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ENVIS NEWSLETTER

Centre for Environmental Studies (CES)

Dept. of Forest & Environment, Govt. of Odisha

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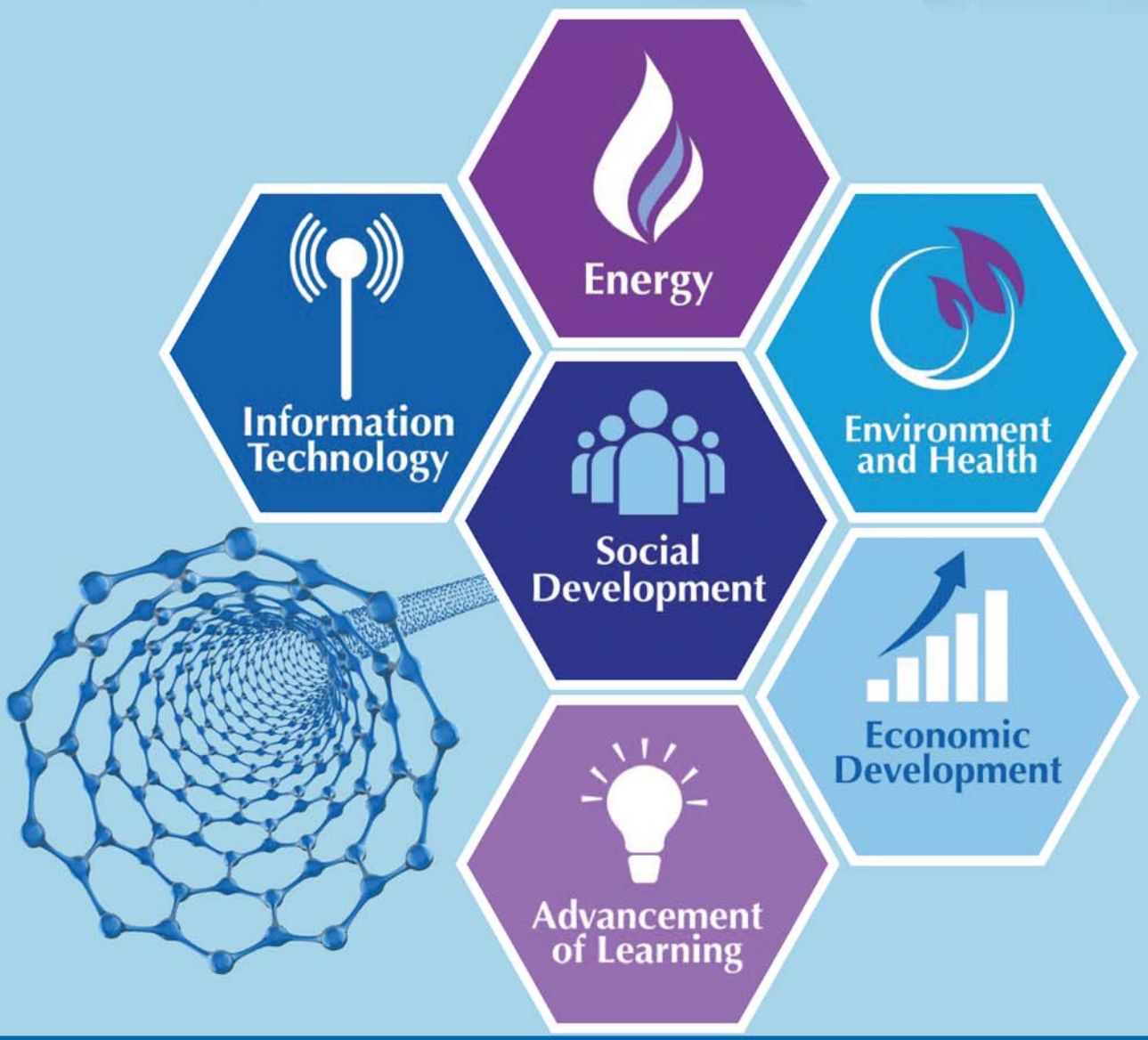

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From the Coordinator's Desk...

Dissemination of information on various issues related to environment of the State is the main objective of establishment of our ENVIS Hub. We have discussed on various issues in our earlier publications. In this issue we have focused on one of the important topic "**Nanotechnology and Environment Ethics**". I hope the information will be useful.

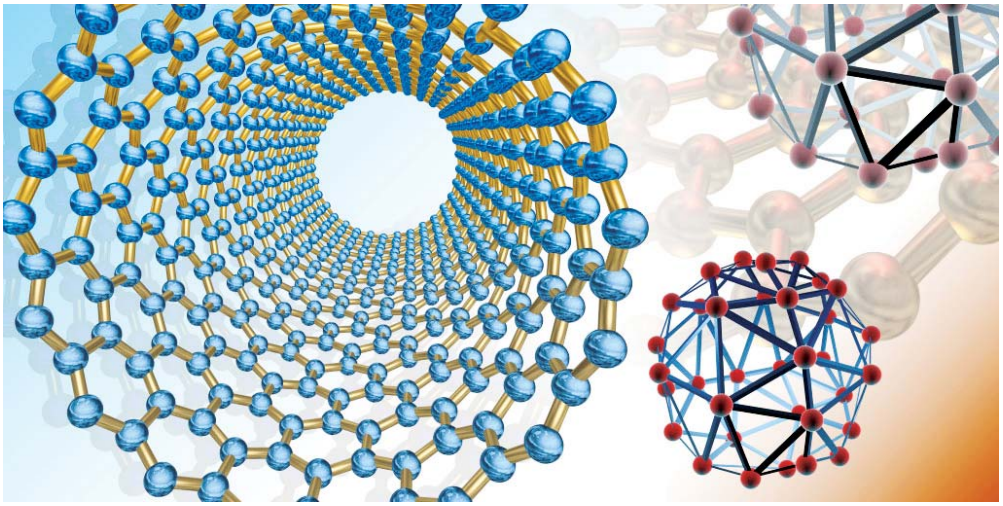
(Prof. Dr. Ashutosh Debata)
Director, CES and Coordinator, State ENVIS Hub,
Forest & Env. Department, Govt. of Odisha

NANOTECHNOLOGY AND ENVIRONMENT ETHICS

Introduction

Imagine a world in which cars can be assembled molecule-by-molecule, garbage can be disassembled and turned into beef steaks, and people can be operated on and healed by cell-sized robots. Sound like science fiction? Well, with current semiconductor chip manufacturing encroaching upon the nanometer scale and the ability to move individual atoms at the IBM Almaden laboratory, we are fast approaching the technological ability to fabricate productive machines and devices that can manipulate things at the atomic level. From this ability we will be able to develop molecular-sized computers and robots, which would give us unprecedented control over matter and the ability to shape the physical world as we see fit. Some may see it as pure fantasy, but others speculate that it is an inevitability that will be the beginning of the next technological revolution.

Laboratories, such as the Stanford Nanofabrication Facility (SNF), have already been researching nanofabrication techniques with applications in fiber optics, biotechnology, micro-electromechanical systems (MEMS), and wide variety of other research fields relevant to today's technology. MEMS, "tiny mechanical devices such as sensors, valves, gears, mirrors, and actuators embedded in semiconductor chips", are particularly interesting because they are but a mere step away from the molecular machines envisioned by nanotechnology. MEMS are already being used in nulomobilc airbag systems as accclcromctcrs to detect collisions and will become an increasing part of our everyday technology.



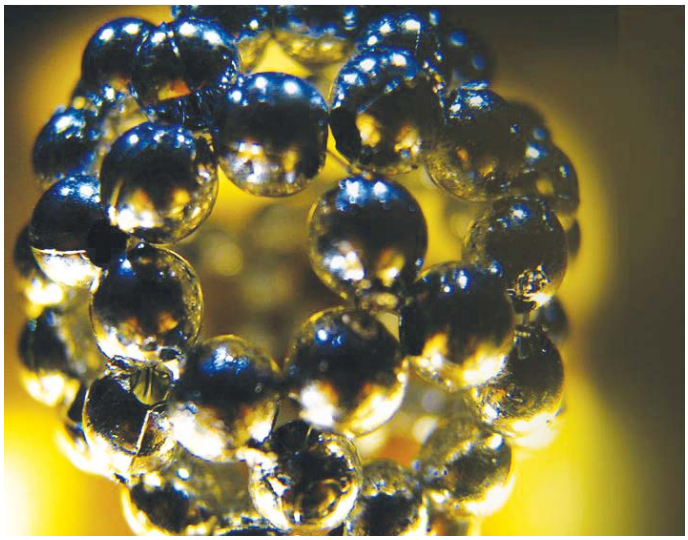
In 1986, a researcher from MIT named K. Eric Drexler already foresaw the advent of molecular machines and published a book, Engines of Creation, in which he outlined the possibilities and consequences of this emerging field, which he called nanotechnology. He

was inspired by Nobel laureate Richard Feynman's 1959 lecture, There's Plenty of Room at the Bottom, about miniaturization down to the atomic scale. Since then, Drexler has written numerous other books on the subject, such as Unbounding the Future, and has founded the Foresight Institute, which is a nonprofit organization dedicated to the responsible development of nanotechnology. It hosts conferences and competitions to raise the awareness of nanotechnology and the ethical issues involved in its development.

Today, nanotechnology research and development is quite wide spread, although not high profile yet. Numerous universities, such as Univ. of Washington and Northwestern Univ., have established centers and institutes to study nanotechnology, and the U.S. government has created an organization, the National Nanotechnology Initiative (NNI), to monitor and guide research and development in this field. In fact, as noted in an April 2001 Computerworld article, the Bush administration increased funding to nanoscale science research by 16% through its National Science Foundation (NSF) budget increase. DARPA (Defense Advanced Research Projects Agency) and the NSF are currently the two largest sources of funding for nanotechnology research and have an enormous influence on the direction of scientific research done in the United States. With so many resources dedicated to its development, nanotechnology will surely have an impact within our lifetime, so it is important to examine its ethical implications while it is still in its infancy.

What is Nanotechnology

Nanotechnology, also called molecular manufacturing, is "a branch of engineering that deals with the design and manufacture of extremely small electronic circuits and mechanical devices built at the molecular level of matter." The goal of nanotechnology is to be able to manipulate materials



at the atomic level to build the smallest possible electromechanical devices, given the physical limitations of matter. Much of the mechanical systems we know how to build will be transferred to the molecular level as some atomic analogy. As envisioned by Drexler, as well as many others, this would lead to nanocomputers no bigger than bacteria and nanomachines, also known as nanites, which could be used as a molecular assemblers and disassemblers to build, repair, or tear down any physical or biological- objects.

In essence, the purpose of developing nanotechnology is to have tools to work on the molecular level analogous to the tools we have at the macroworld level. Like the robots we use to build cars and the construction equipment we use to build skyscrapers, nanomachines will enable us to create a plethora of goods and increase our engineering abilities to the limits of the physical world.

Potential Benefits of Nanotechnology

It would not take much of a leap, then, to imagine disassemblers dismantling garbage to be recycled at the molecular level, and then given to assemblers for them to build atomically perfect engines. Stretching this vision a bit, you can imagine a Star Trek type replicator which could reassemble matter in the form of a juicy steak, given the correct blueprints and organization of these nanomachines.

Just given the basic premises of nano-technology, you can imagine the vast potential of this technology. Some of it's more prominent benefits would be:

Manufacturing

- Precision Manufacturing
- Material Reuse
- Miniaturization

Medicine

- Pharmaceutical Creation
- Disease Treatment
- Nanomachine-assisted Surgery

Environment

- Toxin Cleanup
- Recycling
- Resource Consumption Reduction

Along with all the obvious manufacturing benefits, there are also many potential medical and environmental benefits. With nanomachines, we could better design and synthesize pharmaceuticals; we could directly treat diseased cells like cancer; we could better monitor the life signs of a patient; or we could use nanomachines to make microscopic repairs in hard-to-operate-on areas of the body. With regard to the environment, we could use nanomachines to clean up toxins or oil spills, recycle all garbage, and eliminate landfills, thus reducing our natural resource consumption.

Potential Dangers of Nanotechnology

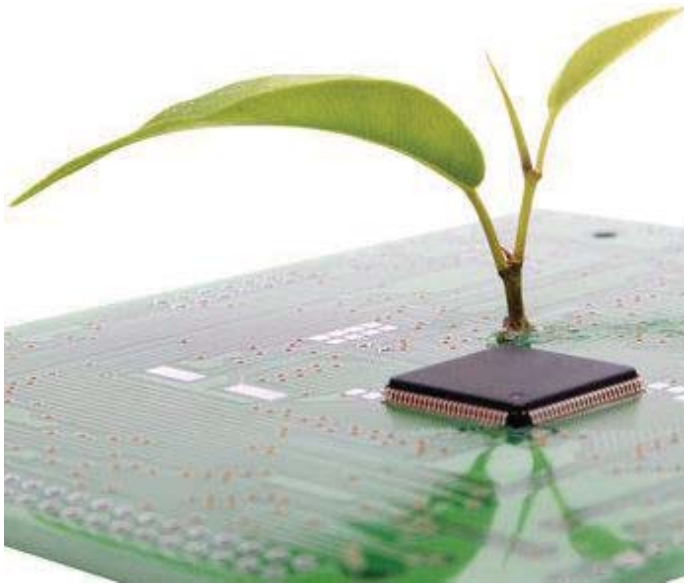
The flip side to these benefits is the possibility of assemblers and disassemblers being used to create weapons, be used as weapons themselves, or for them to run wild and wreak.

Ethlcal Issues & Analysis

Willi such awesome potential dangers inherent in nanotechnology, we must seriously examine its potential consequences. Granted, nanotechnology may never become as powerful and prolific as envisioned by its evangelists, but as with any potential, near-horizon technology, we should go through the exercise of formulating solutions to potential ethical issues before the technology is irreversibly adopted by society. We must examine the ethics of developing nanotechnology and create policies that will aid in its development so as to eliminate or at least minimize its damaging effects on society.

Professional Issues

- Currently, nanotechnology research is primarily funded by DARPA and the NSF so the research agenda is primarily controlled by the government.
- Since nanotechnology is being developed in many different fields, how can everyone's principles be synchronized?



Legal/Policy Issues

- Since nanotechnology concerns many different fields, who should create and enforce policies regarding its R&D?
- What international laws should be made regarding the safe development of nanotechnology? And who can enforce them?

Ethical Issues

Nanotechnology will give us more "god-like" powers havoc. Other, less invasive, but equally perilous uses of nanotechnology would be in electronic surveillance.

Weapons

- Miniature Weapons and Explosives
- Disassemblers for Military Use

Rampant Nanomachines

- The Gray Goo Scenario
- Self-Replicating Nanomachines

Surveillance

- Monitoring
- Tracking

Weapons are an obvious negative use of nanotechnology. Simply extending today's weapon capabilities by miniaturizing guns, explosives, and electronic components of missiles would be deadly enough. However, with nanotechnology, armies could also develop disassemblers to attack physical structures or even biological organism at the molecular level. A similar hazard would be if general purpose disassemblers got loose in the environment and started disassembling every molecule they encountered. This is known as "The Gray Goo Scenario." Furthermore, if nanomachines were created to be self-replicating and there were a problem with their limiting mechanism, they would multiply endlessly like viruses. Even without considering the extreme disaster scenarios of nanotechnology, we can find plenty of potentially harmful uses for it. It could be used to erode our freedom and privacy; people could use molecular sized microphones, cameras, and homing beacons to monitor and track others.

- It has to potential to eliminate other ethical issues (e.g. assembling beef instead of slaughtering cows, constructing cells rather than getting them from reproduction, etc..)
- May lead to undetectable surveillance, Right to Privacy could be jeopardized
- Do we have a duty to help and provide for others [countries] with this technology?

Stakeholders

- NSF - [the government] since it funds much of the nanotechnology research
- DARPA - enforcing ethical guidelines may conflict with military research

- Researchers - their freedom of how to conduct their research and what to conduct their research on
- Explicit users of nanotechnology - may slow down development of the technology
- Potentially Everyone - nanotechnology may eventually be so far reaching, it could affect everyone

Possible Actions

1. Nanotechnology R&D should be banned
2. A non-government regulatory or advisory commission should be setup
3. Adopt design guidelines
4. Nanomachines should only be specialized, not general purpose
5. Nanomachines should not be self-replicating
6. Nanomachines should not be made to use an abundant natural compound as fuel
7. Nanomachines should be tagged so that they can be tracked.

Consequences

1. With the first possible action, it may stop general development of nanotcchnology and prevent its wide spread potential harms, but it will retard current day technological advances and may not prevent rogue researchers, companies, countries, or armies from developing it anyway.
2. The second possible action could unify R&D policies and procedures and force the research community to seriously consider the potential consequences of nanotechnology.
3. The third possible action would minimize "accidents" with nanotechnology by preventing potentially deadly behavior from nanomachines.

Individual Rights/Fairness

The second and third options seem to be the most prudent course of action since the second option is commonly done now for emerging technologies and the third option consciously prevents designs that could lead to the catastrophic scenarios.

Common Good

The second and third options also seem to advance the most common good since the second option involves promoting ethics within the research community and the third option is a set of design principles to discourage unethical or accidental uses of nanotechnology.

Final Decision

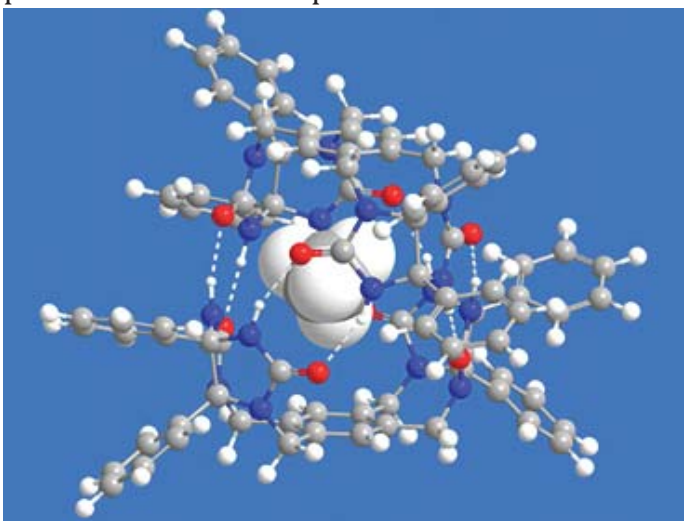
Nanotechnology research should be allowed to continue but with a non-government advisory council to monitor the research and help formulate ethical guidelines and policies. Generally, nanomachines should NOT be designed to be general purpose, self-replicating, or to be able to use an abundant natural compound as fuel. Furthermore, complex nanomachines should be tagged with a radioactive isotope so as to allow them to be tracked in case they are lost.

Medical Technologies

Prospects for human enhancement and augmentation, Improved genetic screening advanced cures.

Secutity and privacy implications

Novel weaponry and defense technologies, pervasive surveillance potential



Less Obvious Societal and Ethical Issues in Nanotechnology

National and international politics

- National research funding commitments and the "nanodivide," technology transfer

Media and public perceptions

- Polarized reactions to nanotechnology, involvement of lay public in decision making

Legal and regulatory issues

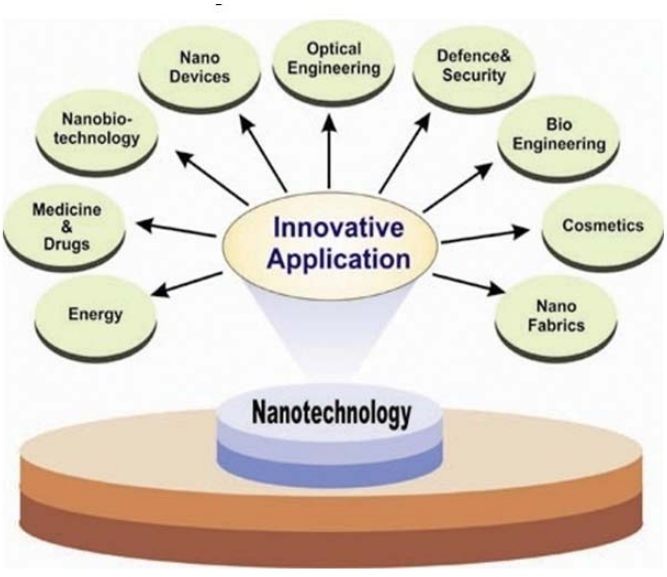
- Proactive versus reactive regulation, international standard-setting

Cultural and religious repercussions

- New media and modes of representation, new challenges in defining life

Conclusion

It would be difficult to deny the potential benefits of nanotechnology and stop development of research related to it since it has already begun to penetrate many different fields of research. However, nanotechnology can be developed using guidelines to insure that the technology does not become too potentially harmful. As with any new



technology, it is impossible to stop every well-funded organization who may seek to develop the technology for harmful purposes. However, if the researchers in this field put together an ethical set of guidelines (e.g. Molecular Nanotechnology Guidelines) and follow them, then we should be able to develop nanotechnology safely while still reaping its promised benefits.

Organizations Working on the Ethical Issues of Nanotechnology

Greater minds than mine are hard at work trying to address ail the ethical challenges of nanotechnology. Here is a sampling of those groups and their mission statements:

1. The ***Nanoethics Group*** is a non-partisan organization that studies the ethical and societal implications of nanotechnology. They also engage the public as well as collaborate with nanotech ventures and research institutes on related issues and initiatives.
2. The ***Center for Responsible Nanotechnology*** (CRN) is a non-profit research and advocacy think tank concerned with the major societal and environmental implications of advanced nanotechnology.
3. The ***International Council on Nanotechnology*** is an international, multi-stakeholder organization whose mission is to develop and communicate information regarding potential environmental and health risks of nanotechnology, thereby fostering risk reduction while maximizing societal benefit.
4. ***Latin American Nanotechnology and Society Network*** (ReLANS) intends to create a forum for discussion and exchange of information that follows the process of nanotechnology development in Latin America. To that end, ReLANS will establish links and collaboration agreements with academic institutions, governments and society, intending to examine and evaluate the political, economic, social, legal, ethical and environmental implications of nanotechnologies that are domestically developed, and/or in collaboration with foreign centers and institutions, and imported goods that contain nanocomponents.

* Dr. Ashutosh Debata

OBSERVATION OF STATE LEVEL WORLD ENVIRONMENT DAY FUNCTION ON 5TH JUNE 2019 AT RABINDRA MANDAP, BHUBANESWAR

World Environment Day is the most important day for encouraging worldwide awareness and action for the protection of our environment.

On 5th June 2019, the State ENVIS Hub, Centre for Environmental Studies (CES), Forest & Environment Department, Government of Odisha organized the World Environment Day Function at Rabindra Mandap, Bhubaneswar.

CES also organized an eco-model exhibition on BEAT AIR POLLUTION. 52 models from eco-clubs of different districts participated in the exhibition. The exhibition was inaugurated by Shri Bikram Keshari Arukha, Hon'ble Forest & Environment Minister, Odisha.

Shri Bikram Keshari Arukha, Hon'ble Forest & Environment Minister, Odisha inaugurated this function by lighting the lamp. Shri Suresh Chandra Mahapatra, IAS, Additional Chief Secretary, Forest & Environment Department; Dr. K. Murugesan, IFS, Director, Environment-cum-Special Secretary,

Release of 57th ENVIS Newsletter on "Beat Air Pollution"

Forest & Environment Department and Dr. Ashutosh Debata, Director, Centre for Environmental Studies, Forest & Environment Department addressed in this function.

During the function a book on "PARIBESHARA JAGRAT PRAHARI" and 57th issue of ENVIS Newsletter on "BEAT AIR POLLUTION" were released by the Guests. Hon'ble Chief Guest distributed "Prakruti Mitra" prizes to 166 organisations.

Contact details : **State ENVIS Hub, Centre for Environmental Studies,**
Forest & Environment Department, Government of Odisha
RPRC Campus, Ekamra-Kanan Road, Nayapalli,
Bhubaneswar-751015, E-mail: ori@envis.nic.in
Website: www.orienvis.nic.in

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