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Hon'ble Vice-Chancellor of Shivaji University, distinguished Members of the Management Council and Academic Council of the University, distinguished invitees and Faculty of the University, my young friends who are graduating today, ladies and gentlemen :

I feel greatly honoured on being invited to give the Convocation Address. The students of this University have already made their mark in the intellectual - scientific scene in the country and Kolhapur region is also now as well-known for its industrial activity as for the Mahalakshmi Temple ! The young persons who are graduating out today from the portals of this University should, therefore, do so with a sense of pride. They are also going to get into their various professions at a time when this country needs a rapid pace of development and this is going to throw up both challenges and opportunities to them in the coming years. The country needs today men and women of character and I would like to share with you some of my thoughts on this subject.

**What is Character ?**

Einstein once said :

***“Most people think that it is the intellect which makes a great scientist.  
They are wrong, it is the character.***

This does not mean that any one can do great science. High intellect is necessary but not sufficient; character is more important. The definition of character is, however, not easy. Character means integrity; it means pursuit of excellence within the individual's limitations, of course; it means perseverance in the face of adversity; it means commitment to national and social causes; and it means also a commitment to justice and societal equity. Samuel Smiles says in “Self Help”: *“Character is the noblest possession of an individual. It exercises a greater power than wealth and secures all the honour without the jealousies of fame..... Men of character are not only the conscience of society but in every well-governed State they are its best*

*motive power. The strength, the industry and civilization of nations - all depend upon individual character.... Mind without heart, intelligence without conduct, cleverness without goodness, are powers in their way, but they may be powers only for mischief. We may be instructed or amused by them. But it is sometimes as difficult to admire them as it would be to admire the dexterity of a pickpocket or the horsemanship of a highwayman.”* In Transactional Analysis, they talk of winners and losers and games people play; this is not in the sense of the terminology in sports ! James and Jongeward say in “BORN TO WIN”:

***“A Winner is one who responds authentically by being credible, trustworthy, responsive and genuine, both as an individual and as a member of society. Winners ..... without guilt, enjoy their own accomplishments. Without envy, they enjoy the accomplishments of others.... The loser is self-pitying and shifts the responsibility for an unsatisfactory life onto others. Blaming others and excusing oneself are often part of the loser’s games.”***

### **Excellence in Science**

For a nation to grow and advance rapidly, it has to strive for excellence in all its spheres of activity. Each individual in the society has to strive to fulfill to the maximum the promise of his or her talents and the society should provide the opportunity and the environment to make this possible. In this task, the role of educational institutions is crucial in motivating; youth in its pursuit of excellence.

Among the Indian scientists, the three whom I admire most and who I think sought excellence in their own way and who have had the maximum impact on Indian science are Ramanujan, Raman and Bhabha. Srinivasa Ramanujan has been called by Mark Kac a “magical genius”, a genius which makes you say: ***“I have no idea where these results come from”***. The impact of his contributions to number theory and analysis is still being felt and their significance to particle physics and to fast computer algorithms is still being studied.

This lonely genius, who had no formal training in mathematics, and who spent time in an academic institution only during his brief sojourn in Cambridge - what was the driving force which led him to a pursuit of mathematics and not to a more conformist and profitable occupation? *He* knew he excelled in mathematics and the circumstances in Colonial India did not deter him - he worked in a clerical job in the Port Trust while he did his mathematical research in his spare time. Surprisingly Einstein was caught in a similar situation - he could not get a job in

any University in Europe and ended up in the Swiss Patent Office in 1902

C. V Roman, the greatest experimental physicist that India has produced did write the Civil Service Examination and became the Assistant Accountant General. For many years while he served in the Civil Service, he did research in the Indian Association for the Cultivation of Science in Calcutta -for several hours a day before he went to the office and for many more hours after the office closed. It is amazing how he found energy for both his office work and his research. Later he became the Palit Professor of Physics in the Calcutta University at half the salary he was getting as Assistant Accountant General. The great Arnold Sommerfeld said after visiting C. V. Raman in Calcutta: ***“India had suddenly emerged in competitive, research as an equal partner with her European and American sisters “***

This brings us to the one central point in the pursuit of excellence - there is nothing-worth doing which is not worth doing well. People who seek excellence are thus perfectionists. Homi Bhabha was such a perfectionist. The great edifice of the Department of Atomic Energy is a tribute to this versatile genius. An outstanding theoretical physicist, he decided to start and develop the nuclear science and technology activities in a country where none existed. To many, it might have looked an over — ambitious over ambitious aim. But he had faith in the talents and abilities of his countrymen.

Excellence does not come cheaply. Hargobind Khorana, who got the Nobel Prize for his work on genetics, spent several years of elaborate and painstaking effort putting together a synthetic gene, using chemical rather than enzymatic methods. He had taken several decades to perfect the technology of synthesising artificial ribopolynucleotides of defined sequence, which led to this outstanding final research achievement.

### **Integrity in Science**

It is said in the Gita (Chapter II, Verse 57) : which is normally translated as : He, who is unattached on any side, who, when he comes upon good or evil neither rejoices nor is repulsed, is poised in wisdom. This has been adapted in translation for the definition of the character of a true scientist by my friend Shri. C. V. Sundaram as : *“A true scientist has to be a स्थितप्रज्ञ. He is an individual with an open mind, unaffected by personal inclinations. He accepts results (of experimental observations or theoretical calculations) as they come, pleasant or unpleasant. He is not swayed by emotions of elation or disappointment. He stays steadfast and*

*uncompromising in his search for truth.*

### **Velocity of Research and Development**

My friends abroad often ask me why is it that our performance as Indians in India is not commensurate with their obvious talents, though we have not done badly in any field. In science and technology, the one factor that is holding us back is the low value in India of what I defined many years back as the *Velocity of Research & Development*. This is a relative velocity and compares the speed with which we complete a project in India in a frontier area of research or in a high technology field to the speed with which our counterparts in a developed country in the West do the same project. We have the talent, we have the ideas but we seem to take 50% or a little more time for such a project, compared to a developed country.

There are many reasons - some beyond our control - for our low velocity of R & D. These include antiquated bureaucratic procedures, lack of adequate peer groups in many frontier areas, poorer scientific information access, the inadequate industrial infrastructure in the country, the export policies of developed countries - though all these are improving in recent years - and, to some extent, the technological control regimes in nuclear technology and other high technology areas. India must strive to close the gap in the velocity of R & D and then it will see rapid national development.

### **The Value System in Society**

From the time of Jawaharlal Nehru, it has been recognised that the country's development will be driven by the growth of science and technology. And this growth will depend on the support that research and development receive from the Government and the industry and on the value system in science. The value system in science in any country is synthesized from many value sub-systems. What is it that young persons value most? What is the value system of the scientific community as a whole, the Science Academies and what is the reward system in the scientific community? What is the value system of the society at large - do they value science and respect scientists? As Frederic Seitz says : "*The advance of science requires money given with appreciation and wisdom, but the amounts must be determined by many complex factors*".

Society, of course, has also the right to demand adequate returns from its investments in science. It is essential that we encourage all kinds of research and development - basic research, applied research and technology development. It is clear that the technological development of India in the short-term will be led by applied scientists, instrument developers and development engineers. However, our applied research edifice presently is not strong except in mission-oriented agencies like those dealing with atomic energy, space and defence. But the growth of this applied research edifice in the future will be sustained by building a strong basic research foundation now. It must also be realised that the boundary between basic and applied research is not sharp. The S & T community, of course, must also have a strong commitment to indigenous technology development.

#### **Co-operation between Universities and DAE Institutions**

From its very inception, the Department of Atomic Energy has espoused a symbiotic relationship between the Universities and national laboratories. Indeed writing about the Tata Institute of Fundamental Research, Dr. Homi Bhabha, the founding father of the Atomic Energy Programme in India, spelt out his philosophy in the following words : *“...this institute has been a constituent recognised institution of the Bombay University from the very beginning and has had close relations with many other Universities in India, so that the students of many of them have done work for the Ph.Ds of their Universities in the Institute”*.

The various Units of the DAE have over time built up mutually beneficial programmes with several Universities. These include, for example, the neutron scattering studies being performed at the high flux Dhruva reactor at Trombay by scientists of different Universities in collaboration with -4 scientists of BARC under the auspices of IUCDAEF (Inter-University Consortium for DAE Facilities). This Consortium is also spearheading the cooperation in the Synchrotron Radiation Source-based research activities which will be pursued at the electron storage ring INDUS-1 now coming up at the Centre for Advanced Technology (**GAT**), Indore, and later at the higher energy storage ring INDUS-2.

Apart from the above activities, the BRNS (Board of Research in Nuclear Sciences) of the Department of Atomic Energy has been sponsoring research in many universities, IIs, RECs, IISc and other institutions for more than three decades. To further strengthen this link between DAE Units and teaching institutions we are also emphasizing another class of collaborative research schemes under BRNS.

Its purpose will be to focus on common areas of interest to a principal investigator from a university and a co-investigator from one of the DAE Units, who shall, however, not draw upon the BRNS funds. This kind of collaborative projects will enable the university scientists easier access to facilities in the DAE Units and the DAE Units in turn will have the benefit of interaction with University students and professors.. In the IX Plan, we are also looking at the possibility of setting up joint centres with universities in specific engineering areas of importance to the nuclear programme.

In common with developed countries, the situation in India is that the best technology and the best potential for developing it is in the national laboratories while the young scientific talent is substantially' in the universities. India will grow to its maximum potential only when there is a strong ,, synergistic interaction between the two systems—the national laboratory system and the university system.

### **Economic and Technological Independence**

The spirit of freedom of this Country must today be expressed in a drive for economic and technological independence. .This expression should not be as an opposition to trivial issues like outlets of Kentucky Fried Chicken or Pizza Hut—Tandoori Chicken and Masala Dosa are capable of taking up this kind of fight on their own. The essence of freedom is in establishing a self-reliant India in areas of high technology in the face of international efforts by some countries to hinder and push back our achievements in these strategic areas through technology control regimes and punitive threats.

When his biographer Kameshwar C. Wali asked the great theoretical astrophysicist Subramaniam Chandrasekhar how was it that in the 20s and 30s. India produced a number of great scientists like Raman, Bose, Saha and Chandrasekhar himself, he said that in those days : ***“There was need for self’ expression as a part of the national movement..... To show the West that in their own realm, we were equal to them”***. Dr. Homi Bhabha’s motivation for starting the Tata Institute of Fundamental Research in 1945 - *that scientists for manning the nuclear power programme should be available within the country without looking for foreign assistance* • I consider it part of the Quit India movement of the early 40s.

### **The Purpose of University Education**

Talking about the purpose of University education, Alfred North Whitehead says : *'The tragedy of the world is that; those who are imaginative have but slight experience' and those who are experienced have feeble imagination. Fools act on imagination without knowledge, pedants act on knowledge without imagination. Youth is imaginative and the task of a University is to weld together imagination and knowledge* "It is my view that this welding together of imagination and knowledge not only benefits the individual, but also leads to cultural growth of the society. Yet today, in the Indian context we need to go beyond this and design our university education so that it also paves the way for building the nation and for improving the quality of lives of the citizens in the country. The Indian youth must be encouraged to develop to its full potential in every field - be it science, management, commerce or sports. Then, we will have leaders who will take India to commanding heights in the comity of nations. We have had such leaders in the past, particularly during the struggle for freedom and, I am sure, more such leaders will emerge in the future and some of them will be from amongst you.

I will conclude my talk by wishing all of you young people well, as you go forth from here to the challenging task of restoring to this nation the greatness it once had.

**Thank you.**

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