर्ज शाळेचे विद्यार्थी. त्यांनी आपल्या नम्र वागण्याने आणि बुद्धिमत्तेने सरांना भारून टाकले होते. आणि हे सांगताना सर आजही अगदी भारावून गेले होते. शंभरी ओलांडल्यावरही त्यांची स्मरणशक्ती अजूनही तल्लख आहे. त्यांच्या वृद्ध चेहऱ्यावर आनंद जणू मावत नव्हता. 'ते 1935-36 साल असावे. शिक्षक म्हणून माझी शालेय कारकीर्द नुकतीच सुरू झाली होती आणि माझ्या अगदी सुरुवातीच्या वर्षातच तो विद्यार्थी होता,' असे सरांनी सांगितले.

''आपला हा विद्यार्थी जागतिक कीर्तिचा शास्त्रज्ञ झाला या गोष्टीने ते फार आनंदित झाले ही शाळेला अभिमानस्पद गोष्ट आहे,'' असे ते म्हणाले. ''अर्थात् हे श्रेय आहे डॉ. भालचंद्र उदगावकर यांच्या असामान्य बुद्धिमत्तेचे अन् अभ्यासू वृत्तीचे,'' असेही ते म्हणाले.

**अलका अ. पुराणिक**

(श्री. ग. त्र्यं. खरवंडीकर यांची कन्या, मुंबई )

***दूरध्वनी क्र. 2446405***



# प्रा. भा. मा. उदगावकर - एक ऋषीतुल्य व्यक्तिमत्व

**प्रा. वि. गो. कुलकर्णी**

टाटा इन्स्टिट्यूट ऑफ फंडामेटल रिसर्च या आंतरराष्ट्रीय कीर्तीच्या संस्थेतील ज्येष्ठ प्राध्यापक, यशस्वी संशोधक, विचारवंत, बुद्धिप्रामाण्य वादाचे पुरस्कर्ते आणि विज्ञानाचा प्रसार समाजातील दुर्बल घटकांतही व्हावा यासाठी तळमळीने कार्य करणारे शास्त्रज्ञ, प्रा. भालचंद्र माधव उदगावकर यांच्या वयाला नुकतीच म्हणजे 14 सप्टेंबर, 1987 रोजी 60 वर्षे पूर्ण झाली. विज्ञान आणि तंत्रज्ञान, तसेच धोरणविषयक नियोजन, उच्चशिक्षण, संशोधन इत्यादी क्षेत्रात त्यांचे नाव आदराने घेतले जाते. दोन वर्षांपूर्वी भारत सरकारने पद्मभूषण ही पदवी देऊन त्यांच्या कार्याची दखल घेतली होती. तथापि, प्रा. उदगावकर यांच्या काहीशा भिडस्त आणि प्रसिद्धीपराङ्मुख स्वभावामुळे, त्यांच्या व्यक्तिमत्वाचा आणि कार्याचा नेमका आणि व्हावा तेवढा परिचय सर्वांना झालेला नाही. म्हणून या लेखाचा प्रपंच.

**भौतिक शास्त्रातील संशोधन**

प्रा. उदगावकरांनी भौतिकशास्त्रात मोलाचे संशोधन केले आहे. पदार्थ हा काही मोजक्या मूलकणांचा बनलेला असतो. इलेक्ट्रॉन, न्यूट्रॉन, प्रोट्रॉन यासारख्या काही मूलकणांची नावे अनेकांनी ऐकलेली असतील. मूलकणांचे गुणधर्म, विविध मूलकणांतील आंतरक्रिया, मूलकणांचे स्वरूप इत्यादी विषय तसे गहनच. भौतिकशास्त्रातही हा विषय गहनच मानला जातो. कारण या क्षेत्रात प्रयोग करावयाचे तर करोडो रुपयांची गुंतवणूक करून अजस्त्र आणि सुसज्ज प्रयोगशाळा बांधायची तयारी हवी आणि सैद्धांतिक संशोधन करावयाचे तर उच्च गणितावर पूर्ण प्रभुत्व हवे. प्रा. उदगावकरांनी उच्च गणित आत्मसात करून या विषयात मोलाचे संशोधन केले आहे. त्यांच्या संशोधनाचे नेमके स्वरुप गणिताचा आधार न घेता सांगता येणार नाही, तथापि, त्यांच्या या जगन्मान्य संशोधनाचे दोन पैलू सांगितलेच पाहिजेत. पहिला असा की निरनिराळ्या क्षेत्रातील संकल्पनांचे एकत्र कलम करून अगदी अनोखी अशी नवीन संकल्पना निर्माण करण्यात त्यांनी यश मिळवले. अशी किमया दुर्लभ आणि म्हणूनच आदरणीय असते. दुसरा पैलूही तेवढाच महत्त्वाचा आहे. त्याकाळी म्हणजे 1950 च्या सुमारास पाश्चात्य सल्लागारांचे पेवच फुटले होते. (आजही त्यांची लुडबूड थांबलेली नाही.) भारतासारख्या गरीब देशाने संशोधनाची महागडी क्षेत्रे न निवडता, तत्काळ उपयोगी पडेल आणि परवडेल अशाच विषयावर संशोधन करावे.'' काहींचे तर असे म्हणणे की जगाच्या या दारिद्री आणि उपेक्षित भागात मोलाचे संशोधन होणे नाही. उदगावकरांनी असल्या आत्मघातकी प्रवृत्तींना सतत विरोध केला आहे. त्यांनी स्वत: तर उत्कृष्ट संशोधन केलेच, शिवाय आपल्या मर्गदर्शनाखाली टाटा इन्स्टिट्यूटमध्ये तरुण संशोधकांचा एक उत्कृष्ट संच तयार केला. अलिकडच्या काळात प्रा. उदगावकरांनी आपले लक्ष शिक्षणविषयक प्रश्नांवर केंद्रित केले. तेव्हा या तरुण शास्त्रज्ञांनी उच्च दर्जेदार संशोधन करून भारतात उच्च दर्जाचे संशोधन होऊ शकते हे निरपवादपणे सिद्ध केले आहे.

प्रा. उदगावकर शास्त्रीय संशोधनाकडे कसे वळले याची हकीगतही मनोरंजक आहे. कोणत्याही विषयात सहज संचार करू शकणारी अलौकिक बुद्धिमत्ता आणि प्रतिभा यांचे जन्मजात वरदान असल्यामुळे ते कोणत्याही क्षेत्रात चमकू शकले असते. महाविद्यालयीन शिक्षण पुरे करीत असतानाच त्यांच्यापुढे अनेक संधी चालून आल्या. त्यावेळी काही शहाण्या आणि दूरदर्शी आप्तांनी विज्ञान संशोधनाकडे वळण्याचा सल्ला दिला. तुझ्यासारख्या बुद्धिमान मुलांनी संशोधन केले नाही तर दुसरे कोण करणार? या स्पष्ट शब्दात दिशा दाखविली. सुदैवाने त्या काळी डॉ. होमी भाभा यांनी टाटा इन्स्टिट्यूटची स्थापना केली होती. डॉ. भाभा अशा संशोधकांच्या शोधातच होते.

त्यांचे आणि उदगावकरांचे सूर जुळले आणि एका आगळ्या कारकीर्दीची सुरुवात झाली. ही सारी कथा येथे सांगण्यात काही स्वारस्य आहे. भारताला स्वातंत्र्य मिळून आज चाळीस वर्षे झाली. या चार दशकात किती तरी संशोधन शाळांची तसेच परमाणुऊर्जा, अंतराळ संशोधन यासारख्या मोठ्या प्रकल्पांची स्थापना झाली. संशोधनासाठी फार मोठी संधी आज उपलब्ध आहे. तथापि आपले तरुण तिकडे वळताना दिसत नाहीत. गेली काही वर्षे प्रा. उदगावकर विद्यार्थ्यांचे लक्ष या क्षेत्राकडे जावे म्हणून प्रयत्न करीत असून त्यांना छान प्रतिसाद मिळत आहे.

### विद्वत्ता आणि देशप्रेमाचा संगम

चाळीस वर्षांपूर्वी परदेशी स्थायिक होणे खूप सुलभ होते. बुद्धिमान आणि यशस्वी शास्त्रज्ञांना तर देशोदेशींची आमंत्रणे मिळत. प्रा. उदगावकरांवरही अशाच आमंत्रणांची खैरात झाली. काही समक्ष, काही पत्रांनी, तर काही फोनवरून सुद्धा. परंतु उदगावकरांचे देशप्रेम पक्के होते. 'जरि उद्धरणी व्यय न तिच्या हो साचा। हा व्यर्थ भार विद्येचा।।' या उक्तीचा तत्त्वज्ञान म्हणून त्यांनी स्वीकार केला असल्याने ते परदेशी स्थायिक न होता, भारतातच राहिले. टाटा इन्सिट्यूट ऑफ फंडामेंटल रिसर्च ही त्यांची कर्मभूमी. गेली जवळजवळ 38 वर्षे ते या कर्मभूमीत तपश्चर्या करीत आहेत. त्यांच्या विज्ञानविषयक संशोधनाचा उल्लेख वर आला आहेच. गेली पंचवीस वर्षे प्रा. उदगावकरांनी शिक्षण क्षेत्रातही मोलाचे कार्य केले आहे. या कार्याची आढावा घेणे उद्बोधक ठरेल.

### शैक्षणिक कार्य

पस्तीस वर्षांपूर्वीची परिस्थिती लक्षात घेतली पाहिजे. विज्ञानात नवी क्षेत्रे उदयाला आली होती. भौतिकशास्त्राचा अभ्यास, सापेक्षता सिद्धांत तसेच क्वांटम भौतिक अशा नव्या सिद्धांताच्या अभ्यासाविना पूर्ण होऊ शकत नसे. आज अशा विषयांवर लिहिलेली कितीतरी पुस्तके उपलब्ध असून विद्यार्थी आपल्या रुचीप्रमाणे पुस्तक निवडून घेऊ शकतो. त्याकाळी मात्र पुस्तके फार थोडी होती. मध्यंतरीच्या युद्धजन्य परिस्थितीत विज्ञान वाढले. परंतु पुस्तके निघाली नाहीत. अशा परिस्थितीत हे नवे विषय शिकवणाऱ्या प्राध्यापकांची कुचंबणा होई. यातील काही उत्साही आणि विद्याप्रेमी प्राध्यापक प्रा. उदगावकरांच्या भोवती जमा झाले. त्यांची दर बुधवारी संध्याकाळी बैठक भरे. अवघड आणि अगम्य वाटणाऱ्या काही संकल्पनांची तेथे चर्चा होई. एका अर्थाने विज्ञानाच्या क्षेत्रातील हे रविकिरण मंडळच होते. बुधवारच्या बैठकांचे एक वैशिष्ट्य नमूद केलेच पाहिजे. इतर अनेक कामे असूनही प्रा. उदगावकरांनी बुधवारची बैठक कधीही चुकवली नाही आणि आपल्या भोवती जमा झालेल्या मंडळींचा आत्मविश्वास कसा वाढेल यावर सदैव भर दिला.

अशा कार्यक्रमांचा एक मोठा फायदा झाला. उच्च शिक्षणाच्या समस्यांचे यथार्थ दर्शन झाल्यामुळे, देशाच्या शिक्षणात त्वरेने सुधारणा घडवून आणली पाहिजे असे प्रा. उदगावकरांना वाटू लागले. जगात एवढे नवीन शोध लागले, नवे सिद्धांत उदयाला आले, परंतु मुंबई विद्यापीठाच्या अभ्यासक्रमात काहीच बदल झालेले नव्हते. जुनेच विज्ञान जुन्या पद्धतीने शिकवण्यात येई. प्रा. उदगावकरांनी 1966 च्या नोव्हेंबरमध्ये कुलगुरूंना पत्र पाठवून दोन प्रमुख सूचना केल्या, अभ्यास सुधारावा ही पहिली सुचना, दुसरी सुचना फार महत्त्वाची आणि दूरदृष्टीची होती, ''मुंबई शहरात अनेक शास्त्रज्ञ आणि तंत्रज्ञ उपलब्ध आहेत. त्यांचे सहकार्य घेऊन जगातील सर्वोत्कृष्ट विद्यापीठाशी स्पर्धा करू शकेल असा विज्ञान विभाग निर्माण करण्याची जिद्द आपण का धरू नये? हा विचार त्यांनी आपल्या सहकाऱ्यांना पटवून दिला आणि टाटा इन्स्टिट्यूटचे पूर्ण सहकार्य विद्यापीठाला देऊ केले. परंतु विद्यापीठासारख्या प्रचंड यंत्रणेची हालचाल इतकी झटपट होत नसते. भरपूर पत्रव्यवहार आणि सतत पाठपुरावा केल्यावर चार पाच वर्षांनी फक्त अभ्यासक्रम बदलण्यापर्यंत प्रगती झाली. पुढे फारसे काही घडले नाही.

### विद्यापीठांची सुधारणा

या सर्व प्रकरणाने दुसरा कोणी हताश झाला असता. ''या देशात सुधारणा करणे अशक्य आहे.'' अशी धारणा होऊन निराश झाला असता. परंतु प्रा. उदगावकरांचा आशावाद आणि सर्व समस्यांकडे स्थितप्रज्ञाच्या भूमिकेतून पाहण्याची दृष्टी खरोखरीच अतुलनीय! विद्यापीठे आणि त्यांची यंत्रणा इतकी वर्षे थंड पडून असतील तर त्यात चैतन्य उत्पन्न करण्यास वेळ लागणारच. त्याहून महत्त्वाची गोष्ट म्हणजे हा प्रश्न मुंबई विद्यापीठापुरता मर्यादित नसून भारतातील सर्व विद्यापीठांना अशाच समस्या भेडसावत असल्या पाहिजेत हे त्यांनी हेरले.

विद्यापीठ अनुदान मंडळाच्यामार्फत विद्यापीठांची जागृती करण्याचा कार्यक्रम हाती घेतला तर भारतातील उच्च शिक्षणात सुधारणा घडवून आणता येतील हा विचार पक्का केला. या विचारामागे दूरदृष्टी होती. भारतात अनेक मोठ्या प्रयोगशाळा स्थापून झाल्या. परंतु अखेर या प्रयोगशाळात संशोधन करणार कोण? मनुष्यबळ तयार करण्याचे कार्य विद्यापीठांनी करायचे असते. विद्यापीठे कमकुवत असतील तर प्रयोगशाळांतील संशोधन कार्य व्हावे कसे? उच्च शिक्षणात मूलग्राही बदल घडवून आणण्याखेरीज या देशातील विज्ञान वाढणार नाही हे जाणून त्यांनी विद्यापीठ अनुदान मंडळाशी पत्रव्यवहार सुरू केला.

विद्यापीठांच्या कार्याची दोन प्रमुख अंगे असतात. विद्यार्थ्यांना शिकवण, परीक्षा घेणे हे एक अंग. संशोधन करून ज्ञानात भर घालणे हे दुसरे अंग. ''दोन्ही अंगे एकमेकांशी निगडित असून, एकमेकांना पूरक असतात, एक लुळे पडल्यास दुसरे पंगू होते. म्हणून दोन्ही अंगे जोपासली पाहिजेत.'' या तत्वज्ञानाचा प्रा. उदगावकरांनी कसोशीने प्रचार केला. फक्त अभ्यासक्रम सुधारून भागणार नाही. विद्यापीठातील कर्तबगार प्राध्यापकांना संशोधन करण्यास उत्तेजन दिले पाहिजे. त्यासाठी पुरेसे अनुदान दिले पाहिजे आणि अनुदान मंडळाने उदार धोरण स्वीकारून दिरंगाई टाळली पाहिजे असा विचार मांडला. 1970 पासून विद्यापीठ अनुदान मंडळाशी जोराचा पत्रव्यवहार सुरू केला आणि शिक्षणविषयक परिषदांतून आपले विचार मांडण्यास सुरुवात केली. पुढे विद्यापीठ अनुदान मंडळाचे सदस्य झाल्यावर हा कार्यक्रम अंमलातही आणला. त्यांच्या कार्याचा संपूर्ण आढावा इथे घेणे शक्य नाही. वानगीदाखल एक उदाहरण देता येईल. संशोधन प्रकल्पाला मंडळाची परवानगी मिळायला खूप वेळ लागे.

सरासरीच्या भाषेत सांगायचे तर 1970 साली सरासरी अनुदान फक्त 700 रुपये इतके तुटपुंजे होते! आपल्या कारकीर्दीत प्रा. उदगावकर यांनी हे चित्र बदलले. 1980 साली विद्यापीठातील प्रकल्पाला (अर्थात चांगल्या प्रकल्पाला) एक लाख रुपये मिळणे सोपे झाले होते. आपल्या प्रयत्नांनी अक्षरश: वाळूचे कण रगडून तेल मिळवून दाखवण्यात प्रा. उदगावकरांना यश आले.

### दुर्बल घटकांचे शिक्षण

उच्च शिक्षणाच्या क्षेत्रातील त्यांची कामगिरी डोळ्यात भरण्यासारखी आहे यात शंका नाही. परंतु विशेष म्हणजे शिक्षणाच्या सर्व पैलूंमध्ये त्यांनी रस घेतला आहे आणि भरीव कामगिरी केली आहे. अगदी शालेय स्तरावरसुद्धा समस्या नेमक्या हेरून त्यावर मात करण्यासाठी संशोधन प्रकल्पांना उत्तेजन देण्याचे कार्य त्यांनी केले आहे. शिक्षणाचा सार्वत्रिक प्रसार व्हावा, सर्वांना शिक्षणाची समान संधी मिळावी, याबाबत दुमत नसते. परंतु मागास विद्यार्थी शाळेत का टिकून राहू शकत नाहीत. त्यांची गुणवत्ता वाढवण्यासाठी नेमके काय केले पाहिजे, इत्यादी गोष्टींवर फारसे संशोधन होत नाही. टाटा इन्स्टिट्यूटमध्ये आम्हा काही शास्त्रज्ञांना अशा संशोधनात रस वाटत असल्याने, आमच्या फावल्या वेळात मुंबई महापालिकेच्या काही प्राथमिक शाळात आम्ही संशोधन प्रकल्प सुरू केले होते. या कार्यास प्रा. उदगावकरांनी पूर्ण पाठिंबा दिला. एवढेच नव्हे तर पुढे हे कार्य वाढल्यानंतर स्वत: पुढाकार घेऊन होमी भाभा विज्ञान शिक्षण केंद्राची स्थापना केली. हे केंद्र टाटा इन्स्टिट्यूट ऑफ फंडामेंटल रिसर्चचा एक भाग असून आज तेथे पंधरा शास्त्रज्ञ पूर्णवेळ संशोधन करीत आहेत.

### एक आगळा प्रकल्प

प्रा. उदगावकरांच्या आवडीच्या संशोधनाचा एक नमुना म्हणून एका प्रकल्पाची थोडक्यात माहिती करून घेऊ. अनुसूचित जातीच्या विद्यार्थ्यांसाठी शिक्षण संस्थांमध्ये तसेच नोकऱ्यांमध्येही राखीव जागा ठेवलेल्या असतात, आजवर शिक्षणापासून अन्यायाने वंचित झालेल्या समूहासाठी जागा राखून ठेवाव्या हे ठीक आहे. परंतु त्यांची गुणवत्ता वाढण्यासाठी कार्यक्रमही हाती घेतलेच पाहिजेत. बुद्धी, प्रतिभा, सर्जनशीलता इत्यादी गुणांचा ताम्रपट कोणत्याही जातीला, वंशाला किंवा धर्माला मिळालेला नसतो या तत्त्वज्ञानावर श्रद्धा असेल तर सर्व कौशल्य पणाला लावून हे संशोधन झाले पाहिजे. होमी भाभा विज्ञान शिक्षण केंद्राच्या एका प्रकल्पात, महापालिकेच्या शाळांत शिकणाऱ्या, अनुसूचित जातीच्या विद्यार्थ्यांची गुणवत्ता किती वाढू शकते याचा अभ्यास करण्यासाठी एक प्रकल्प हाती घेण्यात आला. हा प्रकल्प गेली पाच सहा वर्षे चालू असून त्यातील निष्कर्ष काढता न येणे परीक्षेत उत्तरे कशी द्यावी याची कल्पना नसणे, आपल्याकडून नेमकी काय अपेक्षा

आहे याची कल्पना नसणे, वगैरे अनेक कारणे असू शकतात. योग्य मार्गदर्शन करून ही कारणे दूर केली की, या तथाकथित मागास विद्यार्थ्यांनी शेकडा 80 गुण मिळवण्यापर्यंत प्रगती होते. गेली पाच वर्षे सातत्याने हा अनुभव येत आहे. प्रा. उदगावकरांनी अशा प्रकल्पांना पूर्ण पाठिंबा दिला. त्यांना सवड मिळेल तेव्हा प्रकल्पातील विद्यार्थ्यांशी चर्चा करून सक्रिय मदतही केली. होमी भाभा विज्ञानशिक्षण केंद्राच्या कित्येक प्रकल्पांमागे त्यांची प्रेरणा आहे.

### वैज्ञानिक दृष्टिकोन

विज्ञान आणि तंत्रज्ञान प्रयोग शाळांपुरते मर्यादित राहिले तर समाजाते भले होत नाही. हे नवे ज्ञान समाजात रुजावे लागते. अर्थातच विज्ञानातील कूटप्रश्नांची सांगोपांग माहिती बहुजन समाजाला व्हावी, असे कोणीच म्हणणार नाही. परंतु विज्ञानाच्या थोड्याशा शिक्षणानेसुद्धा एक दृष्टी येऊ शकते. सृष्टीच्या नियमानुसार घटना घडतात, हे नियम आपण समजून घेऊ शकतो, व्यक्तिनिष्ठेपेक्षा बुद्धिप्रमाण्यावरील विश्वास अधिक हितावह, त्याचे ज्ञान सर्वांना झाले पाहिजे. हा वैज्ञानिक दृष्टिकोन स्पष्ट करण्यासाठी प्रा. उदगावकरांनी अनेक लेख लिहिले, व्याख्याने दिली आणि कित्येक चर्चा सत्रात भाग घेऊन तरुणांना मार्गदर्शन केले. भारताच्या विविध भागातून एक विज्ञान यात्रा नोव्हेंबर महिन्यात भोपाळला जाणार आहे. प्रा. उदगावकर त्या जथ्याचे नेतृत्व करीत आहेत.

प्रा. उदगावकरांच्या व्यक्तिमत्वाच्या आणखी एका पैलूची माहिती सांगितलीच पाहिजे. अनेक संस्थांशी त्यांचा संबंध आहे. संस्था चिरस्थायी कशी होईल त्यात काम करणारे सर्व कार्यकर्ते एकत्र कसे नांदतील याची आस्था ते बाळगतात. काही वर्षांपूर्वी मराठी विज्ञान परिषदेत कटुता निर्माण होऊन कार्यकर्त्यांचे काही गट एकमेकांपासून उगीचच दुरावले अशा कटु वातावरणातसुद्धा आपल्या कुशल आणि निस्वार्थी नेतृत्वाने हे गट पुन्हा एकत्र आणण्यात प्रा. उदगावकरांनी बरेच यश मिळवले आहे. सार्वजनिक कार्य करताना, आपले ज्यांच्याशी बारा आणे पटते आहे त्यांचे संबंध उरलेल्या चार आण्यासाठी तोडायचे नसतात, हे धोरण त्यांनी स्वीकारले आहे.

प्रा. उदगावकरांच्या व्यक्तिमत्त्वावर काही थोर मंडळींची छाप स्पष्टपणे दिसते. त्यांचे वडिल गेल्या पिढीत एक प्रमुख सामाजिक कार्यकर्ते म्हणून गणले जात. आपला वैद्यकीचा व्यवसाय सांभाळून समाजकार्याच्या अनेक अंगात त्यांनी रस घेतला. अनाथ महिलाश्रमाचे काम असो वा साहित्य संघाचे असो, किंवा गोरगरिबांना विनामूल्य औषधोपचार करण्याचे काम असो डॉ. उदगावकर तेवढ्याच तळमळीने जिद्दीने आणि रसिकतेने काम करीत. ''न ऋते श्रान्ततस्य सख्याय देवा:'' हे त्यांचे बोधवाक्य प्रा. उदगावकरांनी प्रत्यक्ष आचरणात आणले आहे. डॉ. होमी भाभा यांचाही खूप प्रभाव दिसतो ''आपले सर्व काम उत्कृष्टच हवे, गुणवत्तेच्या बाबतीत तडजोड संभवत नाही'' हा संदेश प्रा. उदगावकरांनी अनेकांना सोदाहरण शिकविला. विशेष म्हणजे आपल्या सहकार्याच्या प्रगतीत आनंद मानला, अशी माणसे पुराणकाळी झाली म्हणतात. त्यांना ऋषी म्हणत. आजच्या काळातही प्रा. उदगावकरांसारखे ऋषी आपल्यात आहे हे आपले भाग्य.

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# निगर्वी उदगावकर

**चिं. मो. पंडित**

**अ.** पां. देशपांड्याचा फोन येतो. उद्या मंत्रालयात जायचयं. दुसऱ्या दिवशी मी, देशपांडे, नारळीकर, उदगावकर आम्ही मंत्रालयात पोहोचतो. मंत्र्यांना भेटण्याची वेळ पूर्व निश्चित होती. आम्ही पाच मिनिटे आधीच पोहोचतो. स्वागत कक्षातून आम्हाला थोडे थांबायला सांगण्यात येते. कोणतरी आत जाऊन नारळीकर आल्याची वर्दी देते. लगेचच त्यांना आत बोलवण्यात येते. मी अस्वस्थ होतो. माझे, अपांचे ठीक आहे पण सरांनी बाहेर बाकावर बसायचे? एवढ्यात मंत्री महोदय बाहेर येतात. सरांना आणि त्यांच्याबरोबर आम्हालाही आत घेऊन जातात. बहुदा नारळीकरांनी सर बाहेर असल्याचे त्यांना सांगितले असावे. या सर्वांत सर मात्र अगदी सहज शांतचित्त होते. सरांचा हा सहज साधेपणा, कुठचाही अभिनिवेश नसणे मला अनेकवेळा जाणवलाय. सुसंकृत लीनता म्हणजे काय ते मी पहायलय. नारळीकर, गोवारीकर ही (इन क्लास अँड इन मास) सुपरिचित असतात. सरांना कितीएक तज्ञ आदराने गुरू स्थानी मानतात.

सरांचा हा स्वभाव उगीचच आपले वजन इकडेतिकडे फेकत, दहाजणांचे लक्ष वेधत ते सार्वजनिक ठिकाणी कधीच वावरत नाहीत. मला तर वाटते की कधीकधी ते फारच संकोचीपणे मागे राहतात. पार्ले म्युझिक सर्कलमध्ये पं. भीमसेन जोशींचा सत्कार आणि गाणे असते. पंडितजींना पद्मभूषण किताब मिळालेला असतो. मी कार्यक्रमाला दोन-चार मिनिटे उशीरा पोहोचलेला असतो. सभागृह खचाखच भरलेले असते. बऱ्यापैकी मागची जागा मिळते. पहातो तर काय उदगावकरसरही कार्यक्रमाला आलेले. आम्ही ती मैफल छान एन्जॉय करतो. पण माझ्या मनात सतत एक विचार घोळत राहतो. सरांनाही याच यादीत पद्मभूषण मिळालयं की!

काही दिवसांपूर्वी पुण्यात निखिल वागळे यांनी श्रीराम लागू आणि विजय तेंडूलकर यांची जाहीर मुलाखत घेतली. मुलाखतीच्या शेवटी वागळ्यांनी संकोचून, भीतभीत पण अतिशय नम्रपणे दोघांना प्रश्न विचारला. 'तुमच्या आयुष्यात अतिशय दु:खदायक, मन पिळवटणारे प्रसंग घडलेत. तुमचा देवावर विश्वास आहे का? तुम्ही सावरलात का? कशाच्या जोरावर?'

लागूंनी तडकाफडकी उत्तर दिले. 'मी नास्तिकच आहे. पण इतका अचूक, वेळ साधून नेम मारणारा देवच असला पाहिजे.' तेंडूलकरांचे उत्तर होते, 'मी देव मानत नाही. पण नियती मानतो.' अनेकवेळा आयुष्य कल्पनातील वळणे घेत असते. कधी भल्यासाठी, कधी दु:खदायक. बऱ्याचवेळा आपण जगरहाटीशी जुळवून घेतो. पण आतून सावरतो? हा आपलाच आपल्याशी संघर्ष असतो. फार क्लेशकारक असतो.

सरांच्याही आयुष्यात असा एक प्रसंग घडला. अमेरिकेसारख्या अत्यंत आधुनिक देशात, सर्व वैद्यकीय सोयी उपलब्ध असताना सरांची कन्या - निदान नीट झाले नाही म्हणून म्हणा, योग्यवेळी योग्य उपचार मिळाले नाहीत म्हणून म्हणा - तडकफडकी गेली. शेवटची भेट पण झाली नाही. त्याकाळातला सरांचा हा अनुघर्ष - आपलाच आपल्याशी संघर्ष - मी जवळून पाहिलाय. एकीकडे वैज्ञानिक दृष्टिकोन, बुद्धिनिष्ठ विवेकवाद समाजाला शिकवायचा आणि अनेक वर्षांचा सामाजिक संस्कारांचा, लोक मानसातील देव, दैववादाचा (कलेक्टिव्ह अनकॉन्शिअस) निग्रहाने सामना करायचा ही गोष्ट सोपी नाही. कधी मला आतून अस्वस्थ व्हायला होई (त्यावेळी परिषदेच्या कामामुळे त्यांच्याशी बऱ्याचवेळा संपर्क असे) पण सर हारले नाहीत. आयुष्यात फार काही शिकायला मिळाले. एक निराळे बळ मिळाले.

नेतृत्त्वाचे तीन टप्पे असतात. पहिल्या टप्प्यात नेता स्वत:पुढे होऊन जनतेला पुढे घेऊन जातो. दुसऱ्या टप्प्यात नेता स्वत: मागे राहून लोकांना संघटित करून कार्यप्राप्त करत असतो. तिसऱ्या टप्प्यात संघटनेला, लोकांना वाटायला लागते की तेच स्वत:च्या प्रेरणेने पुढे जाताहेत. मराठी विज्ञान परिषद, भाभा विज्ञान शिक्षण केंद्र यांची कामे मी ज्या काळात जवळून पाहिली त्या काळात सरांनी हा तिसरा टप्पा सहज ओलांडला होता.

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# *Why Aren't We Doing Better?*

***Prof. B. M. Udgaonkar***

It is always good to see how others view our predicament, all the more so when the commentator is a veteran and perceptive journalist like John Maddox, and commentary comes at a time when our country is at one of the water-sheds of history.

The tone of the 20-page special feature in a recent issue of Nature (12 April, 1984), written by its Editor, John Maddox, with contribution from Vera Rich, is set by its title : "Science in India : Excellence in the Midst of Poverty", and his bias is made explicit in the inset entitled "India's Inheritance of Ambivalence," where he States : "Among developing nations, India has by far the best chance of succeeding. The doubt is not whether but when. The country's greatest asset is not its natural resources (which are nonetheless vast) but the ingenuity and articulateness of its people" (emphasis added).

In search of clues to an answer to this question, Maddox has obviously visited a large number of our institutions – as many as 20 of these are subjects of some discussion in the survey - and talked to a large number of people, from the Prime Minister downwards. The result is an impressionistic macro-view; painted with broad - sometimes sweeping-strokes, and punctuated by snapshots of institutions and individuals, often in a journalistic style (for example, scientist X, people say, "can get away with murder"). One finds the familiar formidable difficulties listed : population, poverty, illiteracy, cultural and geographical diversity, multiplicity of languages, the problem of centre-state relationships. There is credit for achievements ("many in India overlook what has been accomplished"): the green revolution; the space programme; urban prosperity; the ability to gear up quickly to new challenges like Antarctic research or ocean research, including work on deep-sea poly-metallic nodules; the islands of excellence; the fact that the principle of democracy and the conviction that science and technology (S & T) are indispensable for development continues to be upheld; and the vast S & t infrastructure, ranging Over wide fields, that has been built up.

It also brings out the weaknesses, vulnerable spots, and failures of the system : the gap between what could be and what is. For example, the sad situation that diseases banished elsewhere are still common and the inadequacy of immunisation programmes: the contrast, between rural poverty and high technology; the coexistence 'of success stories in some sectors of the system with sheer inefficiency in others (as represented, for example, by the situation that "the Indian telephone system is apalling, and a bizarre impediment to efficiency"); the tendency to spread resources thinly, which is "a recipe for doing everything a little less than excellently"; "the peculiar difficulty that first-rate institutions are so few as to be a veneer that barely conceals the prevalence of the second-rate"; the poor pay 'of scientists; other impediments like a hierarchical system and the non-delegation of authority to spend even relatively small

amounts, from which, scientists suffer in many institutions, especially in the universities; the problems of university structures, in general; the enormous brain-drain from "the splendid institutions of higher learning in science and technology", ("IITs are India's most generous gifts to the United States").

"But what's new in what Maddox tells us- something we didn't know already?" ask my scientist friends. "Isn't the writeup too journalistic? Should we not have, expected Maddox, a frequent visitor to India, with .easy access to individuals and institutions, to go beneath the surface .and provide a more analytic survey? Why these snap-shots of some institutions, taken in the style of a journalist who listens to some impressarios and does not look beneath the gloss presented by them?"

We do not agree. An indepth review of this kind would require an army of experts in the relevant areas, and had better be done by us ourselves. In fact, instead of the self-flagellation which Seems to have become a' national 'pastime, we would do well to carry out a Strength Weakness Opportunities and Threats (SWOT) analysis, ourselves, sector by sector and institution by institution preferably by insiders, with the help of a few outside experts.

To us, the macro-view presented by Maddox is more important than the details - the details merely serve to provide a flavour of, certain components of our system. Especially, the strength of the system that he sees, is often missed in our country, even on the part of the makers of policies and decisions - the decisions in favour of foreign collaboration in particular,

Science-based success, for which India has been striving since Independence, seems to him to be within our reach. One can almost hear him asking in exasperation : When will these people recognize their strengths and potentialities, and learn to organise themselves more effectively, and gear themselves not only for a purposeful, attack on poverty at home, but also for a substantial participation in the competitive international market of technology-intensive goods, as Japan has done'! And do they accept that there are and will always be two Indias - a developed third that is comparable with developed countries, juxtaposed with an underdeveloped two thirds, with very little interaction between the two? He does not attempt to provide what he calls "a presumptuous answer" to the, question, "Why aren't we doing better?" He merely points out that the question is being raised elsewhere too - in UK, W Germany, even in USA, and leaves it to us to seek the answers.

While raising such questions, explicitly or implicitly, Maddox provides a far better perspective than is seen in some of the, dismal correspondence on Indian science that has appeared recently in the columns of Nature. The reason is obvious: Maddox is not an emigre Indian who has to rationalise his decision to stay out of India by painting the Indian scientific scene, with a black brush - one of these thanks Providence on behalf of the world at large that Einstein was not born in India! Nor does he have to react defensively, like many insider. An outsider, he can draw upon the perspective that he has gained over the years as the editor of a prestigious journal. ,

I have a feeling that perceptive foreigners are able to see our potential and growing strength in S & T somewhat better than we are willing or able to do ourselves. I am reminded of Abdus Salam's prophesy that India will emerge as a technological, superpower by the turn of this century and, of recent article, by Bertrand Goldschmidt on Indian Nuclear Problems (Physics News volume 14, 1983), in

which he. evoked the possibility that India may, in the not-too-distant future, start exporting heavy-water power reactors - a sobering backdrop to the current public discussion of the problems of our atomic energy programme, of our heavy water plants in particular.

It is not my intention to claim that a foreign observer like Goldschmidt or Salam or Maddox is more objective in his assessment than most of us. But could it be that we are too close to the scene, or too involved with components of it and, overwhelmed by the immediate problems and frustrations, are unable to take an objective view? To see the wood rather than the trees? Why, did it need an Attenborough to produce Gandhi?

It is interesting to note that Maddox does not, share the prejudice of many commentators from the West, that what they call "elitist institutions", or our Government's pursuit of space application and nuclear energy, are to be considered a laxury in the midst of poverty, squalor and needless death. He sees the logic of these pursuits. On the other hand, he does not seem to understand the logic of our of repeated policy of self reliance which he thinks is a recipe for spreading resources thinly and thus for doing everything a little than excellently.

In the brief space available, I can only delineate the directions in which we have to move if the nation is to realise its S & T potential and bridge the gulf that separates the two Indias. These may be pertinent at a time when the seventh Five year Plan is on the anvil.

First of all, one looks in vain in the documents of the Planning Commission for a definition of the kind of Indian society that our decision making elites would like to see emerge by the year 2000. There is too much ambivalence A bold vision and a phased action programme calculates to realise the objective in the course of three Plan periods, with resource allocations commensurate with the magnitude of each task, is urgently called for. This would no doubt call for structural changes and a redefinition of many priorities. S & T planning will have to be integrated into this socio-economic planning process. Such integration has been talked about for at least 15 years, but is hardly in evidence. The tragedy of the first S & T Plan prepared by the NCST in 1973 haunts our memories. Yet there continues to be a big gulf that separates economists and other social scientists from S & T. One has only to see the presidential address of Kamla Prasad at the 66th annual conference of the Indian Economic Association under the title "Planning in India : Some Basic Issues Relating to Operational and Strategic Aspects", and the Sri Ram Memorial Lecture of Man Mohan Singh, under the title "Quest of Self. Reliance", both delivered in December 983. Neither of these seem to consider S & T an (important) ingredient of the issues involved at all.

One may of course point out that addresses of many eminent scientists do not show an awareness of socio-economic problems. True enough. The point is that unless the gulf is bridged, the whole process of planning itself will get distorted and discredited - because in the absence of a clear-cut strategy for building up our S & T muscles in the context of economic targets . and purposefully using the strength developed to fulfill them, neither S & T nor the . economy can progress. The Planning. Commission too, and most of the economic ministries, continue to be poorly equipped for the tasks involved.

Secondly, we need a greater resurgence of a nationalist or Swadeshi spirit. reminiscent of the . freedom struggle with its boycott of foreign goods. One sees foreign collaboration lobbies

operating every where, and self-reliance getting severely eroded. A senior technocrat once remarked to us: "In Delhi one sees many American Indians. French Indians, Russian Indians but very few Indian Indians."

There has to be a close nexus between the relevant ministry, the public sector and the R & D laboratories to create new technologies and to absorb and improve upon imported technologies (SR Valluri SCIENCE AGE, January 1984), with the objective of using the vast Indian market as a spring-board for exporting selected technologies and their products. Electronics and telecommunications, heavy electricals, fertilisers and petro-chemicals, oil exploration and production technologies would be some examples. in view of the fact that tens of thousands of crores will be invested in each of these sectors in the next 10-15 years. We need our own equivalent of the famous MITI in Japan. There is also a need to absorb the discipline demanded by modern technology and a far greater emphasis on quality control, efficient operation and preventive maintenance. Among the things we have to learn from the oft-mentioned example of Japan is a justifiable national pride.

And what about the educational sector?

The really tertiary sector of education (post-graduate and doctoral) has to be delinked from the mass education sector including the first degree. One must move progressively towards academic autonomy to all colleges by the year 2000, so that there may be greater quality consciousness and accountability and experimentation and innovation in the collegiate system which has become the Achilles' heel of the university system. Any new college that is started should be planned in such a way that it could be autonomous form the beginning. The fiction of university control of colleges through inspection affiliation and common examination had better be discarded forth with.

Once undergraduate colleges are suitably delinked from universities and the undergraduate examination are transferred to Boards (as had already happened first for matriculation or SSC examination and then for the HSC examination) Universities or their departments will have to be strengthened selectively and provided with suitable structures to enable them to become comparable with the more successful national laboratories in the first instance, and then with universities like Oxford or Cambridge, Berkeley 'or Princeton, by the year 2000. A pipe-dream? Why should it be?

I am sure that once a new vision of resurgent India is operationalised, the challenges presented in the new vision will reverse the brain-drain.

All this no doubt calls for changes in the prevalent value system in our society, various structural changes at a variety of levels, and determined efforts in spite of the vested interests involved. A tall order? Not if we reflect that nothing Jess than our. survival as a nation is at stake. The key question is, do we have the courage to take off? The alternative is to resign ourselves to slide back from the crest of the watershed.

There is no third alternative, and there are no soft options.

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# *Science and Technology capability building in developing countries-some issues*

***A Dialogue between 'Prof. Abdus Salam and Prof. B. M. Udgaonkar***

During Professor Abdus Salam's recent visit to Bombay, on 10 and 11 January, 1981, Professor Salam and Prof. B. M. Udgaonkar had extensive discussions on a range of issues relating to the scientific and technological capability building in the developing countries, The discussions covered the scientific disparities-past and present between the North and the South, the problems of isolation and of institution building, the role of basic research in developing countries, the importance of building Centres of Excellence located within developing countries, problems encountered in the North-South dialogue, and the importance of the developing countries depending on their own resources and working out collaborative programmes, amongst themselves. The discussions were arranged by Times of India, Bombay, and a part of these was published in Times of India, 25 January 1981.

**BMU :** Prof. Salam, I would like to discuss with you a range of issues relating to the scientific and technological capability building in the developing countries. Perhaps we can begin with one of the recurrent themes in your lectures and writings-what you have called "the cycle of scientific disparities."

**Salam :** Yes. We were the leaders in sciences at one time but we lost the lead. It was lost mainly because of isolation. It is incredible how the Hindus were isolated quite early. The Chinese destroyed all the boats so that they would not come into contact with the outside world. The Japanese resisted all incursions until Commodore Perry forced them to 'open up', I have found recently that during the mediaeval period the Muslims also cut themselves off. They were really at the top at one time, before the 13th century. In the 12th and 13th century, the Westerners avidly sought the science from the East, translated it, mastered it, and started improving upon it, but we did not do the converse.

**BMU :** Why has this happened ?

**Salam :** There are deeply internal causes apart from the external ones. I think in the world bf Islam, the theological and Sufistic movements took men's minds away from that sort of endeavour altogether. This is my feeling, but a lot of research is needed for a better understanding of what happened. In any case, the fact of isolation is totally indisputable. The Portuguese developed a new style of navigation which did not follow the coast or the ocean currents-as did the old style of navigation. They went by cutting across the currents and came to India, but we made no attempt to pick up the new navigational advantage, or the science which was behind it. Another example: Maharaja Jaisingh was a remarkable man. He tried to correct the old astronomical tables compiled in the 15th century, and he did correct serious errors of the then Western tables for eclipses of the sun and the moon. But he made no attempt to learn the theories of Galileo.

**BMU :** Yes. Also, while planning and

constructing his observatories (Jantar-Mantar), he did not take cognisance of the discovery of the telescope.

**Salam :** Yes. He was totally unaware of the telescope. But, perhaps we cannot blame him for that, because telescopes in observatories came a few years later, after his death. However, the theories of Newton did exist. He was not interested in. them.

There was also a certain degree of arrogance amongst us. Our people became extraordinarily introverted and arrogant. The British Ambassador at the court of Ottoman wrote in 1800 A.D.: "No one has the least idea of navigation and the use of the magnet. Traveling, that great source of expansion and improvement to the mind, is entirely checked by their arrogant spirit and by the jealousy with which intercourse with a foreigner is viewed in a person not invested with official character. Thus, the man of general science is unknown. Anyone but a mere artificer who should concern himself with the founding of cannons, building of ships or the likes, would be esteemed to be a little better than a mad man. They like to trade with those who bring to them useful and valuable articles without the labour of manufacture".

**BMU :** Unfortunately, the same sort of attitude with regard to import of manufactured articles and technology persists in the developing countries even today.

Coming back to the shifting of the centre of gravity of intellectual pursuits, especially in science, one finds certain shifts even in modem times: e.g. the centre of gravity of scientific research in the 1930's was in Europe, to a considerable extent in Germany. It then shifted to USA. More recently, the Europeans have made very deliberate efforts to reestablish a European identity by creating several European Agencies. For example, the European Nuclear Research Centre (CERN), the European Space Agency, the European Molecular Biology Organization, and various European research journals. With these efforts, they have succeeded to a considerable extent in shifting the centre of gravity towards themselves. There have also been, in the industrial field, mergers of small corporations into large ones, sometimes across national boundaries, and joint ventures and other reorganizations so. that they may be able to compete with the American corporations-to meet the American challenge. Do you think that these developments have any lessons for the Third World?

**Salam :** Yes. If a deliberate effort is made in a concerted way by the Third World, we can equally win back, if not the supremacy, at least some sort of equality and decency.

When I go to a hospital and ask for medication for saving my life, it always enters my thoughts whether this potent medicine has anything to do with our fathers or forefathers. Did we make the slightest contribution? Do I have the right to accept it just because I can pay for it, or because those people are kind enough to let me have it? One's self respect and decency suffers. I feel amazed that other people do not suffer in the same way. We have such a habit of begging. Our ambassadors go and say "You must give us technology, because we are developing, and it is a moral right in the universe that you should help the developing countries with technology transfer." God damn it. Let us have some self-respect. Let us create something ourselves.

**BMU :** I agree. I have always felt that there is very little altruism in such matters, and that we have to make deliberate efforts ourselves to build up our own S & T capability. What are your ideas about capability building ?

**Salam :** There are no two ways about it. We have to spend money and efforts on these matters. There is no reason why we should not succeed.

**BMU :** For years, the developing countries have been saying that they must spend atleast

one percent of the GNP on R & D. But, even here in India, R & D expenditure has barely reached about 0.6 percent of the GNP. In other developing countries, it is much less. On the other hand, the developed countries spend 2, 3 or even 4 percent of their GNP on R & D.

**Salam :** Yes. But you are forgetting the absolute amounts. India's 0.6 percent of its entire GNP is still a miserably small sum of money. The costs of science are international. They do not decrease because you do it in Bombay and not in Trieste. In some ways, Europe may be cheaper because of the availability of materials and equipment nearby, and also experts nere by; so that less efforts and money are needed in order to transport them. We in the developing countries are just not doing enough.

I am also more and more worried about science percolating to the masses. That is as important as getting the cream of science and technology. Both are important-one is no substitute for the other. If you really wish to build a base for science, you have to do it.

**BMU :** This is what Panditji used to call the generation of scientific temper.

**Salam :** May be, he was ahead of his time!

**BMU :** Even today, scientific temper is not particularly conspicuous even among the decision makers.

**Salam :** It looks to me that you have begun to have people in high places who are scientifically trained.

**BMU :** Yes. There are some scientists taking up secretarial positions in the Government, but they are up against odds because the methodology and the imperatives of scientific planning, and the discipline which they imply, have not yet been appreciated and imbibed by the system as a whole.

With regard to generation of scientific temper among the masses, there are some beginnings of popular science movements in India. There is already a rather powerful movement of this kind in Kerala-the Kerala Sastra Sahitya Parishad. There is also the beginning of such a movement in Maharashtra: there is a group of committed young people who call themselves "People's Science Movement".

Have you any suggestions to make science percolate to the common man?

**Salam :** We have to get the co-operation of all types of people. Let me not talk about India. In Pakistan, I have been trying to interest the scholars of Islam. Religion is a very, very powerful, potent force, and so far as Islam is concerned, science has been emphasized again and again as a method of acquiring knowledge - I think the same is the case with the Hindu scriptures. If we can get these people in religious seminaries to take up the movement of science on our behalf, it may help. On the other hand, to get them into this way of thinking is not an easy job.

**BMU :** Would it also imply that the scientists must not confine themselves to the walls of their laboratories and universities, but take interest in social problems, especially those which can help the penetration of science into the society?

**Salam :** What you referred to a moment ago, scientific planning and methodology, that is the heart of the matter.

**BMU :** That would be at a rather sophisticated level. The other problem we talked about is at a more general popular level.

**Salam :** Yes. For example, in our countries we use the human labour inefficiently. The sweeper, for example, is using a methodology which he learnt as a craftsman generations ago, and he has never had the opportunity or the time, or thought for himself, how to improve his way of doing things. You will have to get down to that level.

**BMU :** True, but unless people who have a scientific training and way of looking at things, interact with such people and educate them to look at their own occupation in a different light, we cannot change them. Could we?

**Salam :** That is the heart of the matter.

**BMU :** Let me now turn to the international efforts in the matter of S & T for development. In your article "Ideals and Realities" published some years ago, in the Bulletin of Atomic Scientists, you had referred to the 1963 UN Conference on the Application of S & T for the Benefit of Less Developed Areas. At that time, the developing countries had pressed for the creation of a World Science and Technology Agency-a Technological Development Authority -supported by an International Bank for Technological Development. This proposal was turned down by the developed countries. Do you think that the UN Conference on Science and Technology for Development (UNCSTD), which was held in Vienna in August 1979, has made any progress?

**Salam :** The whole UN system, quite honestly, has been vitiated totally by numerous factors. I was a member and then the Chairman of the UN Advisory Committee on Application of Science and Technology to Development (UNACAST). We drew up a World Plan of Action for S & T. After three meetings, I said: " Gentlemen, we should disband. All that we could do has been done already. We were asked to write a report, which has been written. We cannot supervise any action." But UN committees have a life of their own. The Committee did nothing of any significance afterwards, except for preparing for the 1979 Conference: and that was a fiasco.

I think the developing countries have to forget about the rich countries. They are simply not interested in us. May be the climate will change, but I see no signs.

**BMU :** I very much share your feeling. Recently I was discussing this problem with an eminent visiting educationist from the rich North, and he frankly remarked that, except for its oil resources, the Third World just does not exist for these people. There is however an important implication-that the developing countries must work together. There has to be a greater economic co-operation among developing countries (ECDC), and much greater technical co-operation among developing countries (TCDC) too. But these have yet to take off.

**Salam :** We have not even formulated the concept in detail. We have never formulated joint projects among developing countries.

**BMU :** Do you feel that in order to make meaningful progress beyond the rhetoric of ECDC and TCDC, the developing countries need an equivalent of the OECD, with its own Secretariat? This secretariat should have a strong S & T component so as to convert what appears like a rhetoric into a serious action programme. It should also provide an intellectual, analytical backing for the North-South dialogue which has run into a stalemate.

**Salam :** That will be a good idea. We must recognise that we must take our own steps.

**BMU :** One notices another problem. If we succeed in creating an institution, which does the same kind of basic research as done elsewhere in the world, and of comparable quality, our ' friends' criticize it as a transplant from outside, and ask " what is it doing for your society?". They would rather have a transplant of our bright young people into their society than a transplant of such institutions into our society.

**Salam :** Fortunately, India has come to a stage where it can really look at science and technology in a meaningful and all-embracing way. Unfortunately, that is not the situation in the rest of the developing world.

**BMU :** Well, India itself could have done much more in the last three decades, with more purposeful planning for and through S & T. In any case, what India has been able to do, could certainly also be done in smaller countries, where necessary on a regional collaborative basis. Would you agree ?

**Salam :** There is a very practical difficulty-a region does not exist in the minds of people. Take

Latin America for example. It is reasonably homogenous; yet an Institute in one country is not subscribed to by other countries. The Latin American Centre for Physics, therefore, has not been able to take off. In sociology, the first law is "hate thy neighbour".

**BMU :** Who would have thought a couple of decades ago that the Europeans would be able to forget their traditional rivalries and animosities and get together in so many co-operative programmes as they are doing today? I hope necessity will force the Asians, Africans and Latin Americans to co-operate also-and that this will happen before long.

I want to come back to the question of aid. and technical assistance. There exist analyses made in the Northern countries themselves, that through the so-called 'aid' programmes, they get much more out than what they give that they are themselves the real beneficiaries.

**Salam :** Yes. But no one accepts this outlook in our country-so much so, that my son who is reading economics at a university college has been brainwashed from the opposite point of view. Though he is a Pakistani boy, and is my son, and I had given him all my writings, he firmly believes that the whole aid is being wasted. This is what he is learning as an economist.

**BMU :** How do we get out of this situation ?

**Salam :** I think our economists have to do some basic homework. There was Keynes, who wrote so beautifully, with such martialling of facts, that he was able, slowly and gradually, to get across his point. To my knowledge, there is no such intellectual work at all for the New International Economic Order.

**BMU :** I thought people like Samir Amin have done some very useful analysis in this regard. I have also seen some documents from the Third World Forum. I agree, however, that there is not enough work-and even less appreciation of these problems in the Third World countries, especially among the decision makers

**Salam :** I believe-without any evidence, but I hope it will be found-that in aiding the developing countries, the rich countries will be aiding themselves in solving their present serious economic problems. If an integrated approach could be shown to work, if they are made to see that helping us helps them as well, then their self-interest will be aroused. If this belief can be supported by solid work like that of Keynes, we should win the battle in a few years. I had, in fact, wanted at one time to hold a Workshop on the New International Economic Order at Triests, just for this reason. Unfortunately, I could not get enough funds. I hope I am not arrogant, but I feel that we physicists and mathematicians, because of our training, have much clearer comprehension of these global problems and of what is needed, and we could make a logical case better than any professionally trained economists. Remember that Keynes was a mathematician.

**BMU :** What one finds in the North-South dialogue is, that the North continues to consider it as a zero-sum game, and therefore it is not willing to give much by way of financial or technical , assistance' except in a marginal fashion. On the other hand, the South is barely getting out of the phase of rhetorics. The Willy Brandt report does try to bring out the fact that the development of the South is in the interest of the North itself, and suggests various measures in the common interest of both. I find, however, that the Brandt report has either been ignored or severely criticised in the North.

I want to come back to the question of homework by the South. I believe that even though very useful work has been done by UN Agencies like UNCTAD, there are obvious limitations to any work done under UN auspices. Therefore, more work has to be done for the group of 77 by its own intellectual think-tank. This is what I had in my mind when I made a case for a G-77 counterpart of the OECD and its various study groups. Today this

is missing. Such a think-tank should, for example, work out a strategy for S & T capability building in developing countries at various stages of development, with various types of endowment, and with various sizes of population. I do not see why any country with a population of more than 4 or 5 millions should not be able to develop to the same extent as many of the small European countries. The Vienna Programme of Action talks about capability building in rather general terms. These have to be operationalised. Don't you think that the time has come for the G-77 to take such a step ?

**Salam :** I totally agree with you. In fact, it seems to me that your Institute and our Centre at Trieste could probably collaborate in starting such a project together. The International Federation of Institutes for Advanced Study (IFIAS) could have done this. Though I was one of its founding fathers, I now find that it has become far too committed to other matters. Something similar has happened with the UN University also, on whose foundation committee also I had worked.

**BMU :** What I notice about many of these International endeavours is that these organizations, even-though conceived differently and idealistically, with the hope that they would help the developing countries, eventually often tend to project the developed countries' point of view.

**Salam :** Yes, with a few developing countries as guineapigs.

**BMU :** I am afraid this is the kind of thing that is happening.. For example, I was very much dissatisfied with the State of the Planet Report made by the IFIAS. One could and did make comments on the draft, but ultimately the Report retains a certain character which very much projects the Northern view of the global problems. I noticed a similar thing about the International Foundation for Science (IFS). I was at the founding meeting of the IPS with you. At that meeting, I tried to make a plea that if the IFS confined itself to giving grants of 5,000 or 10,000 dollars here and there, it will not solve the problem of scientists in the developing countries such assistance will not help the growth of viable scientific programmes. It will only increase the dependence of the developing country scientists. They were expecting to raise rather large funds for the IFS, and I tried to suggest that they should set apart at least half the amount for creating Centres of Excellence located within the developing countries. To my dismay, I found that they did not take any interest in this idea at all.

**Salam :** They could collect only a few million dollars, and. this was .not enough to create Centres of Excellence.

**BMU :** That may be so, but even in those discussions at the meetings at Stockholm, which were at an idealistic level, where much larger amounts were talked about, and one was trying to project the perspectives of the IFS and the funds needed in the light of the perspectives, there was just no interest among our friends from the North in creating such Centres of Excellence.

As I think the IFS is one of the few organizations which still has the potentiality of thinking along these directions.

**BMU :** Do you think so? I did not get any response then. I would be happy if their attitude has changed.

**Salam :** In agricultural research, they are doing good work around the world. There is a recent proposal to have another branch of IFS in Canada. But funds are a real problem. IFS does not have more than a million dollars. It may take another 3 years to get another million. It is so difficult to raise funds.

**BMU :** Because it is so difficult to raise funds on the scale required to create Centres of Excellence, one ends up by merely giving grants of 5,000 or 10,000 dollars a year here and there. Such amounts are really like a subsistence

allowance. They are no more than palliatives. Such programmes do not touch the core of the problem!

**Salam :** Yes. They merely enable scientists to survive.

**BMU :** They do not help to create viable local centres or the confidence which goes with the creation of such Centres of Excellence-the kind of confidence, for example, which one finds coming out of the TIFR. I believe that such Centres must be created on a large scale in our developing countries. Very probably we cannot expect much help for this purpose from outside.

**Salam :** For such Centres, I think we in the developing countries have ourselves to make up our minds and find resources. Recently, I visited several Latin American countries and tried to persuade them to establish not regional, but international institutes-Brazil, Mexico, Peru, Venezuela.. An International Centre on Alternative Energy is contemplated in Brazil. Mexico is setting up a Centre. In Peru, I have suggested to them to set up an International Centre for Mining Technology, and the new Government has accepted it. A Centre for photovoltaic in Colombia. Venezuela is setting up a Foundation which will guarantee a substantial income for a multi-disciplinary centre. I am trying to persuade the other OPEC countries to get interested to set up similar centres. A centre for fundamental research has been announced by the President of Sri Lanka. I am sure similar suggestions for national or international centres will come from other countries of Asia and Africa which I will be visiting.

**BMU :** What this implies is that we need to create Centres of Excellence in various areas of S & T, located in the developing part of the world, and financed, largely, if not entirely, through the resources of the developing world itse1f

**Salam :** Resources of the country. I have taken the view that such centres should be international in character, and not regional, with international staff and visitors, but largely financed by the countries themselves. That is the only way to create the type of confidence you were talking about

**BMU :** And then build network arrangements among these centres.

**Salam :** Absolutely. It is a great tragedy that the UN University, created for such a purpose, has not taken any initiative in this at all.

**BMU :** By the time such concepts like IFIAS or the UN University get off the ground, they get utilised by the existing system in its own way, for its own purpose, and they get distorted. We do not seem to be paying enough attention to see that the distortion does not take place; or are we powerless?

**Salam :** Partly, we are powerless; partly, we are busy men. Having pushed an idea, one often does not have the time and the energy to follow up. I think the only thing to do is to place the idea in the hands of people who hold similar views. If that happens .the organizations will survive, otherwise not.

**BMU :** Yes, you need people with a commitment to follow up.

**Salam :** Coming back to the point you made earlier about the New International Economic Order and the need for think-tanks in the developing countries, can you think of some institute in India which would be doing this? This would involve a mixture of the economics community and of the physical and biological sciences community as well.

**BMU :** While there are various institutes of economics, I am afraid I cannot think of any institute which deals with these global problems in depth, and in the broad perspective that we are thinking of.

**Salam :** This is a tragedy. However, it takes a long time to get somebody to listen to it-to persuade people to build new structures. If there is some existing structure which could be strengthened, the process could be much more economical and faster.

**BMU :** The problem I find is that while countries like ours have certain aspirations with regard to science, and certain expectations from S &; T, one misses a long term perspective, and an analysis of all the implications of S &; T capability building and self-reliance, both for internal policies and external policies, including the hard political decisions that are often necessary. This kind of thinking is barely beginning, I feel.

**Salam :** I think you are lucky in India.

**BMU :** May be more lucky than other countries. But even here one finds that it is a painful process to convince the decision makers that we need to think in a long term perspective and must not allow ourselves to be just pushed around by immediate problems. Planning, particularly in the domain of S &; T, is not as strong as it should be.

**Salam ::** The problem in the developing countries is not merely that the expenditures on S &; T are inadequate; even more important than this is the will to utilize science and scientists in every sphere of national development.

**BMU :** Let me come back to the importance of basic research for developing countries. One finds that many friends from the North, and even , experts' from the UN Agencies, often advise the developing countries that basic research is not for them; that since they have enormous problems in relation to basic needs which need to be solved urgently, they should concentrate only on them and not try to build institutions of basic research, whose benefits will be seen only after a long time. I have seen this kind of point of view being projected again and again at international forums-Pugwash, UNESCO, UNDP, UNCSTD and so on-and one has had to counter it strongly.

**Salam :** Yes, and our own people get brainwashed. I am reminded of the concept of a 'supermarket of technology , which was promoted by Blackett. We must not forget that technology in the conditions of today, cannot, in the long run, flourish, without science flourishing at the same time. One part of the development without the other is meaningless. This is really the crux of the problem. But they don't seem to see the point. I think you know the famous remark made to me when I suggested the creation of the Trieste Centre at the IAEA in 1962. One delegate put it very clearly: " Gentlemen, Professor Salam is asking for a Centre of Theoretical Physics. Theoretical Physics is the Rolls Royce of Sciences. But what these men need is nothing more than donkey-carts". So it is the donkey-cart which they think is good enough for us. But donkey-car unfortunately, can take you only part of the way, not the whole way. And then the discrimination which needs to be made between one donkey-cart and another -that comes only by knowing about the Rolls Royces. Basic research provides the nation with such discriminating people. It is the class of discriminating people who have to be encouraged.

**BMU :** And basic research creates a culture of science in the country. Otherwise, one has just a borrowed culture, and imitation-in technology and other areas.

**Salam :** Absolutely. Japan, for example, has a very strong. scientific community-more than in the West. Compared to Japan, some of the European country are illiterate.

**BMU :** Right from the beginning of the Meiji era, Japan has laid emphasis on the creation of such a broad basis for science and technology

**Salam :** A recent report of the US National Academy of Sciences bewails the fact that ten years from now, USA may be left behind. One finds them bemoaning that they are no longer undisputed number one in the world of particle physics.

**BMU :** May be this is because of the concerted efforts of Europe, to which I referred earlier.

**Salam :** Yes, but you may ask, why are the Americans not happy being number two? Why has it always to be number one for themselves?

**BMU :** And why should the developing

countries not aspire to number one or two at least in some areas?

Let me pursue this question about basic sciences a little further. As you know, there are several scientists from the developing countries who have done quite well in theoretical physics. But there are very few in experimental physics. This gives rise to a lop-sided development. One may even say. that without close interaction with experimental physics of a high order, it is difficult to have theoretical physics of a high order. So developing countries must build major experimental facilities, e.~. accelerators for nuclear physics, even if they are costly. In high energy physics, developing countries do not have even a local base from which to use international accelerators like those at CERN or Fermi Laboratory, leave alone a major accelerator of their own. They do not even dare to think in these directions. Do you think that time has come for us to embark upon a two-prong programme? In the first place, to build up viable teams of experimentalists locally, and to support them on an adequate scale for building. instrumentation that could be used to carry out first rate experiments at one of the accelerators in Europe, USA or USSR; and secondly, through these efforts, to build a base which can be used either for building a world-class accelerator as a co-operative endeavour among developing countries, or for joining as partners in the world-wide collaboration project on a Very Big Accelerator that is under intensive discussion today.

**Salam :** I entirely agree with you. I have recently been elected to the Science Policy Committee of CERN. I would be very happy to- I want to take up this question there. Unfortunately, they always say, 'you pay for it and join', and we are in no position to pay. What I would like to suggest is that they should make only a nominal charge for participation by scientists from the developing countries. As far as the CERN is concerned, this may not be easy it is a political decision.

**BMU :** This reminds me of a letter I had written several years ago to an eminent scientist-friend at CERN, suggesting that in view of the strong interest shown by bright young Indians in High Energy Physics, and the fact that in India they have no opportunity of interaction with accelerator physicists, it would be very helpful if CERN could provide financial support to a larger number of young post-doctoral Indian theoretical physicists, on merit, without the numerical restriction that arises from the fact that we are a non-member country. This was found difficult to accept. As you say, it is a political decision. Among the difficulties that were pointed out to me was that the authorities concerned "would not be easily convinced of the fact that High Energy Physics is at present the most pressing item in the poorer countries."

**Salam :** They have now accepted the proposal to have more scientists from non-member countries. But they unfortunately make us compete with the Americans. What I do at Trieste is to give special privilege to the less developed, and I want something similar to that set up at CERN. You may know that Ledermann also is planning to set up a little cell at Fermi Laboratory to help the developing countries to use the accelerator there. One has to keep on pushing these ideas all the time.

**BMU :** I have been trying to push one idea about a major experimental facility located in the Third World and built largely as a co-operative endeavour among developing countries-a TCDC project. This is the proposal for a Giant Equatorial Radio Telescope, and, associated with it, an Institute for Space Sciences and Electronics. Its design utilizes the experience of our radio-telescope at Ooty. But it will be ten times more powerful. Its design demands that it has to be located at or very close to the equator. Its unique features are that it will be an instrument at the very frontiers of astronomy, and yet one that can be built with the knowhow that exsists within

the developing countries, and with relatively modest investment-about 20 million dollars over a five year period. And morever, it should have immediate spin-off's for the participating countries in the form of competence building in important areas of sophisticated technology, such as microwaves and antenna systems, communications including satellite communication, and so on. The Director General of UNESCO has taken interest in it. UNESCO helped us to organize a Workshop and prepare a project report. This has been done. The problem now is of mobilising finances for it. The resources at the disposal of the Interim Fund created after UNCSTD are so measly, that one cannot even think of making a proposal to them.

**Salam :** Yes, compared to the 2 billion dollars per year the developing countries were asking for at Vienna, the rich countries agreed to a figure of only 250 mil1ion dollars as an Interim Fund for two years, and I understand that only 40 million dollars have been pledged so far !

**BMU :** The situation seems to be much worse than that. Of the 40 million dollars 'pledged' to the Interim Fund, only about 10 million dollars apparently are actually in the hand !

**Salam :** We are trying to persuade the Italian Government to finance an international solid state physics laboratory. This laboratory will act as a sort of clearing house, not only of information but for actual dispatch of small quantities of materials to people who require them in the developing countries-a kind of repository. Secondly, it will do high quality research. Thirdly, what is called 'fatigue physics'-why devices fall-will be a major branch in this laboratory. I know your views, but the Italian Government will not finance it if it is not built in Italy. Such a laboratory cannot, by definition, be in a developing country, unless some developing country takes a lead in providing the resources.

**BMU :** Could you not persuade some oil-rich country to finance it ?

**Salam :** The trouble with the oil-rich countries is that there is very little awareness of science. It is a long process, to infuse pure sciences particularly. For example, I was recently discussing with a leading nuclear scientist in one of the very rich oil countries-one who shuttles back and forth between his laboratory and a major laboratory in the West. When I asked him about the plans of his laboratory, he said he was going to concentrate on solar energy, and there too on the demonstration of devices under the field conditions in the middle-East. , What about fundamental physics?' I asked. He made a very interesting remark: 'We in our country, by tradition, have been traders and merchants. For us, what is of importance is what can be of immediate benefit to us. We are not interested in basic sciences'.

**BMU :** And this is said by a scientist!

**Salam :** And he is their best scientist.

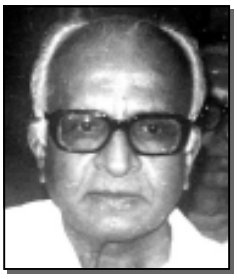
**BMU :** So it is going to be a long educative process?

**Salam :** It is a long process, especially when you have even indigenous friends using all types of arguments. Our people have been so much brain-washed! That is why, in my speeches, I am putting a lot of emphasis on past glories. I am pretty certain that the Arab nations have the potential. Last time, when they were great, they did take off in an enormous way. I have a feeling that after ten years of reminding them of their past accomplishments in science, by which time they will also get tired of spending their money on other pursuits, they may turn to the essentials. The only worry I have is that they may have exhausted their riches by that time. But I am not despondent. We have some friends there. For example, in Saudi Arabia, they are planning for fusion research. But I have only 10 or 15 years of active life. I do not know whether I will see the fruits of all these preachings or not.

**BMU :** Well, if one did only those things whose fruits one can see in one's own life, humanity would not have progressed very far.

***( Courtesy, Times of India, Bombay)***

# *National Security - Its International Dimensions : Some Observations.*



*Prof. B. M. Udgaonkar*

**PUGWASH**

What is Pugwash? Pugwash is an international Non-Governmental Organization (NGO) that was awarded a well-deserved Nobel Peace Prize for 1995, sharing it with its President, Professor Rotblat. Since its inception in 1957, Pugwash has been bringing together scientists, social scientists, and other academics and distinguished people, covering a wide spectrum of ideological and geographical groupings, "to appraise the perils that have arisen as a result of the development of weapons of mass destruction and to discuss a resolution", a call given by the Russell Einstein Manifesto. The R.E. Manifesto, the credo of Pugwash, was issued in July 1955 and was signed by 11 distinguished scientists, most of them Nobelists. It drew attention to the predicament of mankind in very poetic language, e.g.

"We are speaking on this occasion, not as members of this or that nation, continent, or creed, but as human beings, members of-the species man, whose continued existence is in doubt...."

and called upon scientists to

*"remember your humanity and forget the rest".*

Pugwash has been influential in maintaining a continuous focus on global issues of peace and security raised by the development of weapons of mass destruction for over forty years. Pugwash's preoccupations during the cold-war years were, however, largely with arms control rather than disarmament, and correspondingly with nonproliferation rather than concrete steps towards elimination of nuclear weapons. Pugwash thinking has been largely North-centric (about two-thirds of the members of its Council have always been from the countries of the North, and a larger fraction of the participants at the Conferences and Workshops organized by it), but it has sometimes been amenable to persistent suggestions from other cultures, e.g. with regard to a Draft Code of Conduct for Technology Transfer, Guidelines for International Scientific Cooperation for Development, a timeframe for the elimination of nuclear weapons. Pugwash started moving slowly and haltingly toward the promotion of the concept of a Nuclear- WeaponFree World (NWFW), only after the end of the cold war, around 1988. By 1993, it came out with its first monograph on a NWFW. It took some more years for Pugwash to realize the need to call for a well defined time frame for achievement of the objective of elimination of nuclear weapons. This it did with its Quinquennial Statement of Goals, in 1997 when a period of not more than two decades was mentioned for the first time.

**PUGWASH AND THE NPT REVIEWS**

I was elected to the Pugwash Council and Executive in 1987. My primary interest at Pugwash until 1988 was in issues of science and development. My serious interest in nuclear issues was triggered by a draft Pugwash statement for the 1990 NPT Review Conference, which was placed before the Council for approval, at the Council's pre conference meetings at Moscow at the end of August 1988.

It was surprising to find a Pugwash draft following the traditional approach of the Nuclear Weapons States (NWSs) to NPT : It did not address itself to the discriminatory provisions of NPT, it was complacent with regard to the lack of progress on the commitment made by NWSs under article VI of the NPT' and did not mention the objective of a NWFW, nor the logical inconsistency of the doctrine of nuclear deterrence, firmly held by the NWSs, with a nuclear non-proliferation policy. It did not call for a time-bound programme for the elimination of nuclear weapons, and yet it called upon countries which had not joined NPT to do so, "thus enabling NPT to become a universal instrument of peace and security"! I raised strong objections to the tone and content of the draft, and suggested a revision. An attempt was made by some of the veteran members of the Council to have the draft approved without much change, on the ground that there was now no time to revise it substantially. It was clear that they were not worried about the discriminatory character of the NPT, and felt that the world was safe in the hands of the five NWSs, and agreed with the NWSs that it was desirable to keep others out of the nuclear club, without any commitment to a fading away of the club. Like many others in the South, I could not consider the world safe in the hands of the five NWSs, knowing the behaviour of many of them (and their NATO allies) during the colonial era, and even more recently, as in Vietnam, or with respect to Apartheid, etc.

After long discussions, where some members of the Council supported my stand, it was agreed that the Pugwash Executive would finalize the Statement at its meeting at the end of November in London, and it was left to me to make a fresh draft. A reasonably satisfactory statement, incorporating some of the concerns expressed by me as also the relevant recommendations, was finalized and issued on 30 November 1988. This final statement included a strong assertion about the fundamental incompatibility of nuclear deterrence strategy with non-proliferation goals, in as much as there is no logical basis for denying the "right" to a nuclear deterrent to some States while according it to others. It also called for a comprehensive action plan, with a specific time-table, for stopping and reversing the nuclear arms - race, and for a formal commitment of all nuclear weapon States not to be the first to use nuclear weapons. These objectives continue to be elusive.

It was encouraging to note during these discussions that though Professor Rotblat's immediate reaction to my opposition to the original draft Statement was negative, he also remarked that his own personal thinking was similar to mine. He referred to a recent paper of his, "The Elimination of Nuclear Weapons : Is it Desirable ? Is it Feasible ?, " which I had not yet seen; but added that these were not the views of Pugwash and that he was torn between his own views and those of Pugwash.

The discussions on the Statement for the NPT Review Conference had an impact on the customary Council Statement issued after the Dagomys Conference in September 1988, which included, inter alia.

i) NWFW among the goals of Pugwash (For the first time after being kept on the back-burner during the cold war).
ii) an assertion that the policy of nuclear deterrence was in contradiction with the non-proliferation goals of Pugwash.

My proposal that one should include a timeframe for attaining NWFW was rejected on the ground that no one knew how to define a timeframe notwithstanding that Gorbachov had written to Reagan in January 1986 proposing a broad timetable for the elimination of all nuclear weapons by year 2000, and that Rajiv Gandhi had presented to the UN Special Session on Disarmament (UNSSOD-III) in May 1988, an Action Plan for elimination of all nuclear

weapons by 2010 AD.

The ambivalence of Pugwash at this stage (Sept 1988) with regard to the goal of NWFW, could be seen from the fact that the reference to NWFW as a goal, and the above statement about deterrence were missing from the Executive Summary. When I raised a question about these omissions at the next meeting, the reply given to me was that one cannot include everything in an Executive Summary !

It was clear that there were several under currents representing different views and interests at Pugwash. As Secretary General Martin Kaplan remarked in his valedictory address at the Dagomys Conference (1988), there was tension at Pugwash between what he called the "mainstream" or "realists" of the Establishments representing the policies of the government in power, and in the academic circles, think-tanks and industry, and the "borderland" or "idealists" whose ideas were often considered as radical. The central question at Pugwash was how to combine the realistic with the idealistic approach. Correspondingly, I often noticed a certain amount of ambivalence at Pugwash, even among the veterans, which got me worried.

The London meeting of the Pugwash Executive (November 1988) also adopted a Statement for the forthcoming Paris Conference on the 1925 Geneva Protocol Against the Use of Chemical and Bacteriological Weapons. The original draft placed before the Executive had a sentence: "the concept of retaliation in kind' , used as a justification to retain chemical weapons, has no logic in this age of overkill by other means"! When someone pointed out the implication of this sentence for those countries which did not have this capacity for overkill by other means, the sentence was quickly dropped. But the draft again revealed the North-centered thinking dominant at Pugwash.

Soon thereafter Prof. Rotblat decided to set up a Pugwash Study Group on NWFW, and invited me to join it. NWFW started becoming the topic of one of the working groups at the annual conferences from 1990 onwards. From the next Pugwash Conference, I started attending the Working Group on Nuclear issues.

I continued to press for a 'time-bound' approach to nuclear disarmament in another context: the NPT Review and Extension Conference, 1995. Having seen the reluctance of the NWSs to start negotiations for implementing article VI of NPT for 25 years, the Working Groups on nuclear issues at the 1993 and 1994 Pugwash Conferences were not in favour of an unconditional and indefinite extension of the NPT beyond 1995. Most participants in these working groups favoured an extension for one or more fixed periods, linked to the completion of explicit disarmament measures within each period. In fact the Working Group made this recommendation unanimously in 1994, and observed that it was wholly convinced of the necessity of extending the Non-Proliferation Treaty beyond 1995, for one or more fixed periods, and opposed to an indefinite extension. The extension( s) must be of a finite duration to prevent the permanent categorization of some nations as 'nuclear - weapon States' and the implicit legalization and acceptance of nuclear weapons. One or more periods of extension should be envisaged, linked to the completion of explicit disarmament measures.... Again the ambivalence of some of the Pugwash seniors with regard to these matters was revealed by the fact that while they kept quiet when this unanimous recommendation was being made after considerable deliberation by the Working Group, they opposed its inclusion in the Council's post-conference Statement. They claimed that the Working Group was not unanimous, that they had been opposed to it. When I asked why they had not spoken out at the Working Group, the reply was : "oh, we knew that the Council will not accept this any

way" !

What very much worried me was that these were scientists high up in the hierarchy of Pugwash, which was supposed to be the conscience keeper of the scientific community.

**SOME MORE REMARKS ON NPT**

Before I leave the topic of NPT, I would like to refer to a few relevant facts which should be kept in mind in the context of the pressures that continue to be applied on India for signing the NPT :

i) talks have been going on between UK, France and the European Union (EU) about the possibility of the EU. in some way acquiring nuclear weapons from UK and France, and controlling them, for common European defences. When I wrote to a high functionary of Pugwash expressing concern about such a proposal and expressing that it would not only be a backward step in the elimination of nuclear weapons, but also be a serious breach of the NPT, he replied that he agreed that it would be a backward step, and that he was strongly against such a prospect and would fight it; but he "did not agree that a transfer of French or British nuclear weapons to a politically unified Europe of which France or the UK would be part could be construed as a breach of the NPT." "In fact," "he added, "when the NPT was crafted, this possibility was explicitly envisioned and some countries joined the NPT on the explicit understanding that such a 'European clause' be part of NPT" . (emphasis added).

ii) it has been widely recognized that in a nuclear war situation, the six co-user NATO States where tactical nuclear weapons of the USA (about 150-200 in number) are deployed, and whose pilots are being trained in the use of nuclear weapons, would become de facto nuclear-weapon States and can for this reason - among others - be regarded as semi-nuclear-weapon States. As Van der Sijde has observed, "this is, in fact, not in accordance with the NPT, and this situation has - understandably come under increasing attack by signatories of the NPT".

iii) This situation may be considered along with a Statement made by the U.S. Secretary of State, Dean Rusk, to the Senate Foreign Relations Committee on 10 July 1968, when NPT was up for ratification in the US Senate. Dean Rusk said that consultations with NATO allies had provided the understanding that the NPT "does not deal with arrangements for deployment of nuclear weapons within Allied territory, as these do not involve any transfer of nuclear weapons or control over them unless and until a decision were made to go to war at which time the treaty would not be controlling". (emphasis added). Taken with the creation and maintenance of a certain infrastructure for the use of nuclear weapons in the NATO countries, including training of their pilots, this would imply an automatic war-time termination of two important NPT obligations, namely Articles I and II of the treaty. The implication of this for the countries other than the 5 NWSs and the NATO countries should be noted: While the 5 NWSs and the NATO countries would have nuclear weapons, the other countries would not have any nuclear weapons to deter them, if they have been already bound by the NPT. Jan Prawtiz has recently remarked that "the last part (of the Rusk Statement) is disturbing: the NPT would lapse in war-time. Sweden gave up its nuclear option for a variety of reasons, but one was that our European neighbours would do the same. If that were so only in peacetime but not in wartime when it would be most needed, the Swedish

rationale would lose value".

I referred to van der Sijde's observations and the statement of Dean Rusk at a recent Pugwash Conference (Sept 1999) and asked: if the NPT is considered as becoming inoperative and useless at critical junctures, allowing Allies to acquire control of nuclear weapons, why were countries like India and Pakistan being pressurized to join the NPT? A senior Pugwashite angrily replied (!) that the statements of former officers did not represent the policy of the US Government, and any further discussion was aborted!

iv) Matthias Kuntzel has expressed concern about "the German Plutonium bunker at Hanau, which contains at least 2,500 kilograms of Plutonium". He points out that "there is no legitimate future for that Plutonium stockpile, because there neither is nor will be any commercial plant in Germany that could use it", and recalls Victor Gilinsky's words: "A nation with a store of separated Plutonium is a nation with a nuclear option". Japan's situation would be similar. And yet while there is so much concern expressed in western countries about the possible nuclear weapon programmes of North Korea and Iraq, one does not hear much concern about the large stockpiles of Plutonium in Germany and Japan!

v) A somewhat related question is : why is it that it is wrong for an NPT member non-weapon country (e.g. Iraq or Iran) to acquire certain equipment from another (e.g. Germany), but it is not wrong for the latter to manufacture it ? Is it just a question of trust, since most advanced equipment! technology would be of the dual-use kind? Then who decides who is trust-worthy? In this context, one notes that the technology control regimes like the London Club, MTCR, Wassanaar arrangement are essentially controlled by the industralized countries and put restrictions on exports to developing countries. Some of these restriction go against Article IV of NPT.

vi) We are aware, from repeated reports of U.S. Intelligence Agencies, of the on-going China Pakistan collaboration in the area of nuclear weapons (and missiles), which contravenes Articles I and II of NPT. The US has connived at it. The US Senate Foreign Relations Committee Chairman, Jesse Helms, has denounced President Clinton's record of fudging on China's nuclear and missile proliferation activities. Zbigniew Brzezinski, National Security Adviser to President Carter, in a recent article, has remarked: "the US has never followed a genuinely universal and non-discriminatory policy of halting proliferation. In fact, US policy all along has been that of selective and preferential proliferation...."

vii) The Nuclear Weapon States have shown utter disregard for the Advisory opinion of the International Court of Justice (ICJ) that "there exists an obligation to pursue in good faith and bring to conclusion negotiations leading to nuclear disarmament in all its aspects, under strict and effective international control" (going somewhat beyond the Article VI of NPT, in as much as there is no link with general and complete disarmament). They have continued to vote in the UN General Assembly against resolutions calling upon them to start negotiations on nuclear disarmament at CD.

viii) The NPT was never intended to be an indefinite license for a two - tier world of nuclear haves and have-nots, but embodied a bargain in which while on one side, the signatory have-nots agreed not to acquire nuclear weapons, on the other side, the NWSs undertook to pursue negotiations in

good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control (Article VI of NPT). Their "solemn commitments turned out to be a sham, as Professor Rotblat has remarked. For 20 years after signing the NPT, they competed intensively in developing new nuclear weapon systems. The total number of weapons tests carried out by them was over 2000, and the nuclear weapons stockpile of the NWSs actually increased from what it was at the time when NPT was signed (about 38,000) and reached a staggering figure of close to 70,000 in the mid-eighties. Nuclear disarmament is as distant as ever. Development of new nuclear weapons continues. Thirty years after NPT, and ten years after the end of the cold war, some 32, 000 nuclear warheads still remain in the world, almost the same number as when NPT came into force. Even if the START process gets implemented, USA and Russia will still retain about 20,000 nuclear warheads in the year 2007. And yet the NWSs pressurize States which have not signed the NPT to do so using a variety of sanctions. - a sad example of "Do as I say, not as I do".

ix) This situation led Frank Blackaby, a veteran Pugwashite, and a former Director of the Swedish International Peace Research Institute (SIPRI), to advocate what he called "a peasants' revolt" - a warning to be issued by a sufficient number of States party to the NPT, that given that the NWSs are in violation of the NPT, they, the non-nuclear-weapon States, will withdraw from the NPT within two years, unless NWSs agree to start genuine negotiations designed to ultimately rid the world of nuclear weapons. He added: "It is time to think about rejecting a US - imposed treaty unless the treaty can be made to work as intended".

**CTBT**

I now come to some correspondence I had with a very high functionary of Pugwash in February-March 1996, in the context of a letter that the four officers of Pugwash had decided to send to the Prime Minister of India, Sri P. V. Narasimha Rao, in relation to India's stand on CTBT, at the CD. The letter expressed the fear that" the proposal by the Indian government that the CTBT should enter into force only after a commitment to the total elimination of nuclear weapons within ten years will result in the failure to complete a CTBT". It described the CTBT as "an essential step on the way to the total elimination of nuclear weapons," and asserted that "failure to complete the CTBT this year would be a major set-back to the cause of nuclear disarmament". The Prime Minister of India was therefore requested to modify his approach to this Issue.

A draft of this letter was sent to me, and I was asked to give my views on the draft, and if" I would be willing to give it publicity in India after it has been sent".

In my reply to this high official of Pugwash, I expressed my strong opposition to the sending of such a letter. I pointed to the indefinite and unconditional extension of NPT in 1995, dividing the world permanently into' nuclear-weapon States' and 'nuclear-non-weapon States', and implicitly legitimizing and accepting nuclear weapons. In this situation, I thought, Pugwash must review the situation, and clarify its own ideas on the approach to a nuclear-weapon-free world. The CTBT could no longer be considered by itself. Further, I was unable to see how one could claim that an agreement on CTBT, as soon as possible was an essential step on the way to the total elimination of nuclear weapons, in the

absence of an explicit time-bound commitment to such total elimination, embodied in the text of the CTBT. I pleaded that Pugwash should not, by the proposed letter, appear to be supporting a world-order in which the world would be divided permanently into nuclear haves and have-nots - a nuclear apartheid and a technological apartheid accompanying it. I added that any letter to the Indian Prime Minister would be counter-productive, and Pugwash should not throw its new-found weight (arising from the Nobel Peace Prize it had just received) on the side of the NWSs by writing such a letter. It would thereby lose its credibility in the Third World.

The four officers of Pugwash sent the letter to the Prime Minister of India notwithstanding my opposition (mid-February 1996). The correspondence between this high officer of Pugwash (P) and myself (BMU) continued for a few weeks, in an effort to understand each others' position. It may be instructive to summarize its salient features.

In the course of the correspondence it became clear that the main differences between our points of view related to the following:

1) I could not see how the CTBT was threatened by the action of the Indian government in linking it up with steps to eliminate all nuclear weapons. To me it appeared to be a mere assertion. If CTBT was an essential step on the way to the total elimination of all nuclear weapons, as claimed, then the two had to be explicitly linked: why should then there be a reluctance to do so ?
2) P thought that the 10 year period mentioned by India was unrealistic. I pointed out that Prof. Rotblat had himself asserted, in his Nobel speech a few months earlier that "we have the technical means to create a Nuclear-Weapon-Free World in about a decade". Allowing for some 10-15 years for non-technical political aspects, could Pugwash support a period of 20 or 25 years? Could such a period be considered by the Government of India as a period endorsed by Pugwash? There was unwillingness on the part of P to agree to any such period as realistic.
3) P said that dates for completion of the process were not really meaningful. What was important for him was the date for starting negotiations for a Nuclear Weapons Convention (NWC), an agreement by the nuclear powers to sit down round a table and discuss the terms of a NWC. He had therefore been advocating that the NWSs should agree to put the elimination of nuclear weapons on the CD agenda. BMU reminded that this call had so far fallen on ears that had chosen to be deaf. Could he and Pugwash therefore support the proposal made by NAM (G-21) in the CD (in Mid-March) calling for a decision by the CD to establish an Ad Hoc Committee on Nuclear Disarmament, to commence negotiations on a phased programme of nuclear disarmament for the actual elimination of nuclear weapons within a specified framework of time? No specific timeframe was mentioned in this proposal. I added that if Pugwash did not put its weight behind this NAM resolution, which was essentially the earlier Pugwash plea (1993-94) to give such a mandate to the CD, I was afraid that the credentials of Pugwash would be doubted in the Third World, as also the motivation of the Nuclear Weapons Powers in rushing through the CTBT in its present form. This suggestion also could not elicit a positive reply.
4) P would not make this a condition for signing the CTBT because he saw every such treaty as a step in the right direction and part of the overall programme. The sequence and linking of steps, was important for BMU, who was afraid that if the present opportunity was not seized and an

unconditional CTBT was accepted, the NWSs will not be in a hurry to arrive at a Treaty to eliminate nuclear weapons. On the other hand, the other States would have foregone their nuclear option for ever.

Soon later, the Canberra Commission, of which Prof. Rotblat was a member, came out with a very important guideline: "The elimination of nuclear weapons must be a global endeavour involving all States. The process followed must ensure that no State feels, at any stage, that further nuclear disarmament is a threat to its security. To this end nuclear weapon elimination should be conducted as a series of phased verified reductions that allow States to satisfy themselves, at each stage of the process, that further movement toward elimination can be made safely and securely

5) P's advice to Indian govt. (as expressed in the correspondence with BMU) was to demand a more definite statement in the Preamble of the CTBT that it is a first step in the programme for the elimination of nuclear weapons which NWSs must pursue with vigour and urgency and that the progress will be monitored in frequent reviews of NPT. BMU felt that such a statement only in the preamble would be a step-down from article VI of NPT; further, experience with even the article VI of NPT, where no time-frame was mentioned, was not reassuring. He also wondered how progress was to be monitored, as being suggested by P, without a time-frame against which it could be assessed. One had to learn from the fact that NPT reviews had been useless for monitoring the implementation of the NPT. NWFW had to descend from the plane of pious desires to the practical plane of a timebound action plan.
6) At the base of these disagreements, there appeared to be a basic difference of perspective. In a Euro-centric framework, non-proliferation was considered a step towards elimination. The nuclear weapon States and their allies were not too uncomfortable with a world in which the Five kept their nuclear arsenals (essentially indefinitely), but were afraid of any additions to the Five. With the memories of the colonial past, it was difficult for a person from the third world to accept such a nuclear regime.
7) Inability / unwillingness of P to put himself in the position of some one from the Third World and ask why his country should sign the CTBT in the proposed form and give up its nuclear option in the kind of world that exists. It was a world in which the recent 'Nuclear Posture Review of the USA envisaged perpetuation of its nuclear arsenal into the indefinite future and in which some of the other nuclear weapon States too had emphasized the importance of nuclear weapons in their security thinking, by resuming the nuclear weapons tests soon after the extension of NPT in May 1995, thereby also violating the spirit of the assurances given at the time of this extension. Some of them had also recently argued before the International Court of Justice that they were within their rights to use nuclear weapons.

What distressed me during the correspondence was that P had no arguments to counter my persuasive arguments in the course of the correspondence, and yet he insisted that it was wrong for India to take the stand she did. It distressed me all the more that his stand coincided with that of the NWSs.

A tailpiece. India's approach to CTBT was discussed at length at the next Pugwash Conference (Sept 96, Lahti). After this discussion, when I asked some of the members of the Pugwash Executive if they now thought that the letter to the Indian PM should have been sent, two of them (including one of the signatories) replied in the negative! A question

that has nagged me is why could the four officers not wait till they had discussed the Indian stand with some of us, and arrived at a better understanding of it? Why were they in such a hurry to add to the pressures of the NWSs ?

There appeared to be an understanding of the Indian security concerns vis a vis CTBT, reflected in the Council Statement from Lahti (1996) which included, inter alia, the following: "We regard it as extremely unfortunate that the prospects for completing a CTBT were recently damaged by a statement arising from the attachment, to the version of the CTBT prepared in the Conference on Disarmament, of a clause that would make the Treaty's Entry into Force conditional on its having gained the signatures of 44 specific countries. We believe the best way out of the current impasse would be if a means would be found to purge the Treaty of the problematic (and unprecedented) entry - into - force clause, so that a CTBT could enter into force without requiring the signature of specific countries beyond the five declared nuclear - weapon States". The position seems to have changed again, because the Council statement from Rustenberg (Sept. 1999) says: "..... all States required to ratify the CTBT should do so to ensure the treaty's entry into force at an early date".

It is not my intention to make a one-sided criticism of Pugwash. Pugwash has played a very important role during the cold war period in bringing the scientists from the East and the West together and through them promoting an East-West understanding. It contributed to the evolution of the concepts of Common Security and Confidence Building Measures in the European context, and to the elaboration of the Chemical Weapons Convention. The publication of the Pugwash Monograph, A Nuclear - Weapon - Free - World: Desirable? Feasible? can be seen as the start of a series of serious studies (e.g. several reports from the Henry L. Stimson Centre in the USA, the INESAP group in Germany, the International Association of Lawyers against Nuclear Arms, the Committee on International Security and Arms Control (CISAC) of the US National Academy of Sciences, Canberra Commission) and Statements (e.g. by retired Generals Andrew Goodpaster, Lee Butler and 57 other flag officers from 17 centuries). It got a well- deserved Nobel Peace Prize in 1995, sharing it with Professor Rotblat, who has been its moving spirit for over four decades.

Pugwash has now to make similar efforts to promote the concept of Common Security in the North-South context, especially keeping in mind that neo - colonialism in various forms is trying to revive old hegemonies, and the gap between the rich and the poor countries is widening. It should at least guard against promotion of steps which are likely to widen the gap. For this, the Pugwashites, especially the office-bearers, would have to try consciously to place themselves in the position of persons from a third world country like India and ask why that country outside the culture area of most of them should take steps that they are advocating for it, consistently with that country's perception of its security.

I joined Pugwash with great expectations. Over the years, I started seeing it as a window on the outside scientific world, in the matter of nuclear disarmament. It was an educative - and disillusioning experience. I saw that even respected scientists and their respectable non-governmental organization like Pugwash often exhibited blinkered views, largely arising from their being situated in the five Nuclear-Weapons States or their Allies, where a large number of' hidden persuaders' are active and that they (barring notable exceptions) did not make enough efforts to understand the security concerns of those in countries outside the charmed circle, or to promote an equitable nuclear order with emphasis on common security. If so, what about the scientists outside

Pugwash, and those in the governments of the NWSs and their weapons establishments, and the diehards in government who take the ultimate decisions? One obviously has far to go before the peril of nuclear weapons gets eliminated from the world. This has obvious implications for the nuclear policy of a country like India.

**QUESTION OF INTERNATIONAL NORMS**

It has often been argued that non-possession of nuclear weapons (except by the five NWSs) has become or is becoming an international norm that should be followed by other countries. One has to ask what is meant by an international norm. In the context of nuclear weapons, is the norm defined by the numerous resolutions at the UN General Assembly calling for the elimination of nuclear weapons, or declaring use of nuclear weapons a crime against humanity, which were supported by a large majority but always opposed by the NWSs and their allies? or is it defined by treaties like NPT, CTBT which were achieved by arm-twisting and promises which were never meant to be kept? Is it defined by the unanimous Advisory opinion given by the International Court of Justice in 1996 ? and by the Malaysian Resolution at the UN General Assembly, following this Advisory opinion, calling upon all states to commence multilateral negotiations without delay, leading to an early conclusion of a Nuclear Weapons Convention, which received an overwhelming support at the GA ?

"International norms" or "world community" are phrases that are increasingly used to provide global legitimacy to actions aimed at preserving the interests and the dominant position of the USA and its allies. Globalization, Liberalization, Interdependence are, for example, phrases used to describe the West's attempts to integrate the economies of the nonwestern societies (former colonies) into a global economic system dominated by it. IMF, World Bank, and International Financial Institutions are often used as tools to impose on other nations economic and other policies the West considers appropriate. One has only to remember the actions of these institutions in supporting US sanctions against India following Pokhran - II sanctions against a country that had not violated any international treaty or agreement. Pugwash has not expressed itself against such sanctions.

**TREATIES LIKE NPT, CTBT, FMCT, ETC**

We have a situation in which the five nuclear weapons states retain their huge nuclear arsenals and huge stocks of fissile materials, and even assert their right to use nuclear weapons when they feel that their vital interests are at stake, and yet want all other States to join the NPT and CTBT and the proposed Fissile Materials Cut-off Treaty (FMCT). The motivation of the five NWSs in pursuing this policy cannot but be questioned. These treaties put restrictions on the States other than the five NWSs, which are not balanced by commitments on the part of the five NWSs to eliminate their nuclear arsenals in a well-defined time-frame. Their acceptance would imply acceptance of a nuclear apartheid, in which the security of some States (including the most powerful one by far) is to be accepted as depending on nuclear weapons indefinitely, while other States would be denied such security. Why should a country forego its nuclear options now, not knowing how the world is going to develop, all the more so since various recent developments amount to abandonment by the NWSs of the goal of nuclear disarmament?

It is not sufficiently realized that nuclear apartheid implies technological apartheid - embargoes on the acquisition of various technologies, equipments, instruments, components, materials,... India has been subject

to such embargoes for over two decades, and has been subjected to more sanctions after Pokhran - II, including the throwing out of some scientists from US establishments and the declaration of some "entities" for banning scientific exchanges, commercial transactions, etc.

Denial of various technologies, even those related to nuclear reactors goes aginast Article IV of NPT.

The discriminatory character of NPT is well recognised. It is necessary to emphasize that CTBT or proposed FMCT cannot be considered nondiscriminatory so long as they are not embedded in a treaty banning the production, stockpiling dissemination and use of nuclear weapons.

The security implications of these treaties, for the States other than the five NWSs must not be lost sight of. One is led to wonder if the five NWSs and their allies (which among themselves include all the colonial powers of not so long ago.) are at all serious about the elimination of nuclear weapons. It is difficult not to think that their only interest in these treaties is to have one more handle to control the non-nuclear-weapons States, getting them to sign certain treaties which they themselves have no intention of abiding by (e.g. NPT), and inspecting them very intrusively in the light of the treaty obligations, so that the five NWSs may not have even remote fear of nuclear realiation from these countries.

It is pertinent to ask as to whose interests are served by such treaties, whether they really contribute to the objective of a NWFW, (within a reasonable period, to be explicitly specified, with an action programme), thereby enhancing global security and confidence building, or they serve the hegemonistic interests of a few powers.

We live in a grossly unequal world, and the inequalities will not disappear without persistent efforts over a long period. In the meantime one must guard against measures which tend to perpetuate this inequality. Even Pugwash does not seem to have appreciated the importance of this.

**THE ETHICAL DIMENSION**

In discussions of India's exercise of the nuclear option, one frequently reads mention of the legacy of Mahatrna Gandhi and Jawaharlal Nehru, which, it is claimed, India has given up.

It is hazardous to transfer great personalities like Nehru and Gandhi to a period several decades after their death, and guess what they would have done if they were alive today. However, two things appear to me to be central to their thought and action. Firstly, both Gandhi and Nehru were against racialism and colonialism and against dominance / hegemony. In a letter to Bertrand Russell in December 1962, in the context of a proposal from the latter for the resolution of the Sino - Indian crisis, Nehru observed that one lesson he had learnt from Gandhiji was that one must not surrender or submit to what one considers evil. Secondly, while they advocated peace, they were not mere pacifists, but said on several occasions that durable peace demanded a just and equitable international order. Therefore, it seems to me, that today they would have fought against neo-colonialism in all its forms and would not have submitted to the attempts of the NWSs to maintain their hegemony, through treaties like the NPT, CTBT; technology control regimes like the London Club, MTCR, Wassanaar regime, etc, whose effect is to deny various advanced technologies to the Third World; and the control of international financial institutions including the IMF and the World Bank.

Nehru was not in favour of unilateral renunciation of the nuclear bomb by India. Bertrand Goldschmidt has observed: "In the 1950s Pandit Nehru had been a leading crusader for stopping nuclear tests and for

nuclear disarmament; but in 1955. when ..... Homi Bhabha….. suggested to him a solemn unilateral renunciation of nuclear weapons, the Prime Minister had asked him to speak about it again when India would be ready to fabricate a bomb".

When discussing the moral responsibility of scientists one is face to face with the ancient problem of values in the world of fact, in a world which is not governed by altruistic considerations, and of prioritizing values when the need arises. Einstein's name has often been invoked in discussions of the ethical dimension. Einstein is, however, a good example of how an outstanding personality did not hold on to his values in an absolutist or fundamentalist fashion, and was not averse to prioritizing them. Up to the advent of Nazi power in Germany, Einstein was, as he called himself, , a militant pacifist'. He was opposed to military preparedness and compulsory military service. The seizure of power by the Nazis in the heart of Europe, caused Einstein to abandon his support of war resistance and he began to advocate rearmament in the West - a radical departure from his previous views. " ..... is one justified in advising a Frenchman or a Belgian to refuse military service in the face of German rearmament?" he asked. Also, ".... so long as Germany persists in rearming ..... the nations of Western Europe depend, unfortunately, on military defence. Indeed, I will go so far as to assert that if they are prudent, they will not wait unarmed, to be attacked they must be adequately prepared". Later in 1939, he wrote the famous letter to President Roosevelt, which resulted in the making of the first nuclear weapons. He does not seem to have expressed regrets about his role. Einstein had the moral strength to reverse himself in view of compelling circumstances. However, he never failed to distinguish between strategy and principle. As a matter of principle, he never wavered in his profound abhorrence of war, nor in his conviction that only the creation of a supranational organisation would safeguard the peace of the world. NWFW is still beyond the horizons of the NWSs. The NWSs are not even willing to allow Nuclear Weapons Convention to be put on the agenda of the CD. Even Pugwashites (barring notable exceptions) seem to have conditioned themselves to the acceptance of nuclear weapons in the hands of the NWSs for an indefinite future. Peace movements like CND, which looked very powerful at one time, have become moribund. Unilateral military interventions, or interventions supported by one or more allies, but bypassing the UN, have been increasing, and Pugwash has not yet taken a stand against them. It is in this situation that a country like India has to define its nuclear policy.

A self-righteous pacifist approach or unilateral action does not take us anywhere. It leaves us where we are - with tens of thousands of nuclear weapons continuing indefinitely in the hands of the NWSs and their Allies, which include all the colonial powers of not so long ago.

An individual may face death bravely for his absolute principles. Can a country, or those who have the responsibility for its security take a purely moral stand, on behalf of its people, which bind the future generations to an inequitable world order? That is where the nuclear option comes. There is no contradiction between working persistently and patiently towards a NWFW and developing the nuclear option in the interim, in the world as it is.

Having said this, I must emphasize that, while maintaining a minimal deterrent, India must pursue more vigorously than ever in her efforts to get the scourge of nuclear weapons eliminated globally.

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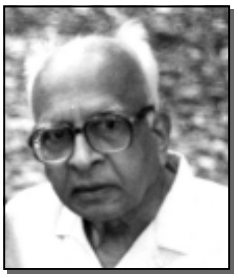
# विद्यापीठे आणि उच्चशिक्षण : स्वायत्तताच करू शकेल गुणवत्तावाढ

प्रा. हेमचंद्र प्रधान आणि प्रा. भा. मा. उदगावकर



**उच्चशिक्षणात गुणवत्ता महत्त्वाची असते; त्यामुळे ज्याचे व्यवस्थापन करायचे, ते एकक लहान आणि एकसंघ असावे असे जगात सर्वत्र मान्य झाले आहे. संलग्न महाविद्यालय पद्धतीची विद्यापीठांची पद्धत जगात जवळजवळ नाहीशी होत चालली आहे, आणि उच्च शिक्षण संस्थांना शैक्षणिक निर्णयांची तसेच प्रशासकीय स्वायत्तता असली पाहिजे ही बाब आजच्या जगात गृहीत धरली जाते.**

**1) विद्यापीठांची कार्ये :**

भारतातील उच्च शिक्षणाची जबाबदारी मुख्यत: विद्यापीठांची आहे. विद्यापीठांची मुख्य कार्ये 1) अध्यापन, 2) संशोधन आणि 3) विस्तारसेवा (एक्स्टेन्शन) ही मानली गेली आहेत. अध्यापनकार्याचा हेतू विद्यार्थ्यांना ज्ञान व कौशल्ये देऊन त्यांना व्यावसायिक, आर्थिक आणि सामाजिकदृष्ट्या सक्षम आणि सांस्कृतिकदृष्ट्या समृद्ध करण्याचा असतो. विद्यार्थ्यांचे एकूण व्यक्तिमत्त्व, त्यांचे नेतृत्वगुण, त्यांची वैज्ञानिक आणि सामाजिक जाणीव विकसित करण्याचे कार्य विद्यापीठात घडत असते.

विद्यापीठीय संशोधन दोन पातळ्यांवरचे असते. एक विद्यार्थ्यांना पदव्युत्तर अभ्यासक्रमात दिल्या जाणाऱ्या ज्ञानाच्या कक्षा विस्तारणारे; परंतु त्याच्या फारसे पलीकडे न जाणारे, तर दुसरे त्याच्या खूप पलीकडे जाऊन नव्या वाटा शोधणारे असते. आपल्याकडील विद्यापीठात दुसऱ्या पातळीवरचे संशोधन क्वचितच होते. याशिवाय, समाजातील विद्यार्थी सोडून अन्य घटकांसाठी; उदाहरणार्थ : शिक्षक, शेतकरी, इतर व्यावसायिक यांच्यासाठी उपयुक्त अभ्यासक्रम तयार करून ते चालवणे, त्यांना निरंतर शिक्षणाची संधी उपलब्ध करून देणे आणि तज्ज्ञ सल्ला देणे अशा विस्तारसेवाही आधुनिक काळात विद्यापीठाकडून अपेक्षित असतात.

प्रत्येक विद्यापीठाची भौगोलिक, आर्थिक, सामाजिक आणि सांस्कृतिक पार्श्वभूमी वेगळी असते; आणि त्याला वरील तिन्ही कार्ये या पार्श्वभूमीवरच करणे सहज शक्य, आवश्यक आणि उचित ठरते. कोणत्या विषयांवरील संशोधन आणि अभ्यासक्रम सुरू करायचे, भर कशावर द्यायचा, कोणत्या अंगाने कितपत जायचे, उपयोजने कोणती घ्यायची हे प्रत्येक विद्यापीठाने आपली पार्श्वभूमी लक्षात घेऊन ठरवायचे असते. हे ठरवताना आपल्याला एकूण निधी, साधनसामग्री आणि तज्ज्ञ मनुष्यबळ किती लागणार आहे, आणि किती उपलब्ध आहे हे तपासावे लागते. आपली शक्ती (स्ट्रेंग्थ) कशात आहे, उणिवा (वीकनेस) कोठे आहेत, आपल्याला संधी (ऑपर्च्युनिटी) आणि धोके (थ्रेट) काय आहेत याचे विश्लेषण (स्वॉट ॲनॅलिसिस) दर काही वर्षांनी करावे लागते.

वस्तुत:, असे विद्यापीठांतील आणि आवश्यक तेथे बाहेरील तज्ज्ञांच्या मदतीने केलेले विश्लेषण विद्यापीठाने आपले सर्व प्राध्यापक आणि प्रशासकीय कर्मचारी यांच्यापुढे मांडणे, त्यांना विश्वासात घेणे आणि त्याद्वारा आपल्या भविष्यातील योजना, व्हिजन बनवणे जरूर आहे.

आपल्या विद्यापीठांतून आपल्या काही प्रकल्पांची, कार्यांशांची समीक्षा केली जाते आणि अहवाल प्रसिद्ध केले जातात; परंतु उद्दिष्टांच्या संदर्भात साकल्याने विश्लेषण, कठोर आत्मपरीक्षण केले जाते याचा पुरावा आढळून येत नाही.

**2) संख्यात्मक वाढ :**

स्वातंत्र्यप्राप्तीनंतर भारतात उच्च शिक्षणाची फार मोठी संख्यात्मक वाढ झाली यात शंका नाही. इ. स. 2002-03 साली भारतात सुमारे 260 विद्यापीठे, 15,500 महाविद्यालये आणि 92 लाख विद्यार्थी होते. यांतील साधारण 18 लाख विज्ञानाचे आणि 58 लाख कला आणि वाणिज्य शाखांचे विद्यार्थी होते. या दोन्ही क्षेत्रांतील साधारण 10 टक्के विद्यार्थी पदव्युत्तर विभागांत होते. (अन्य क्षेत्रांतील विद्यार्थ्यांची विभागणी अशी होती : 7 लाख इंजिनिअरिंग, 3 लाख वैद्यकीय, 3 लाख कायदा, 1.25 लाख शिक्षणशास्त्र, 0.75 लाख कृषी व

संबंधित क्षेत्रे आणि 1 लाख याव्यतिरिक्तची क्षेत्रे.) तुलनेने इ. स. 1947 साली देशात फक्त 18 विद्यापीठे होती, 600 महाविद्यालये होती आणि 2 लाख विद्यार्थी होते. इ. स. 1990 - 2000 या दशकात उच्चशिक्षणातील संख्यावाढीचा दर साधारणपणे 5% होता.

उच्चशिक्षणातील ही संख्यावाढ एकूणच शिक्षणाचा वाढता प्रसार आणि काही अंशी बहुजनसमाजासाठी वाढणाऱ्या शैक्षणिक संधी दाखवते. काही अंशी म्हणण्याचे कारण, इ. स. 1997 मध्ये 17 ते 23 वर्षे या वयातील (म्हणजे महाविद्यालयीन शिक्षण घेण्यासाठी वयाने पात्र) तरुणांपैकी जेमतेम 6% तरुण विद्यापीठात शिक्षण घेत होते. आजही हे प्रमाण फारसे बदललेले नाही. सर्वाधिक दरडोई राष्ट्रीय उत्पन्न असणाऱ्या देशांच्या गटात हे प्रमाण सुमारे 50% आहे, तर मध्यम दरडोई उत्पन्नाच्या देशांच्या गटात हे प्रमाण सुमारे 20% आहे. याचा अर्थ आपल्याकडील उच्चशिक्षणात अजून संख्यावाढ व्हायला खूप वाव आहे.

भारतात शिक्षण, विशेषत: उच्चशिक्षण, हा व्यावसायिक पात्रता वाढवण्याचा आणि त्याद्वारे आपली आर्थिक स्थिती सुधारण्याचा, तसेच सामाजिक सोपानाच्या वरच्या पायरीवर जाण्याचा मार्ग समजला जातो. उच्चशिक्षणाला पर्याय असलेली व्यावसायिक (व्होकेशनल) शिक्षणाची सुविधा आपल्याकडे फारच कमी प्रमाणात उपलब्ध आहे. त्याचप्रमाणे, आपल्याकडे पदवीधारकांनाही नोकरीसाठी किती वेळ थांबावे लागेल हे सांगता येत नाही, किंबहुना नोकरी मिळेल की नाही याची शाश्वती नसते. विकसित देशांत बेकार म्हणून नोकरीची वाट पाहावी लागणाऱ्यांना सामाजिक सुरक्षेच्या योजनांतर्गत साहाय्य दिले जाते; असे कोणतेही साहाय्य आपल्या देशात उपलब्ध नसते. या सर्व पार्श्वभूमीवर भारतासारख्या लोकतांत्रिक समाजात उच्चशिक्षणाच्या संधीपासून कोणालाही वंचित करणे अन्याय्य व अनुचित ठरेल. आपल्याकडे उच्चशिक्षणासाठी प्रवेश मर्यादित असावा, असे म्हणणाऱ्यांनी वरील वस्तुस्थिती लक्षात घ्यायला हवी.

आमच्या मते, उच्चशिक्षणासाठी बहुजन समाजाला मिळणारी वाढती संधी वावगी तर नाहीच, उलट लोकशाहीसाठी पूरक आहे; आणि ती आणखी वाढत राहायला हवी. त्याचबरोबर या शिक्षणाची गुणवत्ता वाढायला हवी. कारण, बहुजन समाजासाठी उपलब्ध असलेले शिक्षण गुणवत्तेत कमी असले तरी चालेल, असे म्हणणे योग्य नाही; आणि लोकशाहीच्या दृष्टीने स्वीकारार्हही नाही.

संख्यात्मक वाढीच्या सुरुवातीच्या काळात गुणवत्तेकडे पाहिजे तेवढे लक्ष देता आले नसले तरी आता, स्वातंत्र्य मिळून अर्धशतकाहून अधिक काळ लोटल्यानंतरही, तसे करून चालायचे नाही. येत्या 10 - 15 वर्षांत एक जागतिक महासत्ता बनण्याचे उद्दिष्ट आपल्या राज्यकर्त्यांनी आपल्यापुढे ठेवले असताना, आणि जागतिकीकरणाच्या जमान्यात तर नाहीच नाही.

**3) गुणात्मक वाढीची जरुरी :**

उच्चशिक्षण क्षेत्रात संख्यावाढीच्या बरोबरीने गुणात्मक वाढ होऊ शकलेली नाही, ही वस्तुस्थिती आहे. राष्ट्राच्या आर्थिक, सामाजिक, सांस्कृतिक, संरक्षण, संशोधन अशा विविध क्षेत्रांतील विकासामध्ये प्रशिक्षित, व्यावसायिक, उच्चशिक्षित मनुष्यबळ हा एक महत्त्वाचा घटक आहे. राष्ट्राची जशी प्रगती होते, राष्ट्राची अस्मिता जशी प्रगल्भ होते, तशी ही गरजही वाढते. जागतिक स्तरावर ज्ञानाचा संचय दर दहा वर्षांनी दुप्पट होतो हे लक्षात घेता, आपल्याकडचे मनुष्यबळ ज्ञान आणि तंत्रे यांबाबतीत अद्ययावत असायलाच हवे.

आधुनिक काळात एखाद्या राष्ट्राची जसजशी प्रगती होते, तसतसा त्या राष्ट्राच्या राष्ट्रीय उत्पन्नातील कृषी व अन्य पारंपरिक क्षेत्रांचा वाटा कमी होत जातो आणि औद्योगिक व सेवाक्षेत्रांचा वाटा मोठा होत जातो. उत्पादन, वितरण, संदेशवहन, वाहतूक, करमणूक, आरोग्य अशा क्षेत्रांत नवनवीन बदल वेगाने होत राहतात. या सर्व बदलांचा एक परिणाम जग जवळ येण्यात, जगातील वेगवेगळ्या भागांच्या, देशांच्या अर्थव्यवस्था एकमेकांशी जोडल्या जाण्यात होतो. जागतिकीकरणाच्या या प्रक्रियेचे जसे अर्थव्यवस्थेचे आधुनिकीकरण, विकासाचा वाढता दर, तांत्रिक प्रगती असे इष्ट परिणाम आहेत, तसेच (भारतासारख्या विकसनशील देशाच्या दृष्टीने) अनेक दुष्परिणामही आहेत.

विकसित देश, विकसनशील देशांकडे मुख्यत्वे बाजारपेठ (मार्केट) म्हणून पाहत असल्याने, विविध क्षेत्रांतील संधींचे जागतिकीकरण होत नाही. उलट, वाढत्या यांत्रिकीकरणामुळे बेकारीत भर पडते, विषमता वाढते. तथापि, जागतिकीकरण ही अपरिवर्तनीय प्रक्रिया असल्यामुळे तिला सामोरे जायलाच पाहिजे. यासाठी आपली उत्पादने उत्पादनशृंखलेच्या खालच्या भागात राहता कामा नयेत; कच्च्या मालाच्या निर्यातीकडून आपण उत्पादनशृंखलेच्या अधिकाधिक वरच्या अंगाला असलेल्या, उत्कृष्ट दर्जाच्या तयार मालाच्या आणि तांत्रिकदृष्ट्या पुढारलेल्या सेवांच्या निर्यातीकडे वळायला पाहिजे.

याकरिता, अर्थात प्रशिक्षित मनुष्यबळाची गरज आहे; आणि ते तयार करण्यासाठी आपल्या उच्चशिक्षण संस्था, विद्यापीठे यांची गुणवत्ता वाढायला हवी. या बाबतीत सद्य:स्थिती निश्चितपणे समाधानकारक नाही. विद्यापीठातील स्नातकच देशातील विविध जबाबदाऱ्या पार पाडत असतात; या दृष्टीने विद्यापीठांचे योगदान महत्त्वाचे असले, तरी त्यांनी आणि देशातील एकूणच उच्चशिक्षण संस्थांनी निर्माण केलेल्या उत्पादनमूल्याचा राष्ट्रीय अर्थव्यवस्थेतील वाटा लक्षात घेण्याजोगा नाही; या बाबतीत, तसेच पदवीधारकांची गुणवत्ता, विस्तारसेवा अशा निकषांवरही आपण विकसित देशांच्या खूप मागे आहोत, हे सतत लक्षात ठेवायला हवे.

**4) दूरदृष्टीचा अभाव :**

भारतातील अनेक विद्यापीठे विद्यार्थ्यांच्या संख्येच्या दृष्टीने फार मोठी आहेत. आपल्या विद्यापीठांतील पदवीपूर्व अध्यापन मुख्यत्वे संलग्न महाविद्यालयांतून होते. आपल्याकडील परीक्षा संपूर्ण विद्यापीठीय स्तरावर घेतल्या जाणाऱ्या बहिर्गत (एक्स्टर्नल) प्रकारच्या असतात. परिणामी पदवीपूर्व महाविद्यालयांची तपासणी करून त्यांना संलग्नता देणे, त्यांच्यासाठी अभ्यासक्रम तयार करणे, परीक्षा घेणे, त्यांचे निकाल योग्य वेळेवर लावण्याचा प्रयत्न करणे अशा कामांतच विद्यापीठाची शक्ती व्यतीत होते; संशोधनाचे उद्दिष्ट बहुतांशी दुर्लक्षित राहते.

याकरिता एक उपाय तत्काळ करता येईल, तो म्हणजे विद्यापीठाचा पदव्युत्तर कक्ष वेगळा काढून त्यातील प्रत्येक विषयाच्या विभागाला शैक्षणिक व प्रशासकीय स्वायत्तता देणे. (जर विद्यापीठाची एकापेक्षा जास्त पदव्युत्तर केंद्रे असतील, तर प्रत्येक केंद्राला स्वायत्तता द्यावी.) अशा स्वायत्ततेमुळे प्रत्येक पदव्युत्तर विभागाला नवीन अभ्यासक्रम सुरू करता येतील; नवीन प्रकल्प हाती घेता येतील; संशोधनाकडे लक्ष देता येईल; जास्त धडाडीचे, तज्ज्ञ, क्रियाशील अध्यापक - संशोधक आकर्षित करता येतील.

मुंबई विद्यापीठाला 1960 - 70 या दशकाच्या उत्तरार्धात भौतिकशास्त्राचा नवा विभाग सुरू करताना अशी संधी उपलब्ध झाली होती. मुंबई विद्यापीठात 1971 सालापर्यंत, म्हणजे विद्यापीठाची स्थापना होऊन 100 वर्षे होऊन गेली तरी, स्वतंत्र भौतिकशास्त्र विभाग नव्हता. मुंबईतच 'टाटा इन्स्टिट्यूट ऑफ फण्डामेन्टल रिसर्च'सारखी जागतिक स्तरावर भौतिकशास्त्रीय संशोधनासाठी मान्यता पावलेली संस्था असताना ही स्थिती स्पृहणीय नव्हती.

जर टाटा इन्स्टिट्यूटच्या सहकार्याने मुंबई विद्यापीठात भौतिकशास्त्राचा विभाग स्थापन झाला असता, तर तो अत्यल्प काळात आंतरराष्ट्रीय दर्जाचा होऊ शकला असता. हे लक्षात घेऊन मुंबई विद्यापीठाने असा मोठा (साधारण 20 - 25 अध्यापक असलेला), भौतिकशास्त्र विभाग सुरू करावा आणि त्याला अनुरूप अशी स्वायत्तता द्यावी, अशी सूचना केली गेली होती. इ. स. 1967 ते 1970 ही सतत तीन वर्षे मुंबई विद्यापीठ आणि भारत सरकारचा विद्यापीठ अनुदान आयोग यांच्याकडे या बाबतीत पाठपुरावा केला गेला होता.

दुर्दैवाने विद्यापीठाकडे आणि त्या काळच्या विद्यापीठ अनुदान आयोगाकडे असे निर्णय घेण्यासाठी लागणारे धाडस आणि दूरदृष्टी नव्हती. त्यामुळे भौतिकशास्त्रात राष्ट्रीय आणि आंतरराष्ट्रीय स्तरावर नावलौकिक,नेतृत्व मिळवण्याच्या संधीला विद्यापीठ मुकले. अजूनही गेली तीसहून अधिक वर्षे पदव्युत्तर विभागांची स्वायत्तता हा मुंबई विद्यापीठात चर्चेचा विषय आहे. युनिव्हर्सिटी इन्स्टिट्यूट ऑफ केमिकल टेक्नॉलजीशिवाय विद्यापीठाचा अन्य कोणताही विभाग स्वायत्त (आणि आंतरराष्ट्रीय कीर्तीचा) नाही.

या संबंधात दोन आनुषंगिक मुद्दे लक्षात येतात. कोठारी आयोगानेही देशात काही विद्यापीठेतरी जागतिक दर्जाची असावीत, असे सुचवले होते. दर्जाच्या दृष्टीने चांगली अशी विद्यापीठे निवडायची झाली, तर आय. आय. टी., इंडियन इन्स्टिट्यूट ऑफ सायन्स, इंडियन इन्स्टिट्यूट ऑफ मॅनेजमेन्ट, जवाहरलाल नेहरू विद्यापीठ अशी नावे डोळ्यांपुढे येतात.यांतील एकही विद्यापीठ संलग्न महाविद्यालय प्रणालीचे नाही. शिवाय, उच्चशिक्षणाच्या बाबतीत केंद्रीय शासनाच्या नियंत्रणाखाली असलेल्या संस्थांचे काम राज्यशासनाच्या नियंत्रणाखाली असलेल्या संस्थांच्या कामापेक्षा अनेक पटीने चांगले आहे असे आढळते. याचे कारण, केवळ केंद्र सरकारचे सढळ आर्थिक पाठबळच नाही, तर या संस्थांना मिळणारी स्वायत्तता, आणि आर्थिक पाठबळ व स्वायत्तता या दोन्हींमुळे येणारी अध्यापन - अध्ययन प्रक्रियेची गुणवत्ता आहे. या दृष्टीने विचार करता, प्रादेशिक (राज्यातील) विद्यापीठांवरील राज्यशासनांची अधिकाधिक घट्ट होत जाणारी पकड हा चिंतेचा विषय आहे.

**5) महाविद्यालयांची स्वायत्तता :**

उच्चशिक्षणात गुणवत्ता महत्त्वाची असल्याने, ज्याचे व्यवस्थापन करायचे ते एकक लहान आणि एकसंध असावे, असे जगात सर्वत्र मान्य झाले आहे. या दृष्टीने, आपली संलग्न महाविद्यालय पद्धतीची विद्यापीठे अव्यवस्थापनीयच आहेत.

जगात ही पद्धत जवळजवळ नाहीशी होत आहे; उलट उच्चशिक्षण संस्थांना शैक्षणिक निर्णयांची आणि प्रशासकीय स्वायत्तता असली पाहिजे हे जगात गृहीत धरले जाते.

शिकवणारा - मार्गदर्शन करणारा जबाबदार शिक्षकच विद्यार्थ्यांचे योग्य मूल्यमापन करू शकतो, हे तत्त्व आणि त्याचप्रमाणे प्रत्येक संस्थेने आपण देत असलेल्या शिक्षणाची जबाबदारी स्वत:वर घेतली पाहिजे, ती विद्यापीठावर ढकलून मोकळे होता येणार नाही, ही अपेक्षा त्यामागे आहे. अशा स्वायत्ततेमुळे आधी म्हटल्याप्रमाणे नवनवीन शैक्षणिक उपक्रम, अभ्यासक्रम, संशोधन प्रकल्प सुरू करण्याची जबाबदारी घेण्याचे स्वातंत्र्य संस्थांना मिळते. संलग्न महाविद्यालयीन पद्धतीत असा प्रत्येक निर्णय विद्यापीठ स्तरावर सर्व महाविद्यालयांसाठी घ्यायचा असल्याने, असे स्वातंत्र्य जवळजवळ राहत नाही.

एखादा निर्णय घेतला गेला, तरी त्याच्या अंमलबजावणीसाठी इतका वेळ लागतो की, त्या निर्णयामागचा हेतूच साध्य होत नाही, विद्यापीठांच्या गुणवत्तावर्धनाची पहिली पायरी म्हणजे जी प्रयोगशील महाविद्यालये आहेत, त्यांना प्राधान्याने स्वायत्तता देणे. हे कसे करता येईल यावर विद्यापीठ अनुदान आयोग आणि अन्य संस्थांनी बराच विचार केला आहे. त्याची पुनरुक्ती करण्याची येथे जरुरी नाही.

जसजशी काही प्रयोगशील, शैक्षणिकदृष्ट्या पुढारलेली महाविद्यालये स्वायत्त होऊन स्थिरावतील, तसतशी अधिकाधिक महाविद्यालये स्वायत्ततेची जबाबदारी स्वीकारण्यास तयार होतील. किंबहुना, भविष्यात सर्वच महाविद्यालये स्वायत्त असावीत. आपल्या गुणवत्तेच्या जोरावर त्यांनी विद्यार्थ्यांना आकृष्ट करावे. दक्षिणेकडील काही राज्यांत अनेक महाविद्यालयांना स्वायत्तता दिली गेली आहे. त्यांच्या अन्य काही अडचणी असल्या, तरी शैक्षणिकदृष्ट्या हा स्वायत्ततेचा प्रयोग सफल झाला आहे.

आपल्याकडे विद्यार्थ्यांना अभ्यासक्रम (कोर्स) निवडण्याचे स्वातंत्र्य नसते. जसे, बी. एस्सी.च्या पहिल्या वर्षाच्या विद्यार्थ्याने जर भौतिकशास्त्र, रसायनशास्त्र व गणित असे विषय घेतले असतील, तर त्या-त्या विषयाच्या सिलॅबसनुसार जे-जे कोर्स शिकवले जातात, ते-ते त्याला घ्यावेच लागतात. त्याला जरी एखादा सूक्ष्म जीवशास्त्राचा कोर्स घ्यावासा वाटला, तरी ते शक्य नसते. श्रेय (क्रेडिट) प्रणालीमध्ये अशी कप्पे-बंदिस्तता नसते; उलट अनेक कोर्स उपलब्ध असतात; त्यांपैकी आपल्याला इष्ट वाटतील ते घ्यायचे.

विद्यार्थ्याने कोर्स पूर्ण केला की त्याला काही श्रेयबिंदू मिळतात. पदवी संपादन करण्यासाठी आवश्यक त्या-त्या विषयांत आवश्यक तेवढे श्रेयबिंदू जमवावे लागतात. या पद्धतीमध्ये विद्यार्थ्याला निरनिराळ्या विषयांत एखाद्दुसरा कोर्स घेऊन आपल्याला तो विषय पटतो का हे तपासण्याची, नवनवीन गोष्टी शिकण्याची लवचीकता असते. आपल्याकडे संपूर्ण विद्यापीठीय स्तरावर असा ॲप्रोच घेणे शक्य होणार नाही. परंतु, स्वायत्त महाविद्यालयांना या दृष्टीने, उच्च शिक्षणात लवचीकता आणण्याच्या दृष्टीने, निश्चित प्रयोग करता येतील. विशेषत:, अनेक परदेशीय विद्यापीठे आपल्याकडे येऊ घातली असताना, स्पर्धेत टिकून राहण्यासाठी अशी प्रयोगशीलता महत्त्वाची ठरेल.

या संबंधात उपस्थित केल्या जाणाऱ्या दोन शंका रास्त वाटतात. एक म्हणजे प्रशासकीय स्वायत्ततेचा परिणाम व्यवस्थापनाकडे सत्ता केंद्रित होण्यात होईल. हे जर टाळायचे असेल, तर शिक्षकांच्या सेवाशर्ती स्वायत्त असलेल्या आणि नसलेल्या महाविद्यालयांत सारख्याच असायला हव्यात. तसेच, स्वायत्त महाविद्यालयांत शिक्षकांचा व्यवस्थापनातला आणि निर्णयप्रक्रियेतला सहभाग वाढायला हवा. स्वायत्ततेच्या प्रक्रियेच्या नियोजन आणि अंमलबजावणीमध्ये या दृष्टीने तरतूद असायला पाहिजे, आणि त्यानुसार खबरदारीही घेतली गेली पाहिजे.

दुसरी शंका स्वायत्त महाविद्यालयांच्या आर्थिक स्वायत्ततेबाबतची. अशी स्वायत्तता म्हणजे कितीही शुल्क आकारण्याची स्वायत्तता असे अनेकांना वाटते. याचा परिणाम सर्व उच्चशिक्षण सामान्यांना, मध्यमवर्गीयांनादेखील न परवडणारे होईल, अशी भीती ते व्यक्त करतात. व्यावसायिक (वैद्यकीय आणि अभियांत्रिकी) शिक्षणक्षेत्रात खासगी, विनाअनुदानित महाविद्यालयांना परवानगी दिली गेल्यानंतर या क्षेत्राचे जे व्यापारीकरण झाले आहे, त्याच्याकडे बघितल्यास वरील भीती किती सार्थ आहे हे पटेल.

### स्वायत्त महाविद्यालयांची शुल्कप्रणाली

एकंदरीत विद्यापीठातील स्वायत्त नसलेल्या महाविद्यालयांतील शुल्कप्रणालीपेक्षा फार वेगळी नसावी. एखादा विशेष कौशल्य व तंत्राधिष्ठित अभ्यासक्रम असेल, तर त्याचा या बाबतीत अपवाद होऊ शकेल. व्यापारीकरणाच्या समस्येवर मूलग्राही विचार करण्याची आणि दीर्घदृष्टीचे निर्णय घेण्याची आवश्यकता आहे.

महाविद्यालयांची स्वायत्तता प्रत्यक्ष येण्यास अजून बराच

कालावधी लागेल, ही वस्तुस्थिती आहे. (देशातील 15,500 महाविद्यालयांपैकी एक तृतीयांशाहून जास्त महाविद्यालयांना अजून विद्यापीठांकडून कायमची संलग्नताही मिळालेली नाही.) हे लक्षात घेता, तत्काळ करण्यासारख्या दोन गोष्टी आहेत. एक म्हणजे, वर म्हटल्याप्रमाणे, विद्यापीठाच्या पदव्युत्तर विभागांना स्वायत्तता देणे.

त्याहीपलीकडे जाऊन विद्यापीठाचे पदव्युत्तर (अ) आणि पदवीपूर्व (ब) असे विभाजन करणे जास्त सयुक्तिक होईल. सर्व पदव्युत्तर विभाग विद्यापीठ 'अ'च्या अंतर्गत स्वायत्त असतील. विद्यापीठ 'ब'च्याखाली सर्व पदवीपूर्व संलग्न महाविद्यालये येतील. आपल्याकडे अनेक विद्यापीठांत विद्यार्थ्यांची संख्या जशी मोठी आहे, तसेच त्यांचे भौगोलिक अधिकारक्षेत्रही मोठे आहे (उदाहरणार्थ, मुंबई विद्यापीठ). याकरिता मोठी विद्यापीठे विभागून लहान विद्यापीठांची निर्मितीही व्हायला हवी. अलीकडेच सोलापूर जिल्ह्यापुरते मर्यादित अधिकारक्षेत्र असलेले नवे विद्यापीठ महाराष्ट्र राज्यात स्थापन केले गेले आहे, हे स्वागतार्ह आहे.

**6) आर्थिक आयाम - काही विचार :**

उच्चशिक्षणाच्या आर्थिक बाजूचा विचार गुंतागुंतीचा आहे. देशातील उच्चशिक्षण हे देशाच्या एकूणच अर्थव्यवहाराशी, आर्थिक – विशेषत: मनुष्यबळाच्या – नियोजनाशी अतूटपणे जोडले गेले आहे. या प्रश्नाच्या विविध आर्थिक आयामांची नोंद घेऊन त्यावर साधक-बाधक चर्चा करणे सोपे नाही. त्या संबंधात काही विचार आम्ही पुढे मांडत आहोत. ही चर्चा साकल्यात्मक नाही, ही जाणीव आम्हांला आहे.

स्वायत्त आणि अस्वायत्त महाविद्यालयांमध्ये अनुदानाच्या बाबतीत फरक केला जाऊ नये. महाविद्यालय स्वायत्त झाले की आर्थिकदृष्ट्याही स्वायत्त होऊ शकेल, ही अपेक्षा अस्थानी आहे. आपल्याकडे अनुदान ठरवताना राज्यसरकारे प्रत्येक शिक्षकाच्या कामाचे तास (वर्कलोड) मोजतात आणि त्यानुसार शिक्षकांच्या वेतनावरचा अनुदानग्राह्य खर्च ठरवतात. नोकरशाहीने शिक्षणाचे जे अनेक तऱ्हांनी अवमूल्यन केले आहे, त्यांतील ही एक तऱ्हा आहे. शिक्षणाच्या बाबतीत स्वत:ला प्रागतिक म्हणवणाऱ्या लोकशाही देशाच्या प्रतिमेशी विसंगत असलेल्या अशा प्रथा लवकरातलवकर दूर करायला हव्यात. अनुदान विद्यार्थ्यांच्या संख्येवरून योग्य प्रमाण (जसे, दर दहा विद्यार्थ्यांसाठी एक शिक्षक) घेऊन ठरवले जावे.

एखादा नवीन अभिनव अभ्यासक्रम सुरू करणाऱ्या महाविद्यालयांच्या बाबतीत हे प्रमाण सुरुवातीच्या काही वर्षांत आणखी कमी असेल, हे लक्षात घेतले जावे. तसेच, पदव्युत्तर विभागांच्या बाबतीत अनुदान ठरवताना संशोधनाची गरज लक्षात घेणे आवश्यक आहे. शिक्षकांचे उत्तरदायित्व कामाच्या तासाने मोजण्याऐवजी अधिक योग्य निकष निर्माण करणे निकडीचे झालेले आहे.

अर्थात, नवनवीन उपक्रम, विकास - कार्ये आणि संशोधन प्रकल्प हाती घेण्यासाठी प्रत्येक महाविद्यालयाने कायमस्वरूपी निधी उभारायला हवा. त्यांनी याकरिता सुयोग्य प्रस्ताव पाठवून विद्यापीठ अनुदान आयोग, वैज्ञानिक आणि औद्योगिक संशोधन परिषद (सी. एस. आय. आर.), भारत सरकारचा विज्ञान - तंत्रज्ञान विभाग अशा संस्थांकडून अनुदान मिळवावे. उद्योगांकडूनही त्यांच्यासाठी छोटे-मोठे प्रकल्प घेऊन आणि कन्सल्टन्सीद्वारा पैसा उभा करता येणे शक्य आहे.

उद्योगांकडून एखाद्या विषयाची प्रयोगशाळा स्थापन करण्यासाठी किंवा अद्ययावत करण्यासाठी, तसेच तज्ज्ञ प्राध्यापकांची अध्यासने निर्माण करण्यासाठीही आर्थिक साहाय्य मिळू शकेल. या बाबतीत मुंबईची युनिव्हर्सिटी इन्स्टिट्यूट ऑफ टेक्नॉलजी एक आदर्श संस्था आहे. इन्स्टिट्यूट ऑफ सायन्स मधील न्यूक्लिअर केमिस्ट्री प्रयोगशाळा, तसेच रुइया महाविद्यालयातील औद्योगिक रासायनिक चाचणी प्रयोगशाळा या उद्योगांच्या मदतीनेच उभारल्या गेल्या आहेत.

उच्चशिक्षण घेणाऱ्यांना देशाकडून आर्थिक साहाय्य (सबसिडी) मिळते हे खरे आहे. कारण प्रत्येक विद्यार्थ्यामागे शिक्षण व्यवस्थेला जो खर्च येतो, तो विद्यार्थी देतो त्या शुल्कापेक्षा खूप जास्त असतो. असा खर्च कला, वाणिज्य आणि विज्ञान विषयांच्या पदवीपूर्व शिक्षणाच्या मानाने पदव्युत्तर शिक्षणासाठी आणि तसेच व्यावसायिक शिक्षणासाठी बराच जास्त असतो. व्यावसायिक शिक्षणात अभियांत्रिकी (सर्वसाधारण महाविद्यालये), वैद्यकीय शिक्षण आणि अभियांत्रिकी (आय. आय. टी.सारख्या खास संस्था) ही तीन क्षेत्रे अनुक्रमे विद्यार्थ्यांवरच्या दरडोई खर्चानुसार सर्वांत महाग आहेत. मग हा खर्च विद्यार्थ्यांकडून शुल्करूपाने का वसूल करू नये, उच्च शिक्षणातील सबसिडी का बंद करू नये असा प्रश्न उपस्थित केला जातो.

कला, वाणिज्य आणि विज्ञान या विषयांच्या पदवीपूर्व शिक्षणाच्या बाबतीतील आपल्याकडच्या परिस्थितीची चर्चा 'गुणात्मक वाढीची जरुरी' या शीर्षकाखाली आली आहे. हे शिक्षण घेणारे बहुसंख्य विद्यार्थी कमी उत्पन्नाच्या गटातील

असतात. त्यांना सामाजिक सोपानाच्या वरच्या शिडीवर जायचे शिक्षण हे साधन असते. पदवीधर झाल्यावरही नियमित उत्पन्नाचे साधन मिळण्याची त्यांना शाश्वती नसते. त्यांना किंवा त्यांच्या पालकांना जर दरडोई शैक्षणिक खर्चानुसार शुल्क आकारले, तर महाविद्यालयीन शिक्षणाला वंचित व्हावे लागेल. शिवाय अशा धोरणामुळे देशातील 17 ते 23 वर्षे वयाच्या गटातील तरुणांचे उच्चशिक्षण घेण्याचे प्रमाण आज जे जेमतेम 6% आहे , ते निदान 20% पर्यंत वाढवायचे उद्दिष्ट सोडूनच द्यावे लागेल. या पार्श्वभूमीवर कला, वाणिज्य आणि विज्ञान विषयांच्या पदवीपूर्ण शिक्षणाचे शुल्क फार वाढवता येणे समर्थनीय आहे, असे म्हणताच येणार नाही.

व्यावसायिक शिक्षणाची परिस्थिती काही अंशी वेगळी आहे. तेथे शिक्षणक्रमाच्या शेवटी व्यावसायिक म्हणून व्यक्तीला मान्यता मिळते; नियमित उत्पन्नाचे साधन मिळण्याची आणि चांगल्या मिळकतीची शक्यता अधिक असते. विद्यार्थी जिथे शिकतो ती संस्था जितकी नावाजलेली, तितकी अशी मान्यता, पुढे जाण्याच्या संधीची निश्चितता आणि मिळकतीचे प्रमाण जास्त.

या पार्श्वभूमीवर अशा संस्थांमधून (उदाहरणार्थ : आय. आय. टी., आय. आय. एम.) अभ्यासक्रमांचे शुल्क जास्त का हे समजू शकते. अर्थात, या संस्थांतूनही प्रत्यक्ष दरडोई खर्चाच्या मानाने शुल्काचे प्रमाण कमी आणि सबसिडीचे प्रमाण जास्तच असते. (कमी उत्पन्न गटाच्या विद्यार्थ्यांना दीर्घ मुदतीच्या वाजवी व्याजदराच्या कर्जाची सोय बँकांमार्फत होणे या संदर्भात महत्त्वाचे आहे. याचा फायदा या गटातील व्यावसायिक तसेच सर्वसामान्य अभ्यासक्रमांच्या विद्यार्थ्यांना उच्च शिक्षणाची संधी मिळण्यासाठी होईल. अर्थात, याही बाबतीत जितके बोलले जाते, तितके प्रत्यक्षात आले आहे का ही शंका आहेच!)

मुख्य म्हणजे, प्रशिक्षित मनुष्यबळ तयार करण्यासाठी आणि एकूणच देशाच्या प्रगतीसाठी केलेली गुंतवणूक म्हणून उच्चशिक्षणातील सबसिडीकडे पाहता येईल. आतापर्यंत या गुंतवणुकीचा देशाला निश्चितच फायदा झाला आहे. खरे म्हणजे सर्व स्तरांवरच्या शिक्षणावरची गुंतवणूक वाढायला हवी. आजमितीस ती राष्ट्रीय उत्पन्नाच्या 3.5% आहे, ती वाढायला हवी. शिक्षणाचा प्रसार ज्या देशांत जास्त आहे, त्या देशांत हे प्रमाण 6%पेक्षा अधिक असते. आपल्याला ते लक्ष्य ठेवायला हरकत नाही.

या दृष्टीने विचार करता, आपल्याला प्राथमिक शिक्षणासाठी निधी उपलब्ध करण्यासाठी उच्चशिक्षणावरील खर्च कमी करायला हवा असे म्हणायची जरुरी नाही. अर्थात, खर्च करताना तो योग्य तऱ्हेने होतो की नाही, हे नेहमीच पाहायला हवे.

व्यावसायिक (आणि आता सर्वसामान्यही) अभ्यासक्रमांसाठी विनाअनुदानित तत्त्वावर खासगी महाविद्यालये काढण्याची आणि त्यासाठी भरमसाट शुल्क घेण्याची मुक्त परवानगी देण्याचे महाराष्ट्र आणि अन्य राज्यांचे धोरण वरील युक्तिवादानुसार असमर्थनीय वाटते. भारतात व्यावसायिक मनुष्यबळ वाढायला पाहिजे यात शंका नाही. शासनाचे असे उद्दिष्ट असेल, तर तेही समर्थनीय आहे. परंतु, हे करताना शिक्षणासाठी निधी पुरवण्याची आणि गुणवत्ता जोपासण्याची आपली जबाबदारी झटकून टाकणे अयोग्य आहे.

शासनाला स्वत:ला नवीन शिक्षणसंस्था काढणे कठीण असले, तर त्यांनी खासगी स्वयंसेवी संस्थांना ते सांगणे गैर नाही. अशा संस्थांना अनुदान देऊन त्यांच्या शुल्कावर आणि अशा किती संस्थांना परवानगी द्यायची यावर नियंत्रण ठेवायला हवे. त्याचप्रमाणे, अशा संस्थांच्या गुणवत्तेवर कडक देखरेख हवी. अशी देखरेख व नियंत्रण न ठेवल्याने व्यावसायिक शिक्षण देणाऱ्या संस्था काढण्याचा धंदा बनला आणि परिणामी बेकार किंवा अपूर्ण रोजगार (अंडर एम्प्लॉइड) असलेल्या व्यावसायिक सुशिक्षितांची फौज उभी राहिली.

उच्चशिक्षणाची गुणवत्ता टिकवण्यासाठी आणि वाढवण्यासाठी आपल्याकडे विद्यापीठ अनुदान आयोग, अखिल भारतीय तांत्रिक शिक्षण परिषद (ए. आय. सी. टी. ई), इंडियन मेडिकल काऊन्सिल अशा ज्या संस्था आहेत, त्यांनी अधिक प्रभावीपणे कार्य करण्याची, तसेच विद्यापीठांचे या बाबतीतील कार्य प्रभावी होण्याची गरज आहे.

अलीकडे, विद्यापीठ अनुदान आयोग आणि अखिल भारतीय तांत्रिक शिक्षण परिषद या दोन्ही संस्थांनी आपापल्या क्षेत्रांतील महाविद्यालये आणि विद्यापीठे यांच्या कार्यांचे मूल्यांकन करून त्यांना गुणवत्तेचा दर्जा देण्याची मोहीम हाती घेतली आहे. वरील संस्थांकडून निरनिराळ्या उपक्रमांसाठी महाविद्यालये व विद्यापीठे यांना मिळणारे अनुदानही गुणवत्तेवर अवलंबून राहणार आहे. गुणवत्तेचा दर्जाही दर पाच वर्षांनी पुन: तपासला जाईल. उच्च शिक्षणाच्या गुणवत्तावाढीच्या दृष्टीने वरील मोहीम नक्कीच स्वागतार्ह आहे.

*होमी भाभा विज्ञान शिक्षण केंद्र, टाटा इन्स्टिट्यूट ऑफ फण्डामेन्टल रिसर्च,* मानखुर्द, मुंबई 400 088.

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# Prof. B. M. Udgaonkar

Prof. B. M. Udgaonkar (b. 1927) began his research career at the Tata Institute of Fundamental Research, under the guidance of Prof. H. J. Bhabha, in 1949. After some publications of interest in Bhabha's theory of elementary particles, he was drawn into the newly emerging Indian Atomic Energy Programme. He underwent training at the French Atomic Energy Commission, Saclay, France for 18 months (1953-55), and on his return built up the core of the Reactor Theory Group of what is now the Bhabha Atomic Research Centre. In 1960, he switched back to High Energy Physics, and spent the next three years in USA, at Lawrence Radiation Laboratory, Berkley (1960-62), Institute For Advanced Study, Princeton (1962-63), and Arogonne National Laboratory (1963). On his return he took charge of the Theoretical Physics Group at Tata Institute of Fundamental Research, Bombay, which soon acquired international reputation.

Prof. Udgaonkar is known for his pioneering contribution in the Regge Pole Phenomenology of high energy cross sections and also for his work in the bootstrap approach to hadron dynamics. He is a Fellow of the Indian Academy of Sciences and of the Indian National Science Academy. He was a member of the Commission on Particles and Fields of IUPAP (1969-75).

In the mid-sixties, Prof. Udgaonkar got interested in the problems of education and he was responsible for the growth of the educational dimension of TIFR- the graduate courses and the Visiting Students Research Programme (VSRP) in the School of Physics of TIFR, and various interactions with the school system and the University of Bombay. Out of these emerged the Homi Bhabha Centre for Science Education (HBCSE) at TIFR, and the Western Regional Instrumentation Centre at the University of Bombay. Also, he was called upon to became a member of the University Grants Commission of India (1973-79). He was Chairman of HBCSE (1975-91) and nurtured it as a Centre of Excellence in school science education and research.

He was Chairman of the Board of Research in Nuclear Sciences of the Department of Atomic Energy (1979-86), and Chairman of the Atomic Energy Education Society (1988-90). He was a Member of the University Grants Commission (1973-79), Member of the Indian Council of Social Science Research (1980-86), and Special Advisor to Deputy Chairman of the Planning Commission (1977-79). He was the first President of the Indian Physics Association (1971-73), President of Maharashtra Academy of Sciences (1979-82), President of the Indian Academy of Social Sciences (1988-89) and President, Marathi Vidnyan Parishad (1982-91). He was Chairman of the National Organizing Committee of Bharat Jan Vigyan Jatha (1987).

Prof. Udgaonkar has been active in Pugwash, the well known international organization of scientists working for peace in the nuclear era, which received the Nobel Prize for Peace in 1995. He was a member of the Pugwash Council and Executive (1987 – 97). He received the Hari Om Trust Award of the UGC, for work at the interface between science and society (1985) and the President's Award, PADMA BHUSHAN (1985).

Prof. Udgaonkar has written extensively on his experiences and ideas relating to Education, Science-Technology and Development, and global nuclear disarmament. A selection of his articles has been published by HBCSE (1996).

**Programme**

# SCIENCE EDUCATION - CHALLENGES OF QUALITY

**12th and 13th September 2007**

**Venue for the Conference :** V G Kulkarni Auditorium
Homi Bhabha Centre for Science Education, TIFR
V. N. Purav marg, Near Anushaktinagar bus Depot,
Next to BARC gate, Mankhurd , Mumbai - 400 088
Phone no: 022- 25567711

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**Wednesday, 12th September 2007 : Time: 14.00 to 16.30 Hrs**

## Session I : School Science Education – Universalisation with Quality

**Speakers :** Chairperson :
- Prof Anil Sadgopal
- Prof. Ram Takwale
- Prof. Anita Rampal
- Mr. V. G. Gambhir
- Dr. Jayshree Ramdas
- Dr. K Subramaniam

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**Wednesday, 12th September 2007 : Time: 17.00 to 19.30 Hrs**

## Felicitation Function

Conference dinner will be served thereafter
Prof. B.M. Udgaonkar will be felicitated at the hands of Prof M G K Menon

**Speakers :**
- Felicitation ceremony
- Prof. M G K Menon
- Dr. Anil Kakodkar
- Prof. Arvind Kumar
- Prof. Jasjit Singh
- Dr. P. Babu
- Dr. Anil Sadgopal
- Dr. Jayant Udgaonkar

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**Thursday, 13th September 2007 : Time: 10.00 to 13.00 Hrs**

## Session II : University Science and Technology

**Speakers :** Chair person :
- Prof. Arun Nigavekar
- Dr. S. P Sukhatme
- Dr. J. B. Joshi
- Mr. P. S. Deodhar
- Prof. N. Mukunda

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**Thursday, 13th September 2007 : Time: 14.00 to 16.30 Hrs**

## Session III : Science Dissemination

**Speakers :** Chair person :
- Prof. D. Balasubramaiam
- Mr. A. P. Deshpande
- Prof. Vinod Raina
- Dr. M P Parameswaran

# National Centre for Science Communicators

**National Centre for Science Communicators (NCSC)** is a pulsating science communication organisation with national and international reach. It's members include science communicators from varied fields of communication – print media, television, radio, science centres etc…….

The NCSC was established in January 1997 with a view to develop Science Communication in India. The Centre provides opportunities for science communicators to explore and express their talents and creativity for better understanding of science and recognises such talents. Presently, the membership strength of NCSC is over 200 spread across the country.

One of the most dynamic campaigns of NCSC is its intensive interaction with the teaching community, to inculcate excitement regarding science education and scientific method of knowledge transfer.

The Centre has been conducting Science Journalism courses in both Marathi and English.

The NCSC has published a National Directory of Science Communicators and National Directory of Science propagating organisations for easy access to information regarding science communication.

Conferences hosted by the NCSC

- The NCSC hosted its First International Conference of Science Communicators at IUCAA in Pune in January 2000, the theme being "**Public Understanding of Science"**. Around 210 Science Communicators across the globe attended the event.
- The second International Conference of Science Communicators was organised at the BARC, Mumbai to felicitate and honor renowned Astrophysicist and science Communicator Prof Jayant Narlikar, in July 2003. The theme of the conference, was **"Man and the Universe"**.
- The third International Conference of Science Communicators was held in Rio de Janeiro, Brazil in the year April 2005; the theme being **Science Communication in developing countries.**
- In October 2005, NCSC organised a National Seminar for Science Communicators on **Expanding Horizons of School Science Education** at the Labour India Complex, Marangattupilly, Kottayam, Kerala
- In November 2006 a National Conference – **Vision 2026 – Challenges in Science Communication**, was organised at the Indian National Science Academy, New Delhi. The conference was inaugurated by Dr. APJ Abdul Kalam, President of India on 26th November 2006
- In September 2007 A National Conference on **Science Education - Challenges of Quality** will be organised in association with Homi Bhabha Centre for Science Education, as a tribute to Prof. B. M. Udgaonkar, eminent scientist and educationist on the occasion of his 80th Birthday on 14 September 2007.

**A. P. Deshpande**
Chairman
National Centre for Science Communicators

# Homi Bhabha Centre for Science Education (HBCSE)

**Tata Institute of Fundamental Research (TIFR), Mumbai – 400 088**

Homi Bhabha Centre for Science Education (HBCSE) is a National Centre of the Tata Institute of Fundamental Research (TIFR), one of India's premier research institutions in basic sciences and mathematics. It started in 1974 as a unit of TIFR under a grant from the Sir Dorabjee Tata Trust. Since 1981, the Department of Atomic Energy, Government of India has supported it. In 1992, HBCSE moved from a temporary location in a Municipal School of central Mumbai to its present independent campus located at Mankhurd, Mumbai.

The broad goals of the Centre are to promote equity and excellence in science and mathematics education from primary to introductory college levels, and encourage the growth of scientific literacy in the country. To these ends it carries out a wide spectrum of interrelated activities.

***Teacher orientation and science dissemination***

This is a large grassroots activity, centering on the education of the socially disadvantaged. In fact, HBCSE grew out of this activity and it was the main focus of HBCSE in its initial years. The Centre has carried out tribal education projects in remote parts of the state of Maharashtra and is also involved with the Atomic Energy Education Society (AEES) in talent search among the underprivileged communities around the Department of Atomic Energy project sites. A large number of teacher orientation programmes are held round the year on the campus and at different sites in the country for AEES, other similar school networks, State and Central Government agencies and many non-governmental organisations. It recently carried out an important action research project on 'Health and Environment Education'. Through numerous field projects, the Centre has evolved a laboratory based on readily available materials for performing a range of experiments in school science. Accompanying this is an activity-based mathematics laboratory including educative games, puzzles, aids and models. As part of its science popularization effort, the Centre has developed two notable exhibitions on 'History of Science' and on 'Gender and Science'. Several popular science books brought out by the Centre supplement these efforts. The Centre received the National Award for Science Popularisation from National Council for Science Technology Communication in 1999.

***Curriculum, Laboratory and Materials Development***

Academic research and grassroots experience have been combined to develop innovative curricular and co-curricular materials: textbooks, teacher books and laboratories in school level science and mathematics. Several co-curricular and popular science books both for children and general readers have been brought out. HBCSE members have also co-authored science and

mathematics textbooks by National Council of Education Research and Training (Government of India), Text Book Bureau of the State Government of Maharashtra, Indira Gandhi Open National University, YC Maharashtra Open University and other organizations.

***Olympiads***

HBCSE is the nodal Centre of the country for Olympiads in five subjects: mathematics, physics, chemistry, biology and astronomy. This is a massive programme involving several stages of selection and training culminating in student teams contesting in International Olympiads in these subjects. Special Olympiad laboratories in physics, chemistry and biology have been developed for the purpose. HBCSE also hosted an International Chemistry Olympiad in 2001 in which 60 countries participated and an International Astronomy Olympiad in November 2006 in which more than 20 countries participated. HBCSE will be hosting International Biology Olympiad in July 2008.

***National Initiative on Undergraduate Science (NIUS)***

This is a major new dimension to HBCSE's activities and a natural sequel to its Olympiad programme. It caters to talented undergraduates of the country and mobilizes some of our best scientists and teachers especially those from Bhabha Atomic Research Centre and Tata Institute of Fundamental Research, for motivating and nurturing promising Indian students for advanced studies and research in sciences. It will involve a large number of nurture camps for students and joint resource generation camps of scientists and teachers from different parts of the country. THE NIUS, which began in December 2004, will involve at its full strength, about 400 students and 100 teachers at any given time in different stages of the programme.

***Research in Science & Mathematics Education***

As part of TIFR (Deemed University), HBCSE runs a Ph. D. programme in Science Education, which includes pre-Ph. D. courses in cognitive science, research methodology, history and philosophy of science, science and technology studies, and related areas. The Centre has held several national workshops and international conferences in this field. A major series of International Conferences on Science, Technology and Mathematics Education has been undertaken by the Centre. The first conference in this series, epiSTEME-1, was held in December 2004, the second, epiSTEME-2, was held in February 2007 and the next has been planned for January 2009. Seminars, colloquia and visits by scientists from India and abroad sustain a vibrant academic ambience at the Centre.

***Major Areas of research at HBCSE include:***

- Cognitive and pedagogic studies of science, mathematics and technology education
- Sociocultural and gender studies in science, mathematics and technology education
- Knowledge structure and dynamics
- Imagery and reasoning; Drawing, design, and cognition
- Curricular issues, assessment and evaluation
- Health and environment education
- Educational implications of history and philosophy of science.