

Address at the  
**Birla Institute of Technology and Science  
Hyderabad**

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**TECHNOLOGY IS THE NON LINEAR SYSTEM FOR  
ACCELERATED DEVELOPMENT**

*May I be a protector for those without one,  
A guide for all travelers on the way;  
May I be a bridge, a boat and a ship  
For all who wish to cross (the water).*

*..... by Acharya Shantideva,  
a Buddhist Master of 8<sup>th</sup> century  
(Nalanda University)*

I am indeed delighted to meet and address the students of Birla Institute of Technology and Science (BITS), Hyderabad. My greetings to the students, faculty members and staff. I greet the professors and faculty of BITS for shaping the young minds who are going to be a vital resource in all our national development missions. I congratulate the pioneers both present and past who have continuously strived to maintain high standards of technical education. The topic I have selected for discussion today is ***“Technology is the non linear system for accelerated economic development”***.

**My great teacher**

I would like to share my experience about acquiring knowledge through my great teacher Prof. Satish Dhawan.

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Dr. APJ Abdul Kalam  
[www.abdulkalam.com](http://www.abdulkalam.com)

First, I worked in Delhi with the Ministry of Defence. Later I joined Defence Research and Development Organisation (DRDO) in 1958 at Aeronautical Development Establishment at Bangalore. There, with the advice of the Director, I took up the development of Hovercraft. Hovercraft design needed the development of a ducted contra-rotating propeller for creating a smooth flow balancing the torques. I did not know how to design a contra-rotating propeller though I knew how to design a conventional propeller. Some of my friends told me that I can approach Prof. Satish Dhawan of Indian Institute of Science, who was well known for his aeronautical research, for help in designing the ducted contra-rotating propeller.

Based on the suggestions of my Director Dr. Mediratta, I went to Prof. Satish Dhawan who was sitting in a small room in Indian Institute of Science with lot of books in the background and a blackboard on the wall. Prof. Satish Dhawan asked me what the problem was that I would like to discuss? I explained the problem to Prof. Dhawan about my project work. He told me that it was really a challenging task and he would teach me the design if I attended his classes in Indian Institute of Science between 2.00 p.m. to 3.00 p.m. on all Saturdays for the next Six weeks. He was a visionary teacher. He prepared the schedule for the entire course and wrote it on the black board. He also gave me the reference material and books I should read before I started attending the course. I considered this as a great opportunity and started

meeting him regularly. Before commencing each class, he would ask critical questions and assess my understanding of the subject. That was for the first time that I realized how a good teacher prepares himself for teaching with meticulous planning and prepares the student for acquisition of knowledge. This process continued for the next six weeks. I got the capability for designing the contra-rotating propeller. Prof. Dhawan told me that I am ready for developing the contra-rotating propeller for a given hovercraft configuration. That was the time I realized that Prof. Satish Dhawan was not only a teacher but also a fantastic development engineer of aeronautical systems.

Later, during the critical phases of testing Professor Dhawan was with me and find solutions to the problems. After reaching the smooth test phase, contra-rotating propeller went through 50 hours of continuous testing. Prof. Satish Dhawan witnessed the test himself and congratulated me. That was a great day for me when I saw the contra rotating propeller designed by my team performing to the mission requirement in the hovercraft. However, at that time, I did not realize that Prof. Satish Dhawan would become Chairman, ISRO and that I would get the opportunity to work with him as a Project Director in the development of Satellite Launch Vehicle SLV-3 for injecting the Rohini Satellite into the orbit. Nature has its own way to link the student's dream and the real life later.

This was the first design in my career, which gave me the confidence to deal with many complex aerospace systems in future. The hovercraft could fly just above the ground level carrying two passengers. I was the first pilot for this hovercraft and I could control and maneuver the vehicle in any direction. Above all, I learnt that in a project, problems would always crop up; we should not allow problems to be our masters but we should defeat the problems. Then successes will sparkle.

Here, I would like to recall one of my early experiences in 1973, of course, many of you would not have been even idea form at that time. The experience goes like this :

***Problem should not become the captain, you should become the captain of the problems, defeat the problems and succeed.***

I was working as one of the technologist in Vikram Sarabhai Space Center of ISRO. One day Professor Satish Dhawan, the Chairman of ISRO and Dr. Brahm Prakash Director VSSC, called me to their chamber. Very rarely I had seen either of them smile but to my surprise, when I entered the room, I found that both of them were all full of smiles. So I was astonished and got the feeling that something was “cooking”. Then Professor Dhawan said "Kalam I have good news for you! You are going to run a huge program for ISRO. I and Director VSSC have decided to appoint you as the project director Satellite Launch Vehicle (SLV). I am going to give all the money required for the project, the management structure

and the human power needed. But you guy by 1980, you should show that you can launch Rohini Satellite using our own launch vehicle."

It was an unexpected message and it was indeed a happy moment. But in my mind, I was full with questions and doubts of whether I can do it? The whole nation would be looking at the performance and India would be joining the leading nations capable of satellite launch. Then I have to deploy many institutions and industries, thousands of technologists, all this in seven year "Can I do it? Can I do it??"

This doubt and uncertainty, made me dumbfound, I could not respond immediately. Then Prof Dhawan came to my rescue and said "We believe in your capacity, we believe in your team building capacity and above all the knowledge required you can assemble and integrate": "I can see the train of your thoughts. Let me tell you something. If one does not do any task, he or she does not have to worry about the result of positive or negative. But when you undertake a big mission like the satellite launch vehicle project, there will be many challenges - technological, leadership, and also some unexpected critical problems which you cannot visualize. Kalam remember, you should not let problems become your captain. Instead, you become the captain of your problems, defeat the problems and succeed." This advice reinforced my thinking and action and I accepted the project.

## **Research Teaching Research**

Technical education in India in the present century will be in a competitive environment where research and teaching are to be the focus. India has a number of institutions and universities having arts, commerce and humanities, and science colleges and professional colleges. The students have many choices of colleges, courses and programmes of learning depending upon their aptitude. In this environment universities have to work for promoting research teaching research.

Good teaching emanates from research. The teachers' love for research and their experience in research are vital for the growth of the institution. Any University is judged by the level and extent of the research work it accomplishes. This sets in a regenerative cycle of excellence. Experience of research leads to quality teaching and quality teaching imparted to the young in turn enriches the research.

Technology is the non-linear tool available to humanity, which can affect fundamental changes in the ground rules of economic competitiveness. Science is linked to technology through applications. Technology is linked to economy and environment through manufacture of knowledge products. Economy and environment are linked to technology, which promotes prosperity to the society. We have to use innovation

to generate high value added products for becoming a global player. The foundation of academic research is creativity.

Now, let me give my visualization of India during the year 2020.

### **Distinctive profile of the nation**

1. A Nation where the rural and urban divide has reduced to a thin line.
2. A Nation where there is an equitable distribution and adequate access to energy and quality water.
3. A Nation where agriculture, industry and service sector work together in symphony.
4. A Nation where education with value system is not denied to any meritorious candidates because of societal or economic discrimination.
5. A Nation, which is the best destination for the most talented scholars, scientists, and investors.
6. A Nation where the best of health care is available to all.
7. A Nation where the governance is responsive, transparent and corruption free.
8. A Nation where poverty has been totally eradicated, illiteracy removed and crimes against women and children are absent and none in the society feels alienated.
9. A Nation that is prosperous, healthy, secure, devoid of terrorism, peaceful and happy and continues with a sustainable growth path.

10. A Nation that is one of the best places to live in and is proud of its leadership.

### **Integrated Action for developed India**

To achieve the distinctive profile of India, we have the mission of transforming India into a developed nation. We have identified five areas where India has a core competence for integrated action: (1) Agriculture and food processing (2) Education and Healthcare (3) Information and Communication Technology (4) Reliable and Quality Electric power, Surface transport and Infrastructure for all parts of the country and (5) Self reliance in critical technologies. These five areas are closely inter-related and if progressed in a coordinated way, will lead to food, economic and national security. All the students and faculty members of BITS Hyderabad can carve out an area where they can concentrate in any one of the development pillars that I have mentioned above. For all these pillars, you may have to utilize more than one technology. Hence, I would like to discuss on convergence of technologies.

### **Convergence of Technologies : bio-info-nano-eco ecology**

The information technology and communication technology have already converged leading to Information and Communication Technology (ICT). Information Technology combined with bio-technology has led to bio-informatics.

Similarly, Photonics is grown out from the labs to converge with classical Electronics and Microelectronics to bring in new high speed options in consumer products. Flexible and unbreakable displays using thin layer of film on transparent polymers have emerged as new symbols of entertainment and media tools. Now, Nano-technology has come in. It is the field of the future that will replace microelectronics and many fields with tremendous application potential in the areas of medicine, electronics and material science. When Nano technology and ICT meet, integrated silicon electronics, photonics are born and it can be said that material convergence will happen. With material convergence and biotechnology linked, a new science called Intelligent Bioscience will be born which would lead to a disease free, happy and more intelligent human habitat with longevity and high human capabilities. Convergence of bio-nano-info technologies can lead to the development of nano robots. Nano robots when they are injected into a patient, my expert friends say, it will diagnose and deliver the treatment exclusively in the affected area and then the nano-robot gets digested as it is a DNA based product. I saw the product sample in one of the labs in South Korea where best of minds with multiple technology work with a target of finding out-of-the-box solution.

**My experience in Harvard University:** Convergence of science is reciprocating. Let me give an example. Recently, I was in the Harvard University where I visited laboratories of many eminent professors from the Harvard School of Engineering and Applied Sciences. I recall, how Professor Hongkun Park, showed me his invention of nano needles, which can pierce and deliver content into individual targeted cells. That's how nano particle sciences is shaping the bio sciences. Then I met Professor Vinod Manoharan, who showed on the other hand bio sciences is in turn shaping nano material science as well. He is using DNA material to design self assembling particles. When particular type of DNA is applied on a particle at the atomic level, he is able to generate a prefixed behavior and automatic assembly from them. This could be our answer to self assembly of devices and colonies in deep space without human intervention as envisioned by Dr K Erik Drexler. Thus, within a single research building, I saw how two different sciences are shaping each other without any iron curtain between the technologists. This reciprocating contribution of sciences to one another is going to shape our future and industry needs to be ready for it. The curriculum designers of BITS, may like to take this aspect into account while formulating new courses.

Now, a new trend is emerging. The aspect being introduced is that of Ecology. Globally, the demand is shifting towards development of sustainable systems which are

technologically superior. This is the new dimension of the 21<sup>st</sup> century knowledge society, where science and environment will go together. Thus the new age model would be a four dimensional bio-nano-info-eco based.

### **21<sup>st</sup> century University Vision**

Friends, I have in the last ten years met more than 10 Million youth and faculty from more than 150 universities in India and 37 universities abroad. Based on these interactions, I wish to formulate a 21<sup>st</sup> century vision for technological institution/university:

- The universities/institutions have to prepare citizens of the future with a global outlook and be capable of serving the nation or nation of their choice.
- Science and technology and public policy are interrelated for mutual benefit and ushering in human kind's development. This link has to be solidly built in the university education.
- Good teachers can be in any part of the world. The university has to bring in this resource through innovative content generation in virtual class rooms.
- Technological connectivities among universities have to be pursued vigorously using cost effective virtual class rooms.

- Cost effective continuing education possibilities are essential for citizens to be in tune with time.
- Can university education lead to sustainable development of the nation?
- With the world population increasing and resources dwindling, a mindset has to be developed for conserving and sharing the resources and look for new research for abundant resources. This calls for a “noble spirit” as well as a “research spirit”

In summary, the 21<sup>st</sup> century university/institution education is about developing enlightened citizenship for a knowledge society for peace and prosperity of nations and the world. 21<sup>st</sup> century University/institution has to be the incubator of world knowledge powerhouse.

### **Conclusion**

Friends, I will suggest all of you should ask a question “what I will be remembered for?” I am sure, you would like to do something different – out of box missions, what are they?

- 1 Will you be remembered for a visionary action for the nation, like Prof. Vikram Sarabhai for Space, or Dr Homi Bhabha for atomic energy or Prof DS Kothari for Defence Research or Dr MS Swaminathan for agriculture?

- 2 Will you be remembered for creating a company which finds a place in the top 100 of the Fortune 500 companies from India?
- 3 Will you be remembered for facilitating the creation of 10 PURA (Providing Urban Amenities in Rural Areas) complexes in your region?
- 4 Will you be remembered for becoming the pioneer in developing a smart water way in the states and Interlinking of Rivers in the nation?
- 5 Will you be remembered for working and creating a validated system for the production of 340 million tonnes of food grains and value addition through food processing by the year 2020?
- 6 Will you be remembered for modernization of 10 million SME's and addition of another million by providing private equity funding ventures?
- 7 Will you be remembered as a venture capital banker by introducing the unique private equity funding for the ideas that will bring new dimension to the society.
- 8 Will you be remembered for bringing energy independence for the nation, particularly by creating large-scale solar energy and wind power and nuclear power based electric power plants?
- 9 Will you be remembered for the action oriented – "Clean home, clean environment, clean state and clean nation"
- 10 Will you be remembered for developing one million enlightened youth in your region who will participate in the accelerated societal transformation of the nation?

I would suggest you that all of you decide on “what you will be remembered for” as quickly as possible, since that statement will act as a goal post for you and facilitate your systematic work for the realization of the goal.

My best wishes to all the students and members of the faculty of BITS Hyderabad for success in their missions.

May God Bless you.

### **Oath for Students**

1. Engineering and Technology is a life time mission. I will work, work and work and succeed.
2. Wherever I am, a thought will always come to my mind. That is what process or product I can innovate, invent or discover.
3. I will always remember that “Let not my winged days, be spent in vain”.
4. I realize I have to set a great technological goal that will lead me to think high, work and persevere to realize the goal.
5. My greatest friends will be great scientific/technological minds, good teachers and good books.

6. I firmly believe that no problem can defeat me; I will become the captain of the problem, defeat the problem and succeed.
7. I will work and work for removing the problems faced by planet earth in the areas of water, energy, habitat, waste management and environment through the application of science and technology.
8. I will work with integrity and succeed with integrity in all my technological missions.
9. My National Flag flies in my heart and I will bring glory to my nation.