SPECIAL CONVOCATION

and the

FIFTY-SEVENTH

ANNUAL CONVOCATION

24 DECEMBER 2012

ADDRESS BY

GUEST-IN-CHIEF

PROFESSOR SAMIR K BRAHMACHARI

Founder Director, CSIR-Institute of Genomics and Integrative Biology

Chief Mentor, CSIR–OSDD Unit

Director General, CSRI

AND

Secretary, DSIR, Govt. of India, New Delhi

JADAVPUR UNIVERSITY

KOLKATA 700 032

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Professor Samir K. Brahmachari*

Being Future Ready

His Excellency, Shri M. K. Narayanan, Honorable Chancellor, Jadavpur University; Vice Chancellor, Prof. Souvik Bhattacharyya; Pro-Vice Chancellor, Prof. Siddhartha Datta; members of the court; faculty members; distinguished invitees; all the students graduating today, ladies and gentlemen.

I am extremely happy to be here today, addressing the young people who are graduating from Jadavpur University, one of the oldest universities in India. The fact that the history of this prestigious institution can be traced back to our country's freedom movement bears testimony to its long and illustrious contribution to the world of education. The birth of this university is the outcome of the feeling of intense nationalism, during the early 20th century, in Bengal. In a scenario, where the British Empire was creating manpower to serve the foreign government machinery, Jadavpur University emerged as a counter to that system. It was initiated with the noble objective of creating free thinking individuals with an independent mindset. To create people, who in their heart and mind would be an Indian and would work for India. And it is a matter of immense pride that today, after 57 years since the legislation for its formal establishment was enacted in 1955, this temple of learning ranks first among the top Engineering and Technology Universities in India and is an UGC-recognized centre of excellence.

Jadavpur University, not only bears witness to India's struggle to build a knowledge-based society, imparting literary, scientific and technical education on national lines but it also has the distinction of having the visionary leaderships of dedicated scholars like Prof. Hemchandra

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Guha, Prof. Hiralal Roy, Prof. Satish Chandra Bhattacharyya and Dr. Triguna Sen etc whose role in the introduction of novel disciplines and domains of engineering have finally changed the dimensions of the colonial engineering education.

I am especially glad to be here because albeit, I have, in the past been associated with Jadavpur University. My association with this institute goes back to the memories of my eldest brother graduating as a mechanical engineer in 1960. I am glad to have in the audience, my uncle, who graduated as a university topper in mechanical engineering in 1945 from here and from whom I have heard many stories of this great institution. I was given an opportunity to pursue my PhD here, which I consider a matter of great pride, but which, could not happen owing to various reasons. Nonetheless, it is a matter of great pleasure for me to be here, addressing you all and I take this opportunity to congratulate the staff and students for their outstanding accomplishments and for taking this institute to the heights of excellence where it can stand shoulder-to-shoulder with more endowed institutes like IITs.

The success of an educational institution is measured by the quality of the students it has produced. Although I graduated and did my masters degree in Physical Chemistry from Calcutta University and Jadavpur University was always competitor, but I have no hesitation as DG CSIR to accept that majority of the best minds from Kolkata, who have been recognized through national awards and recognition like the prestigious Shanti Swarup Bhatnagar Prize, come from Jadavpur University. Today, there are 144 CSIR-supported fellows from this institute and 34 CSIR-EMR Projects are being supported at Jadavpur University. I take this opportunity to specially congratulate those students from here who have brought laurels to the nation. All the students and faculty here can take pride in the fact that there are 7 Shanti Swarup

Bhatnagar awardees from this institution since the inception of the SSB Award. And I am very proud to say that I have the great privilege of leading the CSIR-Institute of Genomics and Integrative Biology, which has four graduates of this university working as leading faculty and one of them Dr. Shantanu Chowdhury, is the recipient of this year's Shanti Swaroop Bhatnagar Prize.

I have always wondered why Jadavpur University attracts so many brilliant young boys and girls compared to Calcutta University. I wonder, could it be because of the beautiful jheels, the romantic setting and the nice walk-arounds.

The recent SIR World Report on worldwide scientific institutions ranks Jadavpur University as the 12th institute in terms of scientific output in India, 2nd among Indian Universities, next to Delhi University, 165th in Asia and 734th in the world. Though we all can be proud of the achievements of this institution, we need to improve. We should attempt to be among the top 100 in Asia and among top 500 in the world and thus move up continuously.

I am aware that this platform from which I am speaking is one from where a large number of eminent scholars have delivered their Convocation addresses. I am truly honored to be standing here to deliver my address.

Kolkata: A Citadel of Knowledge

I am not unfamiliar with the city of Kolkata, since I hail from here. Two of CSIR's prestigious institutes: CSIR-Indian Institute of Chemical Biology and the CSIR-Central Glass and Ceramic Research Institute are co-located in your vicinity.

Kolkata, aptly called the literary capital of India, is indeed the "City of Science and Joy" and has always been a centre of academic and creative excellence. This is evident from the fact that five winners and four Ramon

Magsaysay Award winners are associated with Kolkata. The people of Kolkata have always led from the front: be it as freedom fighters like Sri Aurobindo, Subhas Chandra Bose and Bipin Chandra Pal who were born here, as social reformists such as Raja Ram Mohon Roy and Keshav Chander Sen who launched the Brahma Samaj movement paving way for the uprise of scientific and literary activity amidst a climate of superstition and opposition to free thought or literary icons such as Gurudev Rabindranath Tagore and Bankimchandra Chattopadhyay. The ambience of Kolkata has always been intellect-friendly. From Acharya Sir Jagadish Chandra Bose, Prof Megnad Saha, and Acharya P.C. Ray to Prof S.N Bose, this city has always been associated with some of the most renowned creative and scientific geniuses, the world has seen. It was here, at the Indian Association for the Cultivation of Science that Sir C.V Raman made the phenomenal discovery on scattering of light in 1928, which bears his name and that brought many accolades including the Nobel Prize. It was here in Kolkata, that the Indian Science Congress Association made its modest beginning in 1914, with hundred and five members and which today stands as a strong scientific fraternity with more than twenty thousand members. It is only most appropriate that this historical city is playing host to the 100th Indian Science Congress to be held in 2013. Kolkata hence is really an extraordinary place, characterized by nationalistic fervor, high scholarship, intellectual capability and cultural richness, with a glorious past, exciting present and promising future.

Kolkata, needless to say possesses the heritage and legacy of intellectual enlightenment and progressive movement. I believe that, progress and success is a phenomenon that is the outcome of being ready for the future and being able to anticipate the future. It is this quality that has allowed this city to thrive in the past and will help it

to evolve as times change. Kolkata, I believe has always anticipated the future and so, has always been future-ready.

Today I will talk to you about one such trend that will equip you to be future-ready.

Anticipating the Future

However, before I explain that trend, I have to ask the question, "What is the future?"

To answer that I will share with you, in brief, the major turning points of my scientific career that saw quantum jumps because of massive changes in the world of science, particularly in the way science was being done. The changing face of the future is something that I have been witness to. I was ready for it. I bring this up because you too are lucky enough to be at a similar crossroad today.

The inexorable evolution of Science was driven, in the twentieth century, first by the engine of Physics and then, Chemistry. These disciplines were followed by high throughput and IT-enabled Biology, as a driver, in later times.

In my life, I have been fortunate enough to begin my scientific career in the field of Chemistry in the late 1960s and the early 1970s and subsequently to find myself in a position to share in the excitement of the developments that took place in Biology. I was able to use computation as a tool for future discoveries when my interest shifted from Molecular Biology to Bioinformatics and then to, Genomics.

I was lucky to have been at the right place at the right time even as the face of the future changed. Today we are at the cusp of another huge change and you too must be ready to ride this wave of change.

Trans-disciplinary Applications: Engineering for the Future

Science and Engineering has evolved with time and there has been a continuous shift of paradigm. Knowledge, transcending boundaries and applications transcending disciplines are the need of the hour. What we need is the incorporation of science in engineering and engineering in science. India is perceived to be a geek nation. And why not? The nation produces a million engineers every year. The challenge lies in creating globally competent leader-engineers who can steer Indian S&T to new heights through their bold and unconventional thoughts. And that is why I say, engineers have to work with the future science in mind. Needless to say, the discipline of engineering has evolved, and we have come a long way. It is time to ask, what is the future of engineering? I would say, the trans-disciplinary application of the engineering knowledge, to understand the life processes will be the global focus in the next two decades. Today, we understand the biological concepts of genome organization and information flow, signal transduction, image processing and various other physiological and bio-chemical processes. We now know that the brain functions almost like a computer network centre. The future lies in the application of the biological knowledge to design principles for the creation of new machines and other engineering products. The future belongs to a new discipline called "Biomimetics" and the application of new engineering principles learned from the biological systems. For example, we may be able to make steel that is as thin as hair but much stronger, We may make lens, with as wide an angle of vision as the eye and with auto-focus capabilities, We may make a pump, like that of a heart, which can pump viscous fluid through kilometers of arteries and veins with varied thickness, including micro-capillaries that goes into the eyes, maintaining uniform blood pressure. Today, despite

all the technological evolution, we don't have such a pump, which can work for 80 years without failure. Nature has given us marvelous molecular sensors, sitting in our nostrils, which gives adequate electronic signals to the brain to create the sense of smell. Those molecular sensors are not available as engineering products. So, I say creation of these novel applications is the science of tomorrow. These are the challenges of tomorrow.

This is the era of data-intensive discoveries. Technologies to effectively mine and analyze huge volumes of data are the need of the hour. The applications we develop should be optimized to fulfill this objective. In this regard, applications such as the sensors can play a vital role in large scale acquisition of data. How can we make use of sensors to acquire data like level of blood sugar, blood pressure and temperature, or use sensors to monitor the vibration of bridges, calculate traffic movement or flow of water in the rivers of India and transmit this data through the cell phone, which can then be communicated to the central server. If we can achieve this, we can have thousands of sensors collecting huge volumes of data simultaneously. These data can fuel major discoveries of tomorrow. This is the science of the future.

While the southern part of India, used to disciplined functioning has shown that they can become the back office of the world in disciplined way of working in IT, Kolkata, which is not so well-known for its discipline, should develop maverick individuals who will integrate this complicated multi-disciplinary science into system level understanding of biological systems in the light of principles of engineering. In this context, Kolkata has much to contribute. I hope that University of Jadavpur will train the next-generation students adept in such multi-disciplinary application of knowledge. I hope that the students, who are passing out today will take up higher studies and higher responsibilities, and become the next-generation employees who will be far more

equipped than we were with this hybrid expertise and knowledge.

Fourth Paradigm of Science

Today, we are actually witnessing the advent of what has been described by the pioneering Computer scientist Jim Gray, as the "Fourth Paradigm" in Science. The Fourth Paradigm of Science is based on data-intensive discoveries.

The Fourth Paradigm is not just about huge amounts of scientific data and the computational systems needed to handle it. It also calls for experts in different fields — biologists, chemists, physicists, astronomers, engineers etc. It demands sophisticated tools, technologies, and platforms that integrate seamlessly. Crisply put, it consists of three activities: Capture, Curation and Analysis.

The Fourth Paradigm of science has not happened overnight in a single jump. It is actually the result of the path that scientific discovery has taken over the ages.

There are distinct stages in the evolution of modern Science. From being curiosity-driven in ancient times, it graduated to becoming hypothesis-experimentation dependent and then moved on to a phase where modeling and simulation studies shared the spotlight.

These distinct stages have been referred to as the First, the Second and the Third Paradigms of Science, respectively.

The arrival of the Fourth Paradigm is demonstrated in the large scale analysis of data such as being carried out during the sequencing of the Human Genome and the futuristic 1000 Genome Project.

The Fourth Paradigm of Science has transmuted the way Science is being done. In turn, this has fuelled the need for a totally new generation of Scientists to address the burning issues of today; for example, healthcare to

alternate energy; structural engineering solutions to traffic control on roads; water harvesting to flood management.

This is the time to energize the multi-talented young generation to transform the healthcare of tomorrow and sustainable energy solutions for all. It will mean exploring innovative solutions such as crowd sourcing and cloud computing. It will involve global collaborations, at local levels, to provide services such as affordable healthcare and electricity to all.

Crowd-Sourcing: The New *Mantra*

In the Fourth paradigm of science the new *mantra* is crowd-sourcing. It is diametrically different from the classical or traditional methods of collaboration. The conventional model of collaboration and cooperation involves interacting with a person(s) whom you know.

However, crowd-sourcing takes the approach to an entirely new, almost counter-intuitive, level by outsourcing collaborative tasks to an undefined group of people or community who share the required expertise and interest. It is a model where you take a big problem that you want to solve and look in cyberspace for people willing to cooperate with you. The underlying principle is enabling participatory efforts of people who may not even be acquainted with each other. In crowd-sourcing lies the future of Science education and research. This is Science 2.0. This is the way all science will be done in the future.

Power of Networking

Crowd-sourcing is an enormous networking exercise. Take for example, *Facebook*. As of September 2012, *Facebook* has over one billion active users, more than half of them using *Facebook* on a mobile device (source Wikipedia). You may think of the active users as cyber citizens of the 'largest country' of the connected world. Can you even imagine what the combined intellectual

power of all the cyber citizens of this connected world is? Can you find a way to use this power for public good? How do you find out who has done what and who is interested in the same sort of work that interests you? How can you solve the problem of the future by working together?

This is where the concept of crowd-sourcing comes in. It is a very powerful tool that is just emerging. In the field of science, health science, to be exact; a model has already emerged in India and we can show this by example.

Open Source Drug Discovery Project (OCDD)

The Open Source Drug Discovery Project (OSDD) is CSIR-led Team India consortium with global partnership that seeks to deliver affordable healthcare to all. Drug discovery is an extremely complex process and a specialized job. Yet in just four years, OSDD has mobilized resources from across the globe.

On 1st December 2012 OSDD had more than 6600 registered users from 130 countries. As you can see, OSDD can be said to be an educational system that effectively uses very high-end student power, engages top laboratories of the world and uses crowd-sourcing to pursue the goal of Affordable Healthcare for all. OSDD is only the beginning.

Future of Crowd-Sourcing

Crowd-sourcing does not have to remain confined to specialized or niche areas of S&T. Crowd-sourcing can be a powerful tool for commercial innovation too. It will definitely branch out from the Open Innovation Model exemplified by OSDD to another type more suited for Business models. This could be called Closed Innovation Model, which will be done exclusively by Industry.

The future shape of the global Industry may well be shaped by crowd-sourcing. Even today, it is obvious that the conventional model of manufacturing a product at

a given location is poised to change dramatically. In the future, conventional assembly lines may well be replaced by "virtual industries". It will be possible to be an Industrialist without owning a single piece of land but owning just an assembly line. The entire manufacturing process can be carried out by identifying micro, small and medium enterprises or MSMEs and crowd-sourcing those MSMEs. This has tremendous potential. Just look at the statistics. According to the website of the Ministry Micro, Small and Medium Enterprises, the 4th Census of MSME Sector shows that this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises. It is estimated that in terms of value, MSME sector accounts for about 45% of the manufacturing output and around 40% of the total export of the country. Can you estimate just how rich the future of MSMEs can be when crowd-sourcing takes off in a big way, involving students from engineering, business management, marketing etc?

Preparing for the Future

Just spotting a trend is not enough; you have to actively anticipate the future. So, it is clear that commercial innovation by crowd-sourcing will need a certain framework. First of all, it will need a portal for interfacing. It could be a portal like the one that OSDD has. The OSDD portal SysBorg 2.0 is the Web 3.0 system and cyber-infrastructure for collaborative research. The portal contains resources to effectively organize collaborations and tools to effectively mine and analyze the information collated by the OSDD community.

These advantages that crowd-sourcing can provide as compared to the conventional ways of collaboration are many. Those industries that can position themselves to optimally use this system will be the ones to take the lead in market's future space. This tool will be applicable to all; even social scientists for formulating new policies,

based on data intensive discovery. The future winners will be those who can innovatively tap into this emerging system.

Choose your Path

All of you graduating today belong to what I call the "post-Maruti era". By "post-Maruti era", I mean that you have been lucky enough to be born into an India which gives you many options. You will have plenty of job opportunities and a multitude of products to choose from. In our time, we did not have options.

Your future will be determined by the choices you make. It will depend on the path you choose to take. The actions you take will decide the course your life will take.

I wish that you will realize that in India we have a large middle/upper class to which those of us assembled here today belong. However, there is another India –a large number of hungry millions who live at the bottom of the economic pyramid. The use to which you put intellectual capability that you have and the educational training that you have received may make a huge difference in their lives.

It is a great challenge for this great nation of ours. In 2022...that is in just a little over a decade we will be celebrating the 75th anniversary of our independence. The question is: How do we want to see India in 2022? Will it remain the same India as in 2012 where hungry millions go to sleep without a roof over their heads in the biting cold of Delhi's winter or shiver as they are drenched by the torrential Kolkata monsoon? Will we still have an India where millions of children are deprived of access to education and millions of homes remain without light?

Remember that Science and Technology can do many things. The question is how do we use the knowledge we have acquired during these years of graduation to

achieve this objective. I say, in the present scenario, innovative technology and engineering interventions are imperative with the help of social scientists for implementation at the grass-root level. CSIR with this objective of bringing societal change has launched a programme called CSIR-800 which is meant to take socially relevant technologies to the masses and create a large economic impact. CSIR is also gearing up plans to focus on the micro, small and medium enterprises sector. I say, it is the moral responsibility of every individual here to strive to apply the knowledge he/she has gained during the time spent here to come up with innovative solutions to the problems that are prevalent in society today.

I have a Dream

Although I left Kolkata and although I did not study in the University of Jadavpur, I have walked through the corridors of this University, where the best of my friends lived and studied in the early 1970s while dreaming of transforming India. I have had the privilege of learning Chemistry from Head of Jadavpur polytechnic. I always believed that this extraordinary university, ranked 2nd in the Indian University system, with highly talented students can take up the leadership of the country, in the Fourth Paradigm of science, just as it happened in Physics in the past, only if it had Chancellors and Vice-Chancellors who can plant a new dream in the student's heart. I am very glad, Honorable Chancellor Sir, that under your Chancellorship, and with the present Vice-Chancellor Prof. Souvik Bhattacharyya, this dream is possible. I believe that your new third campus across the road with the National Instruments Limited which was previously affiliated to CSIR will become the centre for generating next-generation leaders of Indian science. My dream is to see a thriving Fourth Paradigm Centre in this campus where Kolkata leads; not follows. Where engineers of this institute will work, shoulder-to-shoulder with physicists, medical practitioners, biologists and chemists to make new data

intensive discoveries in the realm of the Fourth Paradigm. I am sure that with the support of the university and CSIR governing body and the political blessings of the state, we will be able to make this dream a reality.

I am sure we all want our country to be prosperous and our citizens to be happy and healthy. I am sure we all want to live in an India where everybody will have access to education and the chance to rise to one's full potential. It is this India that I dream about. As the educated section of the society, it is your obligation to elevate the downtrodden and relieve them of their sufferings. And you are the hope of the future.

I believe that all of you graduating today will do your bit so that in the next ten years we will fashion an India that is TB-free; an India that is hunger-free and an India where every single child has the opportunity to study. You could say this is my dream.

Kaviguru Rabindranath Tagore had a dream too...of a country *"Where the head is held high..."* and he wrote, *"Into that heaven of freedom, my Father, let my country awake."* I hope that you will be the torch-bearer of that nation which Rabindranath Tagore described...the new designers and young leaders of the India of the future.

Thank You.

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