

NANOLAB: The Role for Science Centers in Capacity Building

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Abstract

Nanotechnology will alter our relationship with molecules and matter as profoundly as the computer changed our relationship with bits and information. Nanotechnology is a new technology which is generating a lot of interest among academicians, practitioners and scientists. Critical research is being carried out in this area all over the world. Governments are creating policy initiatives to promote developments in the nano-scale science and technology developments. Private investment is also seeing a rising trend. Large number of academic institutions and national laboratories has set up research centers that are working on the multiple applications of nanotechnology. Wide ranges of applications are claimed for nanotechnology. This consists of materials, chemicals, textiles, semiconductors, to wonder drug delivery systems and diagnostics. Much interest in nanotechnology also could be because of the fact that enormous monetary benefits are expected from nanotechnology based products. According to NSF, revenues from nanotechnology could touch \$ 1 trillion by 2015. However much of the benefits are projected ones. Realizing claimed benefits require successful development of nano-science and nanotechnology research efforts. That is the journey of invention to innovation has to be completed. For this to happen the technology has to flow from laboratory to market. The aim of the present article is to highlight the role of Science City, Kolkata to develop capacity building among general people and students for the responsible development of productive nanotechnology.

Introduction

It has been said that nowadays any significant problem in science requires interdisciplinary or rather more accurately a multi-disciplinary approach. More than any other areas of science, this holds true for the science of 'NANOTECHNOLOGY'. After the Information Technology and Biotechnology revolutions, Nanotechnology is another much larger industrial revolution in the making. Its effects upon the society are already being felt and it is envisaged that in the years to

come this technology will impact upon each and every sector of our society including the IT and biotechnology considered earlier.

Nano-science is, at its simplest, the study of the fundamental principles of molecules and structures with at least one dimension roughly between 1 and 100 nanometers. These structures are known as nanostructures. Nanotechnology is the application of these nanostructures into useful nanoscale devices. Biologists, chemists, physicists and engineers are all involved in the study of substances at the nano-scale. Nanotechnology offers new engineering tools that can help us address the design problems associated with building better implants. In the context of biomedical engineering, recent technological advancements mean that we now have the ability to manipulate materials with nanometer scale accuracy. This allows us to create biomaterials with features the same size as the proteins and cells with which our implant interact. Nanomaterials may also be used as active sensing elements or receptors, as transducing components (e.g. electro- or chemo-mechanical actuators), and even as electrodes in electronic circuitry and power systems (e.g. nano-wires). Developments in this field are taking place at a very high speed. Nanotechnology can be applied to every item we use in our day-to-day life to make it more users friendly and intelligent, whether it is toothpaste, clothes, phones, laptops, lubricants or medicines. In view of these factors all the developing and developed countries are aspiring to establish strong base for nanotechnology.

Nanotechnology in India

The field of nanotechnology is quite popular in most of the developed countries. India, China, Japan, Singapore, South Korea, and Taiwan are a few countries in Asia which have significant ongoing research projects in nanotechnology. It is one of the main science and technology priority areas for several government in the Asia-Pacific region. Budgets for nanotechnology R&D have been increased substantially and are more strategically allocated. As an outcome of such initiatives is the nano-filters already

available in the Indian market for water treatment purposes. Cosmetics, detergents and drugs are also seeing remarkable application of nanomaterials at this point.

Nanotechnology in India is a government led initiative. Industry participation has very recently originated. Nanotechnology R&D barring a few exceptions is largely being ensued at public funded universities as well as research institutes. The Department of Science and Technology has started with a huge investment of about Rs. 1000 crores under the nano mission promoted by the government. This aims at supporting the research and development activities to come up with specific applications. The department of science and technology has introduced centers of excellence for Nanoscience and Technology to support researchers and scientists to test their materials for at a reduced price. The Department of Biotechnology, Defense Research and Development Organization, Board of Research in Nuclear Sciences and many such agencies and organizations are pumping in funds to support Nanoscience based research. A group of scientists from different research laboratories across India are putting in their efforts and are contributing to the development of different research projects in various research institutions. The Council of Scientific and Industrial Research, also known as CSIR has set up 38 laboratories in India dedicated to research in Nanotechnology. This technology will be used in diagnostic kits, improved water filters and sensors and drug delivery. Nanobiotechnology is being considered for direct delivery of drugs into the human body. This apart, the research trends can be numerous. Currently, nano-materials of different chemical compositions in biomedical applications are pushing the growth of this market. The research is being conducted on using it to reduce pollution emitted by the vehicles. Several Indian institutes have introduced degree courses in Nanotechnology at both the UG and PG levels. The areas covered in the Nanotech are Food and Beverage, Bio- Technology, Forensic Sciences, Genetics, Space Research, Environment industry, Medicine, Agriculture and Teaching. Department of Information Technology has a Nanotechnology Initiative division which initiated the Nanotechnology Development Programme in 2004. This program targets to create R & D capacity and infrastructure in nanoelectronics at national level. Under this programme two nanoelectronics centres

have been established at IIT Bombay and IISc, Bangalore. The facility of IIT Bombay and IISc, Bangalore are being used by all nanoelectronics researchers in the country through Indian Nanoelectronics User Program (INUP).

Public Perception about NANO

The emergence of active nanostructures and nanosystems will challenge existing economic, social, and political systems in ways that are qualitatively different and much more rapid than previous technological revolutions. These effects will be a combination of the completely unfamiliar, the previously experienced, and the roughly analogous. How will social and political systems adapt to these changes and how will these technologies and their effects be understood and described? Many writers will use both familiar and new methods of scientific and popular communication to bridge the gap between public understanding, entirely new technological systems, and policy responses. Studies of the public's understanding of nanotechnology to determine their likely concerns and fears, and research on how to engage the public in a rational, informed dialogue about the risks and benefits of the technology are both underway,

Like so many areas of research, nanotechnology can be discussed quite easily with people who understand it, but can effortlessly mutate into a perfect nightmare when explaining it to people who do not. On many occasions, such people seem keen yet are completely dumbfounded by colourful explanations. There is a sense of dismay as they and others 'misinterpret' descriptions, ask seemingly unrelated questions, and generally find endeavours at explanation incomprehensible and bewildering. In the main, people are quite genuinely either oblivious to nanotechnology, or have a decidedly skewed notion of 'what it does'. This chasm within public understanding can be quite easily filled by other means, and the real difficulty is when that chasm becomes filled by marketing communications, rather than fact.

India has traditionally lagged behind in educating its masses and firing the curiosity of the future generations of technologists and scientists. Science and technology discussions have remained confined to universities and colleges. However, public awareness is critical to

creating public opinion, which in turn has an impact on forming governmental policies and business opportunities. Negative safety perception of nano-scale materials is an area of concern for the nascent nanotechnology industry globally. Various agencies are already conducting studies to provide accurate safety related data and help shape public opinion on these nanotechnologies. In this context, the role of public opinion is critical to the development and growth of the industry in near term. The very public debate on genetically modified (GM) food is a case in point, which led to polarization of public opinion. Action is needed now to keep public updated on various issues related to technology to ensure acceptance of nano-enabled products by the public in future.

Role of National Council of Science Museums (NCSM)

In our rapidly changing world, there is a great need for the public understanding of science and technology to create more science literate society at all age levels. Science Centres and science museums are vital and powerful media for popularization of science and creating a scientific temper across the globe. Science Centres are among those institutions that can play a role in showcasing science to common people.

NCSM has also taken up an initiative bringing nano-scale science to the public because of its wide-ranging

implications both within scientific disciplines and the society at large. One of the museum's main purposes is to offer experiences and products that interest and engage the public and present current science and technology topics in "do-it-yourself" format. Nanotechnology is particularly a challenging topic for museums because the science is very complex and museums sometimes do not have content experts. This thus creates a platform for sustained relationships between informal science education institutions like museums together with universities, research centres, scientific societies and individual researchers to offer activities in cutting edge science such as nanotechnology in do-it-yourself format for the general public using the expertise of the scientists. It also creates an opportunity for the scientists to reach out to the common man and, takes science communication a step beyond conventional approaches, initiating and encouraging a Public Understanding of Research.

NANOLAB in Science City

The NANOLAB aims to create innovative environments for the broad public to learn about and to discuss nano research by directly involving the actors of research themselves. We do this by taking the laboratory environment and the research work out of enclosed academic campuses and relocating them right in the midst of the public in science city.

Activities at a glance in NANOLAB at Science City, Kolkata The NANOLAB was inaugurated at Science City, Kolkata on 5th November, 2011



Fig.2. Students performing "Feel Nano!" activity



Fig.3. Students doing "Effect of Surface Area" activity.

◀ *Fig.1. Students measuring their height in nanometres*



Fig.4. Students making models of Buckyball



Fig.5. Students working with microscopes



Fig.6. Students preparing nano colloid



Fig.7. Students measuring the thickness of human hair in nanometres

NANOLAB will also establish new role models for choosing science as a career: young adults keen to take science as a career will be able to discuss various aspects with young researchers who themselves made this decision recently and also the researchers already in this field will learn that communication is a self-evident part of their professional identity.

Thus, NANOLAB pushes science communication to its extreme, combining communication and research in a powerful way and responding to the need for more transparency and accessibility in science. Furthermore, the strong synergetic network approach of the project enables contents and models to be developed for further distribution and implementation in educational and scientific communities.

Typically, scientists act in two completely different modes of operation which are completely independent of each other: on the one hand they conduct research within their scientific community, whilst on the other they separately explain or “demonstrate” their work to the lay public. This approach, however, often leads to a

top-down science communication which can easily overwhelm or confuse the average person.

Having a full-size, perfectly operational research lab in the public space of the Science City is an idea that breaks right through the conventional lines of demarcation that normally seal off science from society as a separated subsystem. As this approach requires both experience in running scientific research and in dealing with public discourse, a close networking of institutions from both fields is necessary to the benefit of all.

NANOLAB can help in creating innovative spaces for spreading excitement and insights about nanoscience around the public. The major two activities of NANOLAB include -

Inform the public about Nano: A wide range of activities including publication of catalogue of educational programs, activities and demonstrations, organizing various awareness programs and debates, seminars etc. to raise public awareness, understanding

and engagement with nano. Business executives, educators, policymakers, and consumers can make important decisions about nanoscience and technology applications in the coming years, and the more informed the public can be about nano; the better those decisions are likely to be.

latest equipments are becoming expensive which makes it further difficult for researchers and research agencies to carry out research projects within the stipulated time.

India, with its more than one billion people, a wide landscape and a diverse socio-economic base, has

Month	No. of shows	No. of general visitors	No. of students	No. of hands on activities	No. of Special visitors	Total number of visitors
Nov, 2011	36	239	720	116	10	959
Dec, 2011	100	1414	792	--	10	2206
Jan, 2012	117	998	990	--	8	1988
Feb, 2012	83	470	1405	--	10	1875
Mar, 2012	95	704	366	--	8	1070
Apr, 2012	113	1047	276	20	25	1323
May, 2012	70	706	147	--	5	853
Total	614	5578	4696	136	76	10274

Activities at a glance in NANOLAB at Science City, Kolkata

Get kids interested in science: Nano Lab is an opportunity to showcase what is great about science and science careers. In this lab students will learn about cutting edge science, possible new careers, and will visit science labs and meet the researchers.

A MOU has been signed between Science City, Kolkata and Science City, Naples in Italy for organizing collaborative programs for school students on Nanoscience and technology with duration of six months. The aim of such collaborative programs is develop the basic skills among school students and to orient them towards research in new fields of science and technology in international arena.

Challenges faced in India

The field of nanotechnology however faces many challenges in India. One of the important factors that prevent different agencies from funding various research activities is the longer time taken by the products based on nanotechnology to enter into the market. In the present fast and dynamic world technological advancements takes place very frequently. Such frequent technological advancements makes research equipments and tools out dated. More over the

tremendous possibilities for any technological intervention including nanotechnology. Nanotechnology in India is expected to unleash the full force of India's creativity and its craving to satisfy all its basic needs, to catch up with the world, rather to surpass the world.

Career in Nanotechnology

The changes happening in Nanoscience will impact almost all the sectors, which opens up huge opportunities for candidates with degree in Nanoscience. Before going into the area of nanotechnology, the candidate should make sure that he or she is a master of the core field which he or she belongs to. In the present day scientists and researchers are associated with developing commercial products through the application of nanotechnology. So it will be useful for candidates to pursue doctoral degree in the area of interest. But before this a proper training, awareness and education is utmost important and so the major challenge for this NANOLAB in Science City, Kolkata is to impart effective and fruitful education and training to the student's communities for developing highly skilled human resources in this field.

The opportunities in the future

Nanotechnology will have an impact on the average Indian. After all how many of us know that today's detergents or hard-drives are products of nanotechnology? It would make the lives of a common man way simpler, smarter and multi-nodal than what it is right now. In terms of employment opportunities, sophisticated nano-products would take a few decades to come into existence.

Today nanotechnology is mainly concerned with research and so the opportunities for research activities for any one in this field is very high. Since nanotechnology has tremendous potential for applications in the day to day issues, the research in the field will continue as long as human beings exist in the planet. There is huge gap between demand and supply in different industries as far as materials are concerned. It is expected that nano materials will bridge the gap between demand and supply. Industries can collaborate with various government research institutions to incorporate nano technology in their products.

Looking at the progressive prospects of Nanotechnology in India, Nanobiosym Inc., a US-based leading nanotechnology firm is planning to set up India's first integrated nanotechnology and biomedicine technology park in Himachal Pradesh. Nanotechnology has certainly acquired an essential position in the Indian Economy and Scientific Research Department and it is expected to reach the pinnacle of Development thereby making India a role model for the countries of the world.

The future possibilities of NANOLAB include development of new educational activity kits in Nanoscience for other science centres and schools, popular science lectures by eminent Scientists, multimedia shows on nanoscience, more collaborative programs with national and international nanoscale research institutes. This NANAOLAB first of it's kind in the network of NCSM will address national need to inspire and prepare our young students to explore the growing educational and professional opportunities in nanotechnology.

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