CONVOCATION ADDRESS

OF

PROF. M.G.K. MENON, FRS

AT

THE 8TH CONVOCATION OF

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

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Shri Achyut Kumar Saikiaji, Chairman, and Members of the Board of Governors, Prof. Gautam Barua, Director and Members of the Senate; Distinguished Invitees to the Convocation; Members of the Staff; and most important, my dear students who will be receiving their degrees at this Convocation, for whom this whole function has been organized.

I am honoured by the invitation from the authorities of IIT Guwahati to be the Chief Guest at this Convocation. I readily accepted the kind invitation because I have had a long relationship with the IIT system. I have given Convocation Addresses at each one of the other IITs; this was the only one remaining; and I am happy to give the Address here as well.

I am somewhat old to have been a proper alumnus of any IIT. This system came into existence after I had already obtained my PhD.; but I am proud to be an honorary alumnus of two IITs (IIT Madras and IIT Kharagpur), by having been conferred Honorary Doctorates by them. I have also been the Chairman of the Board of Governors of IIT Bombay for six years, and of IIT Delhi over the past three years. I have been present at many of the IIT Alumni re-unions, and participated in the PAN-IIT conferences. I am always very happy to be in a group of IITians, because I feel that they are great boys and girls!

For students who are taking their degrees today, the first point I would like to make is that you can go out into the world with a sense of pride in your Alma Mater. The brand name '*IIT (B.Tech.)*' is the finest brand name that India has produced so far. It is recognized all over the world for quality and excellence.

I was present at the PAN-IIT Conference held in Maryland, USA in May 2005. On that occasion there was a visit to the US Congress. This was because of a special event that had taken place there, which particularly related to the IIT system.

The House of Representatives of the United States of America had passed a Resolution No. 227 on April 26, 2006, in which it is stated amongst other things that-"... *Whereas the Indian-American community and the graduates of the Indian Institutes of Technology (IIT) in the United States have made valuable and significant contributions to society in every profession and discipline*"; and "*Whereas IIT graduates are highly committed and dedicated to research, innovation, and promotion of trade and international cooperation between India and the United States ...*"

"*it resolved that the House of Representatives*

Honors the economic innovation attributable to graduates of the Indian Institute of Technology"

This is a remarkable statement coming from the US Congress, which has honoured a foreign university system in this manner for the first time.

This is an accomplishment that had taken half a century to fructify, from the heady days soon after Independence when so many, who were moved by a spirit of idealism to make India great, planned the creation of a large base of highly trained human resources that would be relevant for the most modern areas, and needed for India's development. The IIT system is a product of that vision. The country has reason to be proud of what it has been able to create and achieve.

Every one of you know that you have been provided the finest education by your country. For this we have cause to be grateful to that visionary, the first Prime Minister of India, Jawaharlal Nehru, who was deeply convinced of the role of science and technology for national development, and strove to ensure that leadership in these areas would be grown, which would fructify on a broad basis across the scientific, technological, industrial, and beyond that, the social and cultural domains. IIT alumni have delivered across all of these at the highest levels.

The IIT system is based on the principles of meritocracy and excellence. This is ensured through an impartial, objective Joint Entrance Examination for the entire IIT system. Every student present in this hall has had to go through a very tough selection procedure before entering the portals of this institution. You are the *crème-de-la-crème* of the country. Simultaneously, efforts were made to have a faculty of high quality. In my interactions with some of the most distinguished alumni of the IIT system, who had reached the top levels in the world in their fields, I found that they remembered their teachers, with fondness, affection and respect. In those early years there was a true feeling of the Guru-Shishya Parampara so characteristic of Indian education. I would like all of you to keep it up.

So far, it has also been possible to have the students live on campus resulting in important interactions between them. In his Nobel Lecture, Jacques Monod, the French Nobel Prize winner, has mentioned how important it was for him to get a Rockefeller Fellowship that gave him the opportunity to work at Caltech in the laboratory of Nobel Laureate Morgan. He has stated, "This was a revelation to me – a revelation of what a group of scientists could be like when engaged in creative activity, and sharing it

in constant exchange of ideas, bold speculations and strong criticisms". This is similar to what characterizes the IITians.

I have been to this beautiful north-eastern part of India many times-indeed I have visited each one of the states of this region, and not just the capital city or main towns, but the interiors. The region is home to very rich human resources, particularly in terms of customs, traditions, and culture. This IIT came into existence on the basis of the Assam Accord entered into by Shri Rajiv Gandhi, the then Prime Minister; I was Scientific Advisor to him. I remember specially mentioning to him that it was not a question having an IIT to provide opportunities for those from the region – after all an IIT will admit on the basis of the Joint Entrance Examination. But it would bring to the region an IIT which would have its own culture and standards of excellence, to which those from many other parts of India would come. And so many of you, from different parts of India, who have spent the most impressible years of your lives here, cannot but fall in love with this part of India and its people.

The students, who have had the privilege of being in an IIT, must remember that, in many ways, they are very privileged and fortunate. So many from their own schools and colleges have failed to pass the necessary hurdles, and have had to be satisfied with an education at a variety of other institutions at regional and state levels, both in the university system and in the non-formal system. It has been your privilege to be in the best of institutions that the country can provide, and which successive Governments have so generously supported. So you must remember the responsibility you have, to those who have not been given this opportunity. Indeed, through the Joint Entrance Examination, a few thousands are selected who actually get admitted; but the next few thousand and indeed the following few thousands are in no way inferior. So each one who has got in, has cause to be grateful.

The principle of social responsibility must be deeply ingrained in the conscience and actions of each one of us. This applies equally to the Government, to the corporate sector, to institutions such as the IITs, and to the students privileged to be here – indeed to every one of us. It is my conviction, from long interactions with each of these sectors, that this is not adequately appreciated. There is a tendency to follow the old saying- "*each man to himself – devil take the hindmost*". This is what results in social injustice, which is the root cause of most of the problems of the world today, including wars, conflicts and terrorism. Even when there is no injustice, there is perceived injustice.

In a moving address to the Pontifical Academy of Sciences, (November 12, 1983), where I had the privilege of being present, Pope John Paul II said, "*Peace is born not only from the elimination of hotbeds of war. Even if all these latter were eliminated, others would inevitably appear, if injustice and oppression continue to govern the world. The intention to direct science to the promotion of justice and peace demands a great love for humanity. Every human virtue is a form of love. This is the case, in particular, of justice, which is love of neighbour, of individuals, and of people. Only the person who loves wants justice for the other person. The person who does not love seeks only to obtain justice for himself.*"

Thirty years ago when I gave the Convocation Address at IIT Bombay, I said-

"*For development to occur, it is not enough to transfer the sum total of the knowledge available with developed countries to the developing countries. It is important for all countries to have their own indigenous scientific capability, which will ensure that knowledge is acquired or discovered, and processes are adopted, which relate to the special conditions and levels of development, and to the specific socio-economic and cultural features of these countries.*"

"*We all represent a privileged group who has had the opportunity to be educated to a very high level. The IITs are elite institutions in their own areas; this is so as a fact, even if one may dislike the concept of elitism. The nation has placed great store by these institutions and has provided the best facilities and the greatest opportunities for those privileged to enter and to study in these. Such a privilege in turn implies a responsibility – and I hope you will be conscious of it. This responsibility is essentially that the nation will require your intellectual ability, your training and experience, and your enthusiasm and motivation, in the tasks that it faces in developing its society as a whole. Individuals may consider that all of these opportunities that you have had are a matter of right; (I do not think that this is so). Accordingly, they may wish to use the opportunities to find a comfortable place in life, with its privileges and perquisites; and unfortunately, our structures today are such that privileges and perquisites are not in proportion to the true contribution that an individual makes to society as a whole. On this matter, I would urge you to look deep into your conscience...*

It should be your endeavour not to work purely for comfortable security, but to seek out opportunities to play a dynamic role in solving the very large problems related to the development of science and technology on a

meaningful basis and related to sound value systems.... It is a fact that whilst the individual human being is extremely important, it is Society as a whole which is even more important... in the happiness of human society will lie the true happiness of the individual human being. "

The purpose of education is to enable an individual to fit into the world that he or she will be entering. I recall that the world which I entered after formal education, around 50 to 60 years ago, was completely different from the world that each of you will be entering now.

At that time the world had just emerged through the Second World War, which had involved a tremendous amount of destruction. Major Empires had collapsed and vanished; the economies and industries of great powers, such as Britain, France, Germany, Italy, Soviet Union, and Japan, had been shattered and greatly weakened; in many parts of the Soviet Union such as Ukraine, there were no men to be part of the work-force. One had seen instantaneous destruction in the atomic bombing of Hiroshima and Nagasaki. There was deeply felt human desire, in all countries, for lasting peace, and for the creation of an international order that would bring about social justice for, in the absence of social justice there was no hope for lasting peace. It was, thus, that the United Nations came into existence, particularly to keep peace, as also many of its Agencies to facilitate development. A major UN Agency was UNESCO, created on the basis of the premise that "*peace is made in the minds of men*"; it was meant to deal with education and culture, to which science was added as an essential component of both education and culture.

India was freed from the colonial yoke in 1947. It was an old society almost completely agrarian. Practically anything that one bought in the shops then, was made abroad; manufacturing industry was in its infancy. There was a great steel plant set up through the vision of Jamshedji Tata in Jamshedpur – great for those days. There were a few textile mills and some hydro-electric plants set up through the vision of the great engineer Vishveswarayya, and the vision of the Tatas. India had also suffered the trauma of Partition and had to deal with the huge refugee population. It did not have much foreign exchange at its disposal. Its level of development was very low. Very few now have memories of those days.

But India had an inheritance, of which we can be truly proud even today. It had its long history of civilization and culture, and all that these implied. It had been steeled in coming through its struggle for Independence, particularly with the sense of idealism and the practice of non-violence, under the leadership of Mahatma Gandhi. It was the country that had seen

in recent past great visionaries and role models, such as Mahatma Gandhi, Jawaharlal Nehru and Dr. Ambedkar on the political scene; great scientists like J.C. Bose, S.N. Bose, M.N. Saha, C.V. Raman and M. Vishveswarayya on the scientific and engineering scene; great cultural figures like Gurudev Tagore and Subramaniya Bhartiar; social and religious leaders and reformers, like Ramakrishna Paramhans, Swami Vivekananda, Pt. Madan Mohan Malaviya. Only a few names have been indicated; there are a myriad of similar names who could be added to this from the different parts of India. I often ask myself the question, "*Where are such role models, icons and visionaries today*?" These were the leaders and visionaries who have given us the basic structure of current Indian society and laid the foundations for our progress.

The world into which you will move when you leave the IIT presents a completely different picture from the one that I have just described. First we encounter a highly fractured civil society, where conflicts within countries and between countries have increased; terrorism has almost become a way of life. Political polarization that involved the USA on the one hand, and USSR on the other, which gave rise to the Cold War, came to an end. The map of Europe was redrawn and the Soviet Union has fragmented into many independent entities. China has emerged as a major military as well as economic power.

In India too there has been a major transformation. Periodic famines that haunted the country are only a part of history. Agriculture has achieved a high degree of self-sufficiency to feed the large and growing population. This was particularly on account of the Green Revolution relating to cereal crops, and the White Revolution in dairying; in other sectors of agriculture also India has done well. The growth rate of the economy has exceeded an average of 8% between 2003 and 2006. India can look forward to sustaining this growth rate with an investment rate of 30%. Foreign Exchange resources are significant at over US $140 billion; and exports are increasing by 20% per year in dollar terms. This growth has been significantly due to completely new sectors in the economy such as services and software, where India is doing exceedingly well. Indian manufacturing has come of age; it is already contributing about 17% to India's GDP; this share could easily rise to 30-35%. The key to this (as also in the IT sector) lies in India's intellectual capital, which is a source of sustainable competitiveness. By the year 2020, India will have about 760 millions in the working population. Counting on 10% of this as having adequate knowledge capabilities in science, engineering, IT and English, there would be competitive work-force of 76 million; this is large by world standards. This could even be larger if one is able to implement better

education policies to take advantage of huge numbers of the disadvantaged in India's large population.

All in all, the India that you will be moving into is already in the stage of transition to a sustainable double-digit growth in economic terms.

It is a matter of pride that this has been achieved by a nation that has adhered to democratic traditions since it became independent almost six decades ago; and by a society where there has always been freedom to express one's views. India has been fortunate in its judicial system that has upheld the Constitution and human rights; and acted in a proactive manner in areas that relate to the benefit of society.

However, there are still many serious handicaps in moving to sustainable growth of an egalitarian society. Two of these clearly are: inadequate attention to human resource development; and inadequacy of the infrastructure in terms of energy, transportation, air and sea port facilities, and urban development.

In terms of the human resource development index, which includes life expectancy, adult literacy, school enrolment and per capita income, India stands 127th out of 177 countries; Sri Lanka has a ranking of 93 and China 85. In many areas in the health sector, we stand even below Sub-Saharan Africa, which we regard as least developed. The Indian figures (with figures for Sub-Saharan Africa in brackets) are: malnutrition of children 50% (31%), anemia in women 76% (43%), low birth weight 30% (15%); these are just a few comparative figures. We have very high infant, child and maternal mortality; and what is so astounding is that the sex ratio (female to male) is extraordinarily low in this country; and more particularly so in the developed parts of the country. This brings out the serious flaws in our societal and cultural attitudes.

The human resources of this country can be likened to an iceberg, with only a small part above the surface of the ocean. We see only that part which has all the opportunities; those in the IIT system fall in that part, just as much as I do. And then there is, below the surface, the bulk of the iceberg, of human resources which have not yet been given appropriate education and health care necessary for their meaningful development. This constitutes one of the major tasks before us, where the issues of social responsibility come to the fore.

To a great extent one has been depending on the Government to perform the task of developing the human resources in this country. Increasingly,

one realizes that it can be accomplished in a major way only by society itself. There are efforts in this direction, which significantly relate to commercialization of education and health services to cater to the upper strata and to make money. But most important to me is what a large number of non-governmental organisations are doing for the disadvantaged. I am very happy that many who have come out from the IIT system are involved in these activities, and particularly at leadership levels. In my view this will turn out to be like an avalanche. Once these individual efforts start to succeed, they will catch on and more and more efforts will come into being. We are at a stage when this is just about happening. I have a great confidence that, in course of time, not only will we be able to salute those from the IIT system who have achieved success in areas such as science, technology, (particularly information technology, materials technology and biotechnology) and in the world of business and finance, but also those who are in the leadership of the movement for improved development of our human resources, particularly of the disadvantaged.

When one looks at the great university systems of the world, one finds that they are all major research institutions. It is in these that new knowledge is generated, which has the power to breed new technologies, often disruptive, in eras of human civilization. These educational systems are places where the young abound; and the students are taught by those who are in the process of generating new knowledge through research. A significant fraction of the research groups consist of students doing their PhD or young post-doctorates, although it should also include the best of the undergraduates. The most cost effective way of conducting research is in places where the young, who have intense curiosity and enthusiasm, as well as true originality unspoiled by the dead weight of knowledge and restrictions, whose minds soar freely, asking both '*why*' and '*why not*', work day and night, not for salaries or money but for the kick of it. Indeed, I could give you many examples of Nobel Prizes won by those who had produced the most daring ideas at this stage of their career. The IIT has to aspire to be an institution of that type, and not just one where high quality undergraduate training is imparted.

As we move into the future, into what will increasingly be a knowledge economy, science will have to be given its rightful place in the IIT system, for it is only through scientific understanding that advanced engineering and technology will fructify. And equally, it is the capabilities of engineering and technology that will enable the flowering of science. It is important to appreciate the synergistic and symbiotic convergence of science and technology. I am convinced of the great opportunities for experimental research in science of the highest order in the IITs, with the capabilities of

wide ranging advanced technology in the proximity; one has only to create the right conditions. The IIT system has not yet taken advantage of this potential.

It would also be necessary to get the best amongst the young to come into science, and to take up research as a career. For this there has to be a sustained campaign to point out the excitement of science, and of the discoveries that come through it. Science does not consist of the technological artifacts such as TV sets, computers, cell phones, cars, planes or nuclear bombs that most in Society associate with science. Science is knowledge, the search for truth, to try to understand nature and the way it functions. But this knowledge does lead to the artifacts just cited.

Society, government and our institutional structures, including business and industry, will have to recognize that high quality research workers, including those who have obtained their doctorates, are worthy of being paid higher salaries that they truly deserve – perhaps even more than those who join finance, management and routine production; they must also be made use of effectively, with challenging responsibilities; this is particularly so in the newly emerging sunshine industries. The country cannot become one of the advanced countries purely on the basis of a large number of those who are well paid for relatively routine work, as is the case today.

In the areas of technology, the importance of innovation of the highest quality needs to be recognized, as different from discoveries in science, as also the need to foster interdisciplinarity, and the ability to enter new areas of opportunity as they emerge. This calls for cooperative research programmes between various areas and departments within an IIT, as also between IITs; this has yet to take root. It has to be ensured that innovation is not restricted to technology, but also is in management, application and the entire financial, legal and human resource system. The IIT system is uniquely placed in this regard, and must seize these opportunities that lie in front of them.

Now let me deal with another great handicap in achieving the desired sustainable economic growth. This is the slowness in putting the necessary infrastructure in place.

The first of these areas relates to energy. Within the next quarter of a century, India will have to increase its primary energy supply by 3 to 5 times; and electricity supply by 5 to 7 times of today's consumption. Power generation would have to be increased from the present level of 150,000 MW to around 780,000 MW. The location of our coal fields, and the poor

quality of the coal, apart from the enormous quantity of CO_2 that would be put into the atmosphere through coal-based energy generation, would demand that we look for other sources of energy. The opportunities available are nuclear energy and renewable energies.

More than six decades ago, a great visionary Homi Bhabha had visualized that India would need to produce enormous quantities of energy. This was because of the very low base level of energy consumption, and the estimated requirements of energy for a reasonable quality of life.He foresaw that nuclear energy would be an answer, since the energy produced in nuclear reactions would be a million fold larger than that in chemical reactions. He foresaw this in 1943-1944, which was before the first atomic bomb had been tested at Alamogordo; he was then only familiar with public information: on the existence of the neutron and of the fission process; he did not even know of the work on the chain reaction. In 1944, in a letter written (at the instance of Shri J.R.D. Tata) to the Sir Dorabji Tata Trust, he had mentioned, "*Moreover, when nuclear energy has been successfully applied for power production in, say, a couple of decades from now, India will not have to look abroad for its experts but will find them ready at hand*". This was his vision of abundant nuclear power; of a time scale of around two decades (which did happen); and of the importance of human resources of the high quality needed for such a programme. Homi Bhabha went on to lay out a blueprint for the development of the area of nuclear energy in India which is what we have followed for half a century.

Apart from bulk requirements of energy, we also need to take into account the need to meet India's rural energy requirements. In this, renewable energies (wind, solar-thermal and solar-photovoltaic, biomass, fuel cells, hydrogen, mini and micro hydels, etc.) will have a major role to play.

Major efforts are also called for to improve road and rail transportation as also air and seaport facilities, which involve large-scale engineering efforts significantly based on known technologies; these require large investments.

Most of you of the younger generation would like to look at role models of your age group and of recent past. I have often wondered what made Kalpana Chawla such a role model. It was essentially the determination with which she pursued her goals. Coming from a small town in India, she determined to go into the field of engineering, then to the United States to specialize in aeronautics and become an astronaut; all the time her dreams were of space and the stars. She died in that vocation in the disintegration of her spaceship. She was not the first astronaut in the world, nor the first woman astronaut; nor even the first Indian astronaut. In all of this, there

were others who preceded her. But she became an icon and a role model because she determinedly pursued what she had aptly put down in one of the last messages she sent to this country, and I quote:

"*The path from dreams to success does exist.*
May you have the vision to find it, the courage
to get on to it, and the perseverance to follow it."

I would like to conclude by giving you Gandhiji's talisman

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following-

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him.... In other words, will it lead to Swaraj for the hungry and spiritually starving millions?

Then you will find your doubts and your self melting away."

JAI HIND

(M. G. K. Menon)