

# Green Nano-Visions and Their Policy Consequences



historyking.com

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# Why is it Important to Study the History of Nanotechnology and Why Should You Care?



[schoolfood.info](http://schoolfood.info)



[smashinglists.com](http://smashinglists.com)



[bestmeal.info](http://bestmeal.info)

Use the past → Understand the Present → Direct the Future

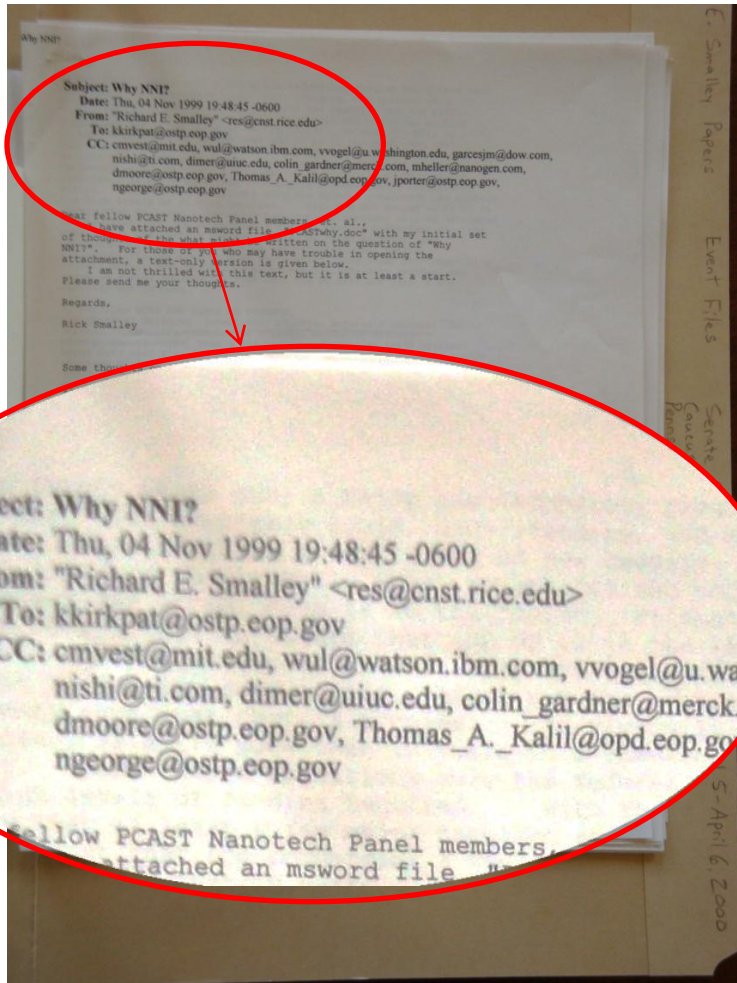
Generate policy recommendation

Benefit the public:  
Information access  
and informed  
decisions

Avoid problems in  
the emergence of  
nanotechnology

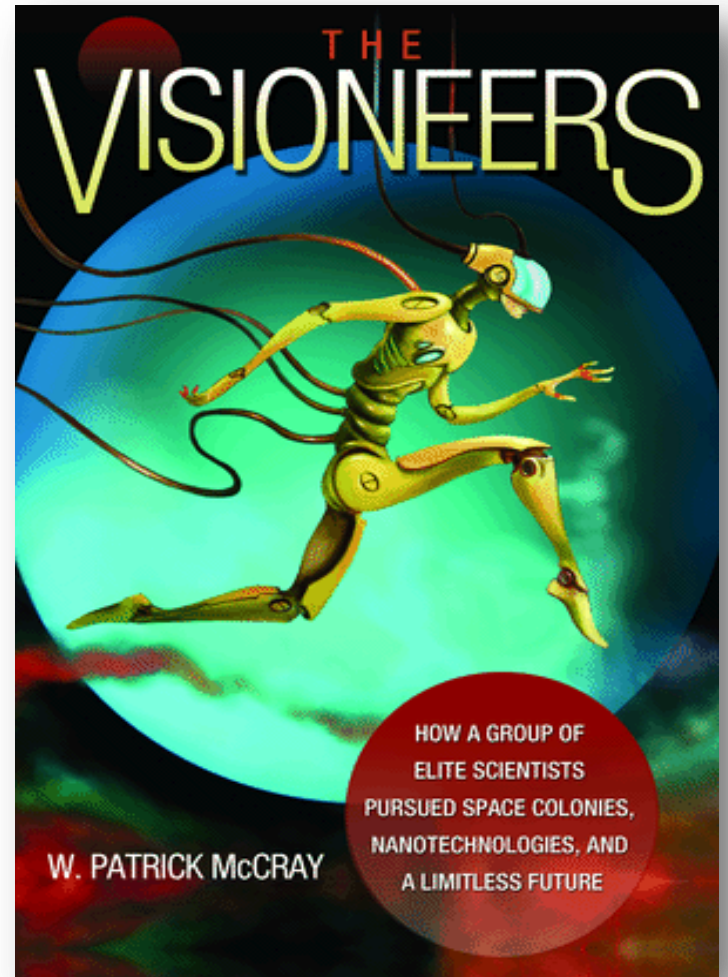
# How Is Evidence Collected?

## Primary Sources



Richard E. Smalley's papers at the Chemical Heritage Foundation

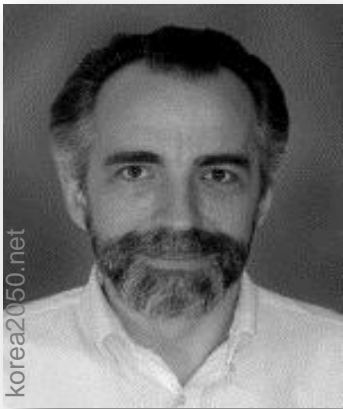
## Secondary Sources



# What Were the Green Nano-Visions and Their Policy Consequences?

**Analyzed** past environmental visions of nanotechnology by scientists and policy makers between the 1980s and 2000s

**Examined** policy consequences of green nano-visions

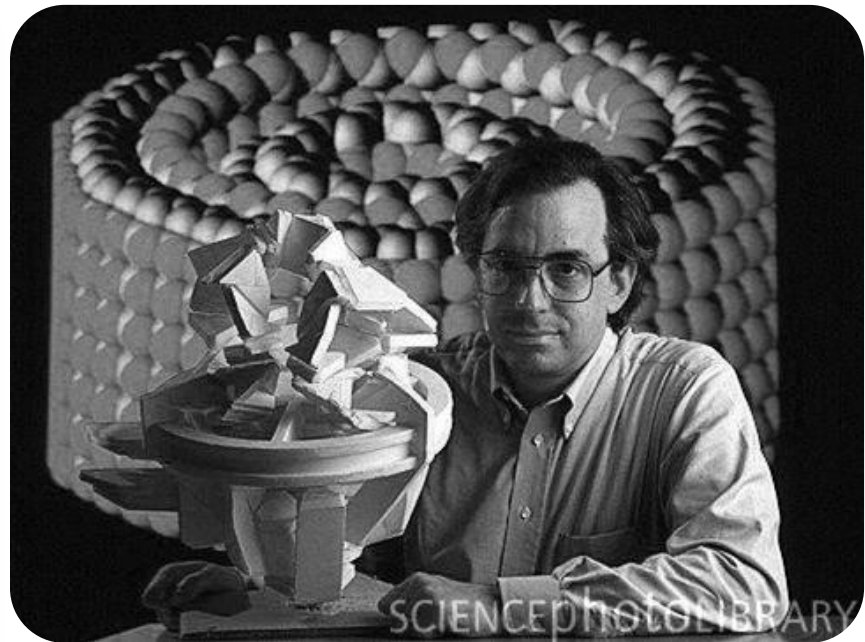
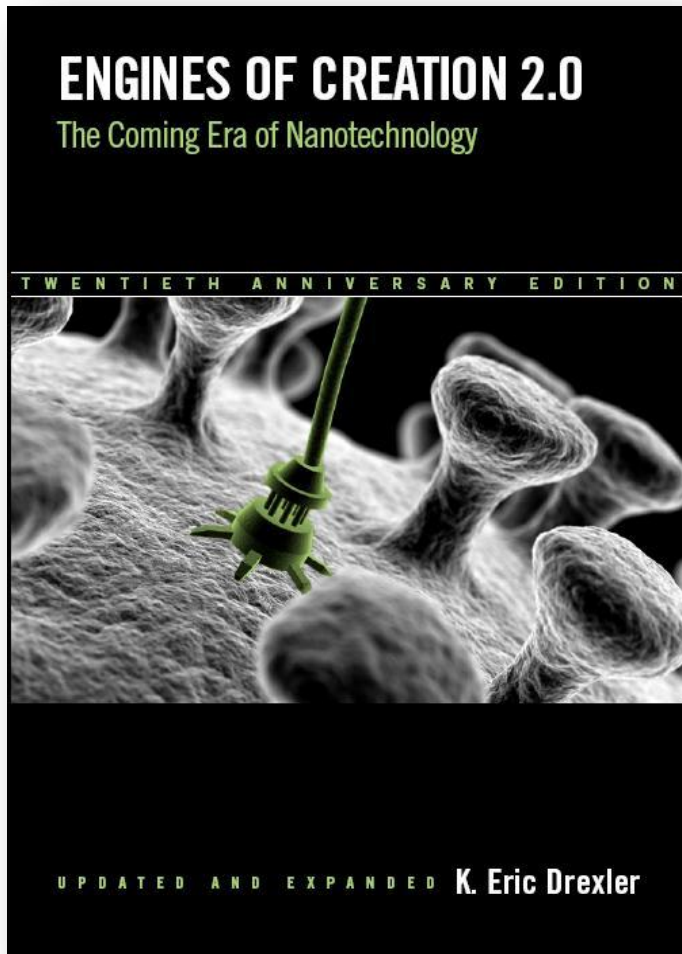


Green nano-visions were one of the reasons for Environmental, Health, and Safety delayed research

# Green Nano-Visions

## Eric Drexler, MIT Ph.D.

- Popularized nanotechnology ideas through *Engines of Creation* (1986)
- Envisioned nano-machinery able to extract CO<sub>2</sub> from the environment
- His visions influenced fellow scientists and policy makers

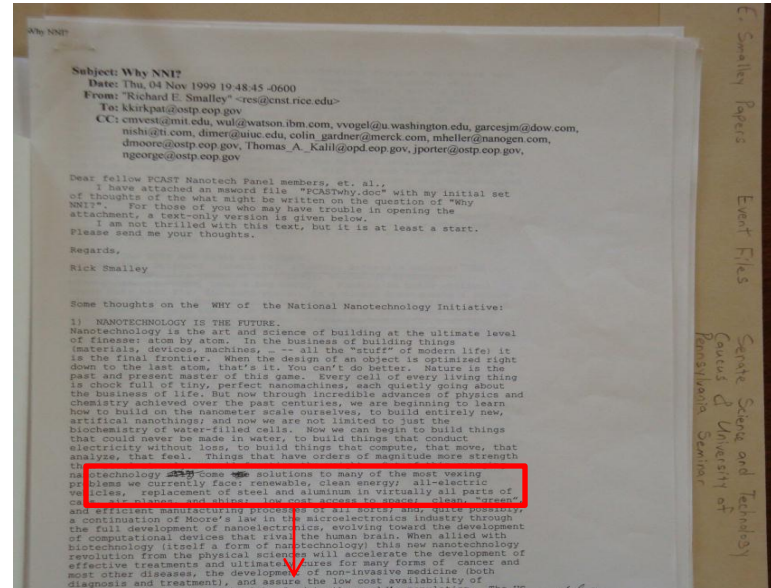
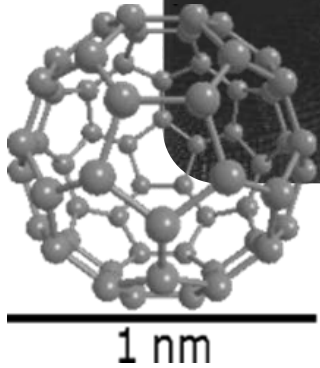
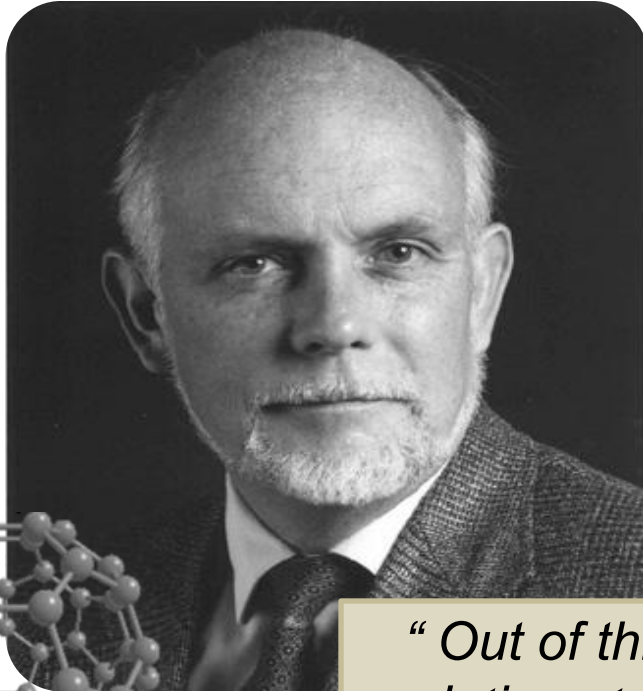


*“Molecular machinery can be used to sort gas molecules to extract carbon dioxide from air.” (Engines of Creation, pg. 16)*

# Green Nano-Visions

## Richard E. Smalley, Rice University Ph.D.

- Nobel Prize Laureate in Chemistry (1996), discovered “buckyballs”
- Advised the government about the need for a NNI (1999)
- Visions of a new, renewable, and clean form of nano-energy



*“ Out of this emerging nanotechnology come solutions to many of the most vexing problems we currently face: renewable, clean energy...clean, “green” and efficient manufacturing processes of all sorts...”*

*(Smalley 1999)*

# Green Nano-Visions

## Dr. Mihail Roco

- Senior Advisor for Nanotechnology at the National Science Foundation
- He formally proposed NNI to the White House (1999)
- Multiple environmental visions for nanotechnology (2000)



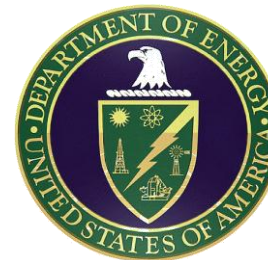
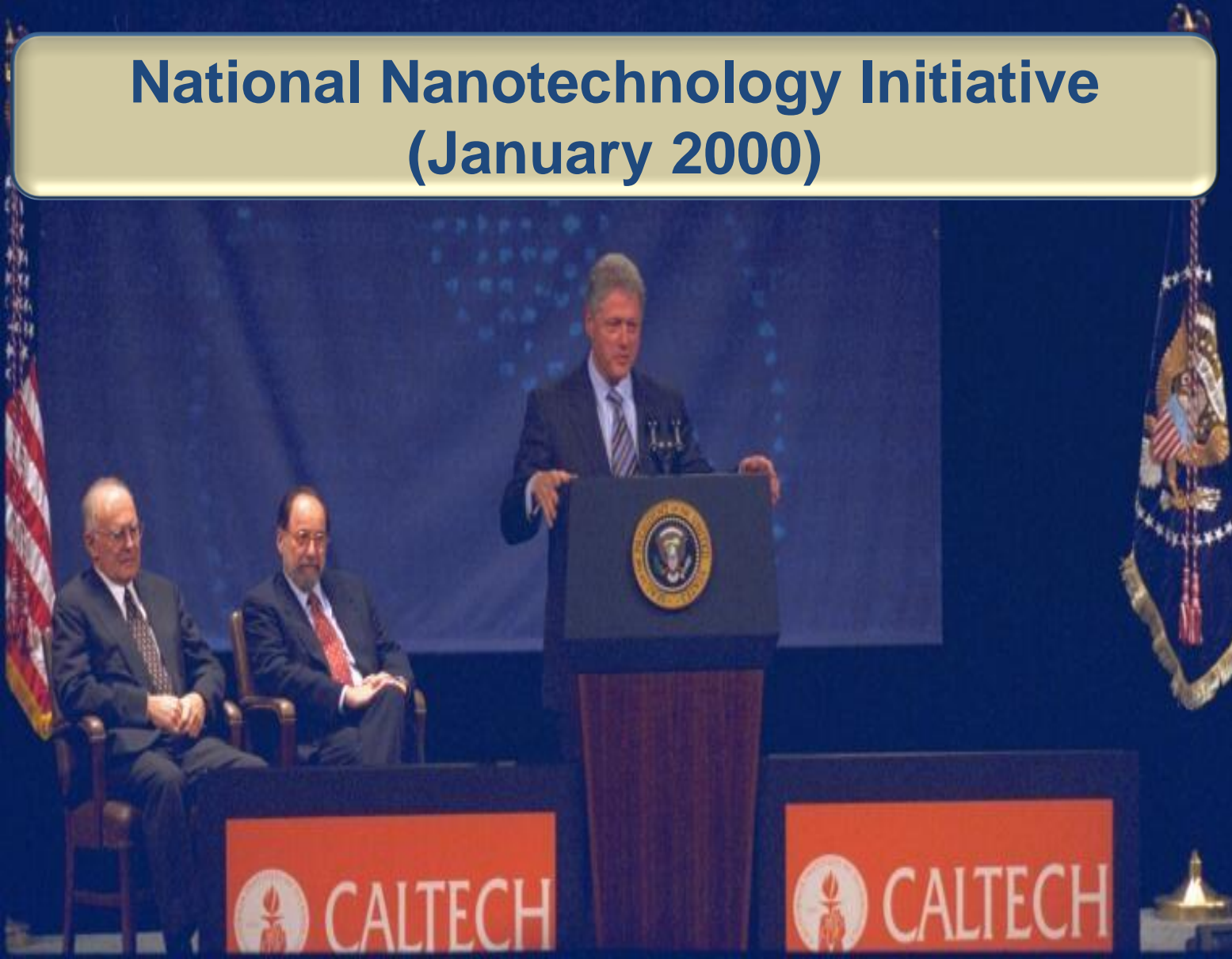
*“Nanotechnology will improve agricultural yields for an increased population, provide more economical water filtration and desalination, and enable renewable energy sources.”*

*(Journal of Nanoparticle Research, M. Roco 2000)*



Investing In Science & Technology  
For A Strong America

# National Nanotechnology Initiative (January 2000)



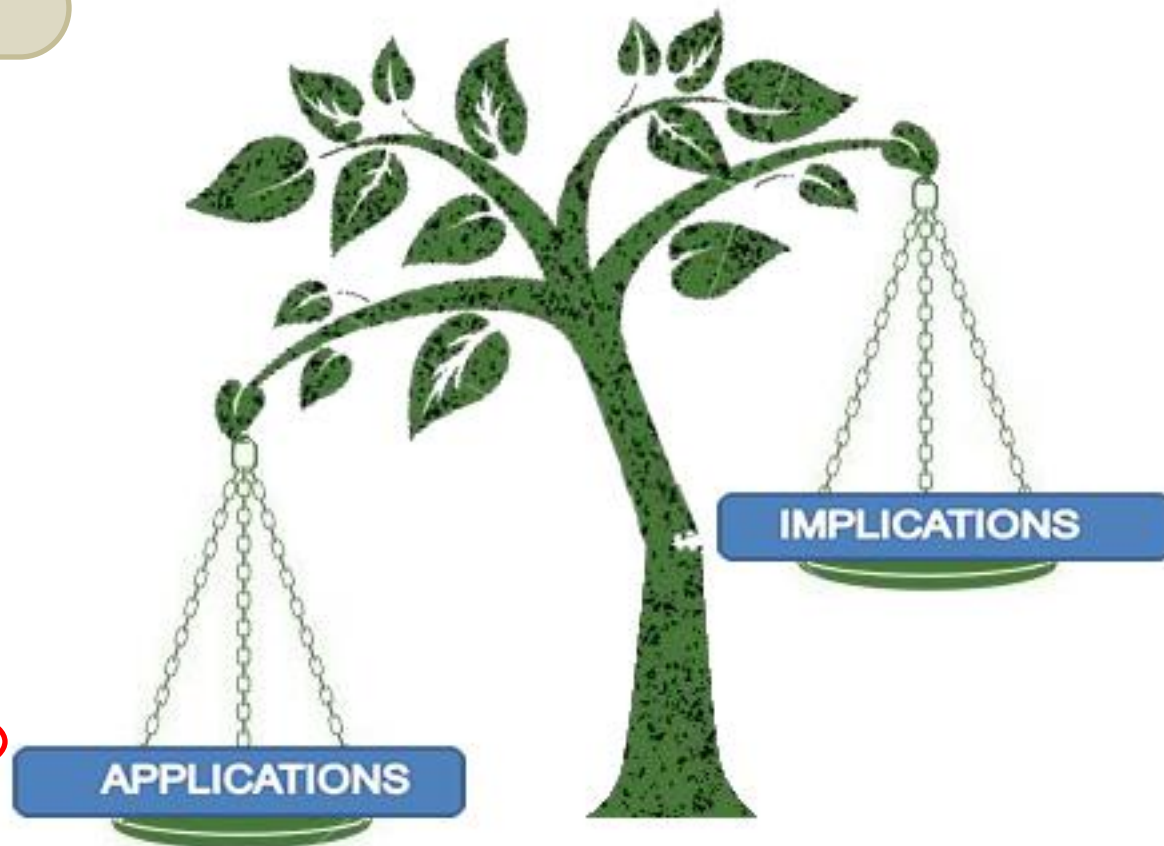


# Policy Consequences

- January 2000: NNI seeks to fund the “Next Industrial Revolution”
- Major U.S. investment in nanotechnology
- NNI focuses on **applications** and commercialization

## Reasons (before 2000):

- Financial
- Historical moment
- Internet boom
- Green Nano-Visions



# EPA's Background Description of the NNI (2000)

January 31, 2000

## MEMORANDUM

SUBJECT: Background on National Nanotechnology Initiative

FROM: Lawrence A. Friedl  
Immediate Office Staff, Technology Applications (8101R)

TO: Norine E. Noonan  
Assistant Administrator (8101R)

As requested, I have examined ORD's involvement with nanotechnology and prepared this overview of the National Nanotechnology Initiative (NNI). As you may know, nanotechnology refers to the construction and utilization of materials and systems at the atomic and molecular scales. The primary "nanoscale" activities within ORD concentrate on the health effects and atmospheric processes of ultrafine particles. ORD may become involved with a broader set of nanotechnology activities through its cooperative research programs with the National Science Foundation (NSF), which organized the Initiative.

The NNI research focuses primarily on atomic and molecular-level phenomena, properties, and processes to support the development of structures and devices. For the environment, the Interagency Working Group on Nanotechnology (IWGN) has suggested that nanotechnologies may lead to cleaner manufacturing, better emissions control, and improved contamination measurements and remediation.

However, nanoparticles and nanostructures may also pose ambient and occupational health effects. The IWGN has solicited EPA's help to identify environmental research topics for the NNI.

Proposed funding for the NNI is \$497 million in FY01 with incremental increases over three years. Funding in FY00 was \$270 million.

As you know, the IWGN has invited EPA-ORD to become a member. Participation in the IWGN and NNI does not require a financial outlay. The IWGN meets monthly, and representatives also develop appropriate papers, reports, and materials. If EPA-ORD elects to join the working group, then NCEER or OSP may be the appropriate representatives. Currently, the IWGN is developing its management plan and building support for the Initiative.

The President's Committee of Advisors on Science and Technology (PCAST) strongly endorsed the NNI in December 1999. The President announced the NNI at a speech on January 21, 2000.

The IWGN chairperson wishes to know by mid-February whether EPA-ORD will participate.

Same month of NNI announcement EPA tries to figure out their role in the NNI

"...cleaner manufacturing, better emissions control, and improved contamination measurements and remediation.

"...nanoparticles and nanostructures may also pose ambient and occupational health effects"

EPA Mission:  
"Protect human health and the environment"

# EPA's Research Grant (2002)

## EPA and Nanotechnology (for NSET 6-3-02)

Environmental Protection Agency research. The mission of the United States Environmental Protection Agency is to protect environment and human health. EPA conducts and supports research to ensure that there is a sound scientific basis for its actions to carry out this mission. EPA's research programs address environmental and health effects of substances, assess potential exposure to humans and ecosystems, determine risk, and inform policy on the most appropriate risk management approaches. Research on environmental applications and implications of nanotechnologies are addressed within this framework.

### A. Research Grants

As part of its interest in nanotechnology research, EPA is offering the second solicitation for nanotechnology research grants through the Office of Research and Development (ORD), National Center for Environmental Research (NCER), under the Science to Achieve Results (STAR) program.

Proposals are solicited to address one or more of the following research topics:

**(1) Environmentally Benign Manufacturing and Processing:** "Green" nanotechnology that eliminates or minimizes harmful emissions and material waste from industrial processes, or that improves reuse or our ability to recycle.

Nanotechnology has the potential to be used to develop new, "green" processing technologies that minimize or eliminate the use of toxic materials and the generation of undesirable by-products and effluents. Research may involve nanotechnology related to improved industrial processes and starting material requirements, development of new chemical and industrial procedures, and materials to replace current hazardous constituents and processes, resulting in reductions in energy, materials, and waste generation. This research may focus on the chemical, electronic, or other sectors of the economy. Proposals should be problem focused, targeting high-priority environmental problems or concerns.

EPA is particularly interested in research proposals that address the following in an environmentally acceptable, cost-effective way: reduction of toxic chemicals, such as Persistent Bioaccumulative Toxics (PBTs), Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs).

Examples of types of nanotechnology research that may lead to reduction or elimination of these pollutants of concern include atomic level synthesis of new and improved catalysts for industrial processes; adding information into molecules (analogous to DNA) that build new molecules; self-assembling molecules as the foundation for new chemicals and materials; and building molecules "just in time" in microscale reactors.

Applications of nanotechnology that will lead to reduced use of resources in manufacturing and minimize associated wastes, such as nanoscale information technologies for product identification and tracking to manage

2002: EPA's focus is still on nanotechnology applications in the environment

### Research Topics:

1. Environmentally Benign Manufacturing and Processes
2. Remediation/Treatment
3. Sensors
4. **Environmental Implications of Nanotechnology**

Out of 4 only 1 research topic talks about implications

# EPA's First Grant for Implications (2003)

(April, 2003)

3-12-03 d  
Environme  
Request fo

FY 2003 Science to Achieve Results (STAR) Program  
National Center for Environmental Research

Opening Date:  
Closing Date:

## FUNDING

It is anticipated that a total of approximately \$4 million will be awarded, depending on the availability of funds. EPA anticipates funding approximately 12 grants under this RFA. The projected award per grant is \$100,000 to \$115,000 per year total costs, for up to 3 years. Requests for amounts in excess of a total of \$345,000, including direct and indirect costs, will not be considered.

## ELIGIBILITY

Institutions of higher education and not-for-profit institutions located in the U.S., and Tribal, state and local governments, are eligible to apply. Profit-making firms are not eligible to receive grants from EPA under this program.

National laboratories funded by federal agencies (Federally-funded Research and Development Centers, "FFRDCs") may not apply. FFRDC employees may cooperate or collaborate with eligible applicants within the limits imposed by applicable legislation and regulations. They may participate in planning, conducting, and analyzing the research directed by the principal investigator, but may not direct projects on behalf of the applicant organization or principal investigator. The principal investigator's institution, organization, or governance may provide funds through its grant from EPA to a FFRDC for research personnel, supplies, equipment, and other expenses directly related to the research. However, salaries for permanent FFRDC employees may not be provided through this mechanism.

Federal agencies may not apply. Federal employees are not eligible to serve in a principal leadership role on a grant, and may not receive salaries or in other ways augment their agency's appropriations through grants made by this program. However, federal employees may interact with grantees so long as their involvement is not essential to achieving the basic goals of the grant. EPA encourages interaction between its own laboratory scientists and grant principal investigators for the sole purpose of exchanging information in research areas of common interest that may add value to their respective research activities. This interaction must be incidental to achieving the goals of the research under a grant. Interaction that is "incidental" does not involve resource commitments.

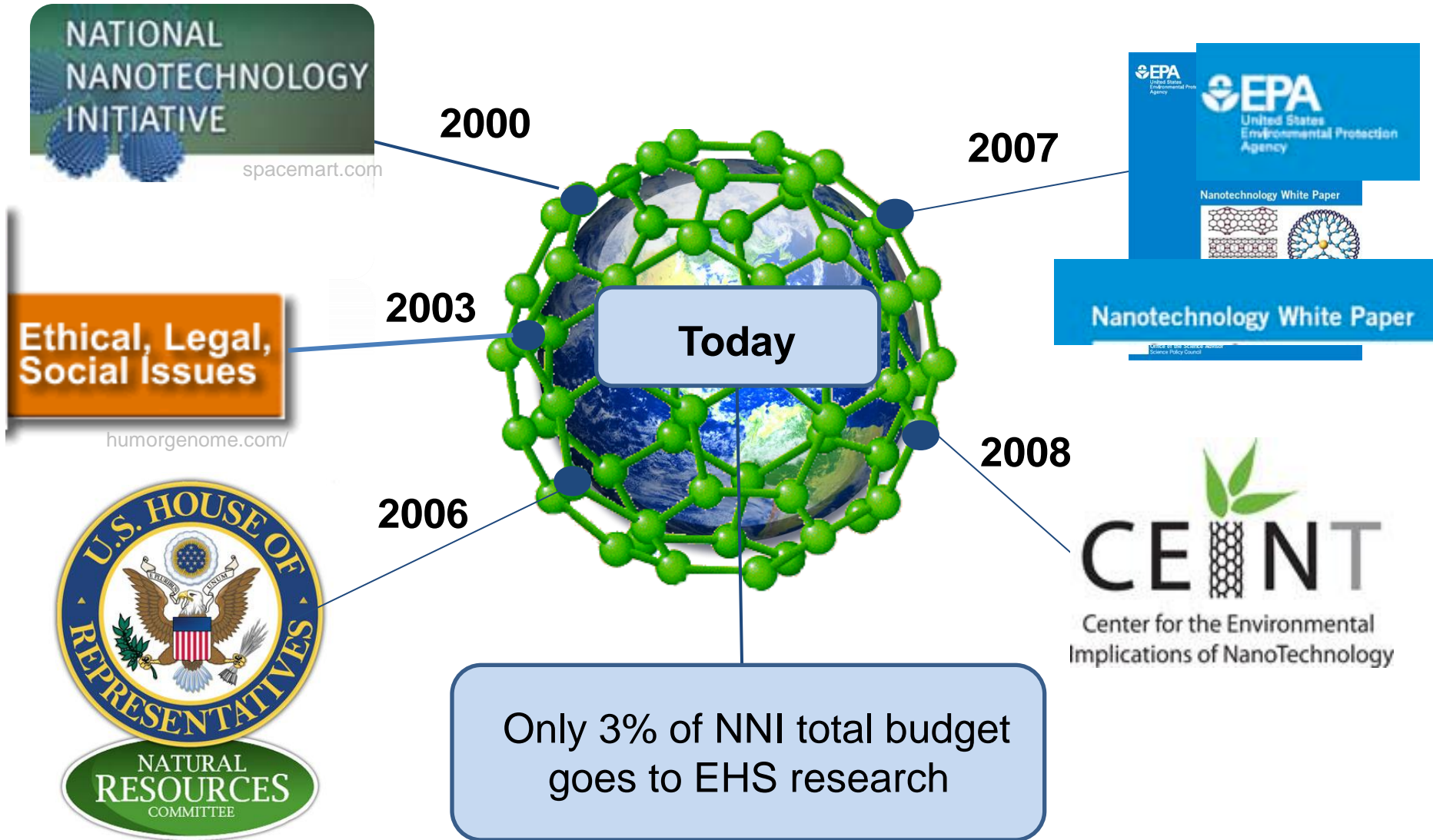
The principal investigator's institution may enter into an agreement with a federal agency to purchase or utilize unique supplies or services unavailable in the private sector. Examples are purchase of satellite data, census data tapes, chemical reference standards, analyses, or use of instrumentation or other facilities not available elsewhere. A written justification for federal

It took The EPA three years to look at the environmental **implications** of nanotechnology.

It took the NNI and the U.S. Government even longer to look at environmental **implications** of nanotechnology.

# Policy Consequences

Environmental concerns about nanotechnology were **gradually** taking place on government research agendas.



# Even Today Implications are Overlooked

The image shows the cover of a report from the U.S. Environmental Protection Agency (EPA) Office of Inspector General. The title is "EPA Needs to Manage Nanomaterial Risks More Effectively", which is circled in red. Below the title is the report number "Report No. 12-P-0162" and the date "December 29, 2011", both enclosed in red boxes. A red arrow points from the circled title to a text box on the right. Below the title are four small images: a red textured surface, a blue and black microscopic view, a green X-shaped structure, and a yellow circular textured surface. A red arrow points from the date box to another date box below the images. At the bottom left is a QR code with the text "Scan this mobile code to learn more about the EPA OIG." The EPA logo and the text "U.S. ENVIRONMENTAL PROTECTION AGENCY OFFICE OF INSPECTOR GENERAL" are at the top.

The EPA itself criticizes its job for not being effective on managing nanomaterials risks. December 2011

*“In the United States, hundreds of nanotechnology products had been released into markets by 2011, but the Environmental Protection Agency had only managed, after several years of delay, to put in place a voluntary regulatory program. (Nanotechnology and Global Sustainability, 2012 pg. 32)*

*“There is no nation (Including the U.S.) that has the oversight policies and institutions needed to deal with these risks” (Governing Uncertainty, C. Bosso, 2010 pg. XIII)*

# Conclusion

Green nano-visions were one of the reasons for the delayed in Environmental, Health, and Safety regulations during the first NNI years. Even today, there is no clear regulations.

My project reminds us that we can not be separated from nature, and that our actions could have implications. We need to pay more attention to the implications.

Applications of nanotechnology are great, but by looking at both the applications and implications we can help prevent environmental and economical losses.

## Further Research

- Study the history of how green nano-visions came to be
- Learn about current nano-products in the market
- In depth research about current nano-products' implications

# Thank You!

## Special Thanks to:

**National Science Foundation (NSF)**

**Internships in Nanosystems Science, Engineering and Technology (INSET) Staff**

**Center for Nanotechnology in Society (CNS) Staff**

**Santa Barbara City College (SBCC)**

**University of California Santa Barbara (UCSB)**

**Roger Eardley-Pryor**

**Dr. Patrick McCray**

**Dr. Cathy Boggs**

**Professor Jens-Uwe Kuhn**

**Professor Nick Arnold**

**Professor Blake Barron**

**Professor Bob Cummings**

**Sam Hammond**

**Ricky Echanique**

**INSET workshop speakers**

**Summer INSET Interns**

**Family and friends**

**Everybody who made this opportunity possible**





# Genetically Modified Organisms (GMOs)



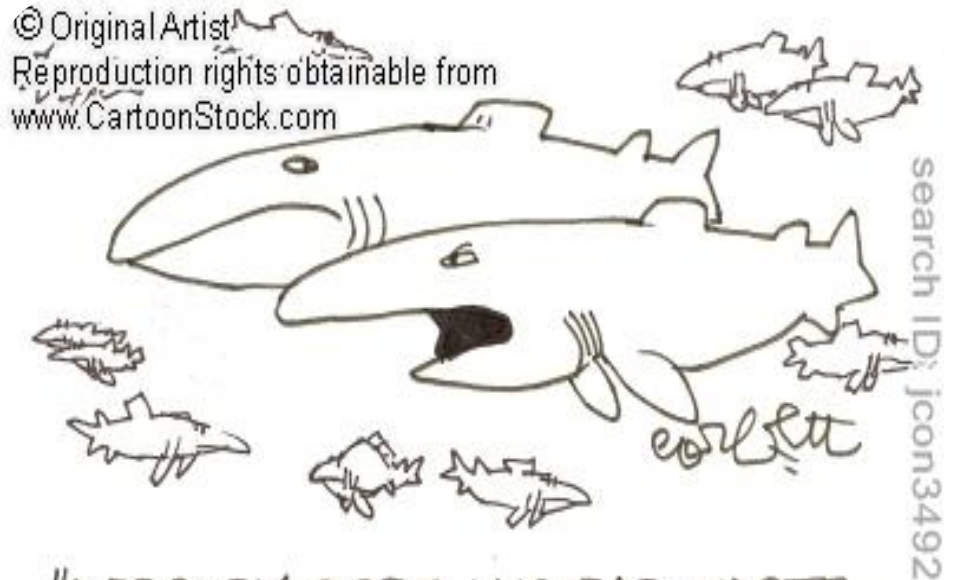
socialistviewpoint.org

## Organisms with altered genetic material.

- The health consequences of eating genetically modified organisms are largely unknown.
- Genetic engineering reduces genetic diversity.
- Genetically engineered foods have not been proven to be safe, but the few studies conducted don't look so hot.
- GMOs require massive amounts of pesticides, herbicides and fungicides.

# Nuclear Power

- Nuclear Power Contaminates Water Supplies
- There is No Safe Way to Mine, Store, or Process Nuclear Materials
- Exposure to the Radioactive Material Can Be Deadly, Causing Health Problems and Cancer



"MERCURY, PCBs, NUCLEAR WASTE -  
IT'S ENOUGH TO MAKE YOU WANT TO  
REMAIN IN THE PLANKTON STAGE!"

REMAIN IN THE PLANKTON STAGE!!  
IT'S ENOUGH TO MAKE YOU WANT TO  
REMAIN IN THE PLANKTON STAGE!!

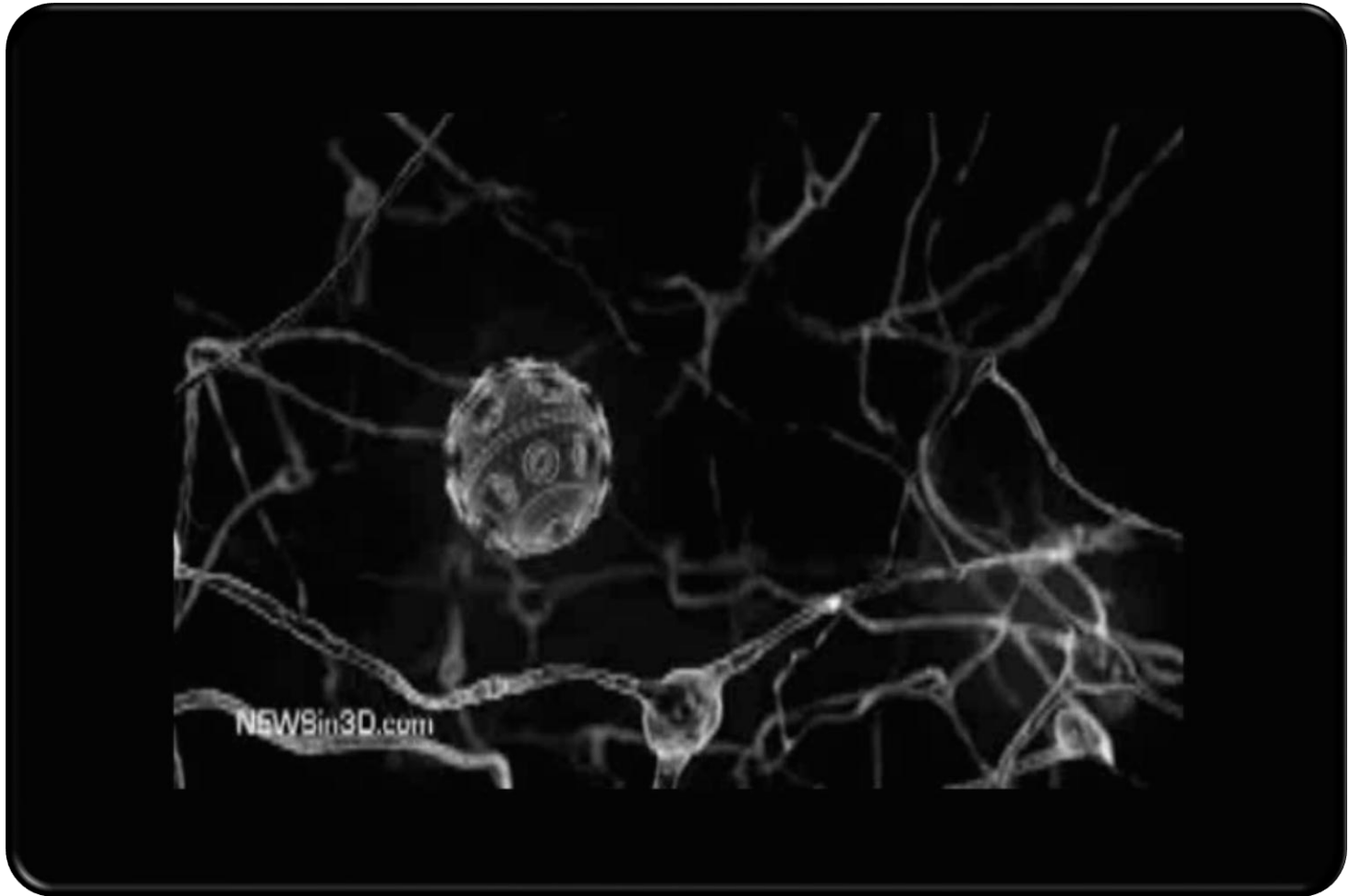
## Pesticide DDT



[fineartamerica.com](http://fineartamerica.com)

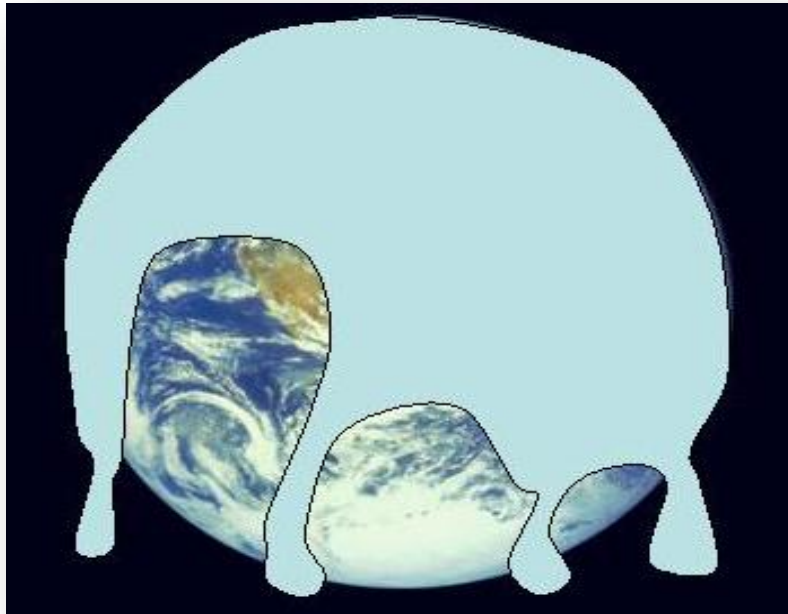
- Used in the early 1940s WWII to control malaria and typhus.
- Late 1940s used in agriculture.
- Evidence indicates that DDT causes cancers of the liver, pancreas and breast.

## Nanobots and Eric Drexler

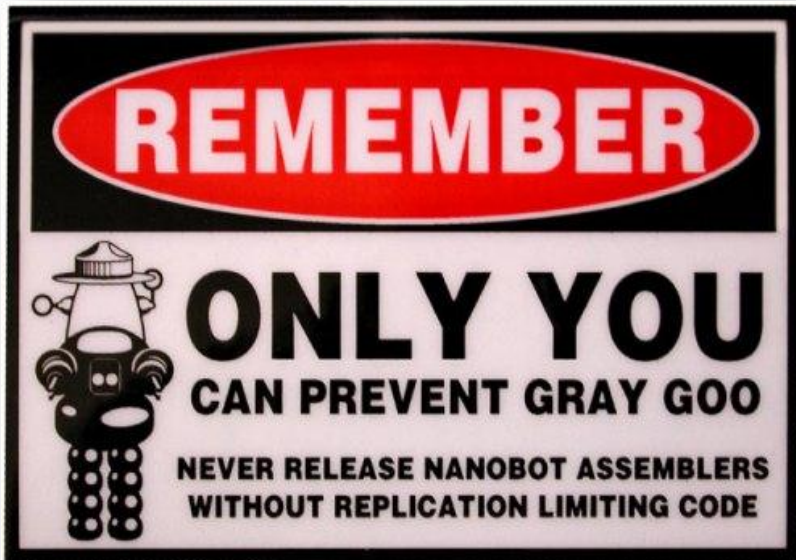


In this animation you can see one of Drexler's visions of a nanobot floating within a nervous systems reaching a malfunctioning neuron and taking its place to fix the problem.

# Dystopian Ideas About Nanotechnology



scitechspec.wordpress.com



talq.blogspot.com

- Ideas created by the media and science fiction writers
- Eric Drexler created the term “gray goo” in his book *Engines of Creation*
- Gray goo: A hypothetical scenario in which self-replicating robots consume Earth.
- Public reaction led to government concerns.
- Creation of nanotechnology centers that look at societal implications



# Applications

vs.

# Implications

Antibacterial

## Nano-Silver



- Washes into ocean
- Kills bad and good bacteria

Harmless at bulk scale

## Nano-Aluminum



clker.com

- Extremely explosive at nano-scale
- Bomb making material by U.S. Army

Thermal conductivity

## Carbon Nanotubes



ati.surrey.ac.uk

- Possibly cell death

Electrochemical Applications

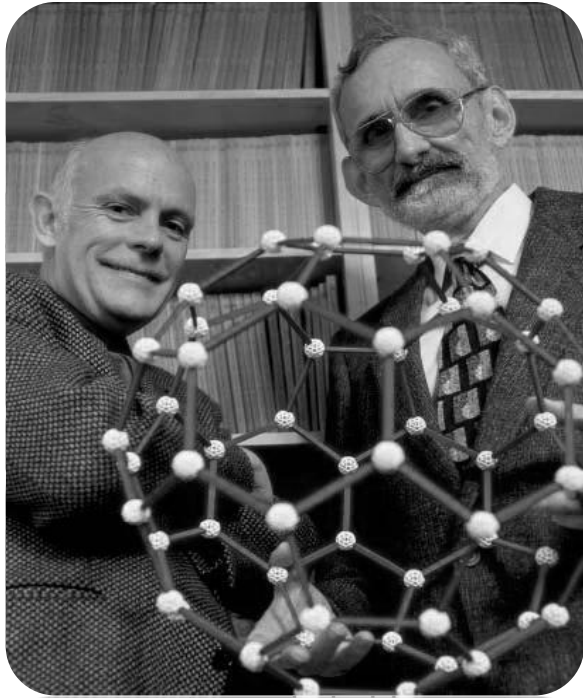
## Nano-Titanium



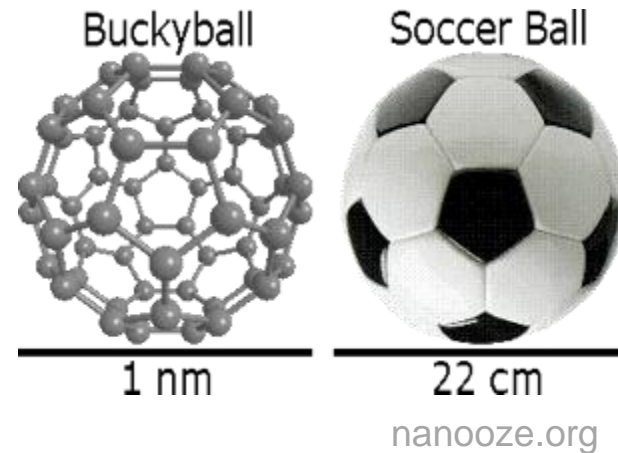
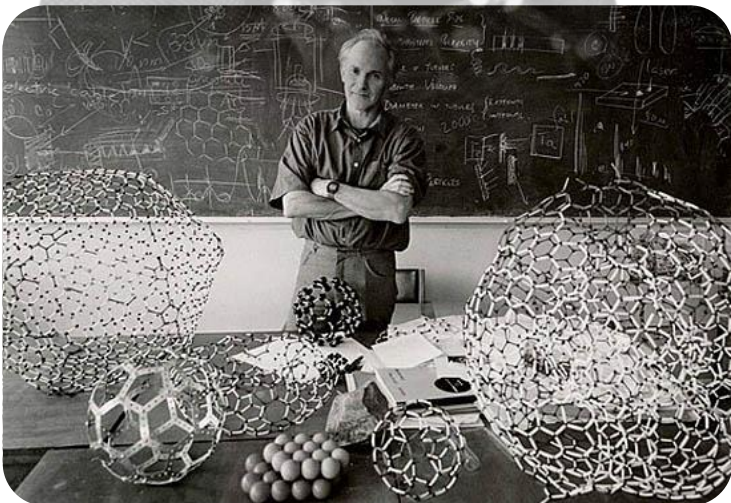
- Possibly carcinogenic



# The Discovery of Buckyballs (1985)



- Discovered by Richard Smalley, Harold Kroto, and Robert Curl
- Buckyballs are hollow spherical molecules made up entirely of carbon.
- Buckyballs look like soccer balls.
- The smallest buckyballs are made up of 60 carbon atoms.



# Acronyms

**INSET:** Internships in Nanosystems Science, Engineering, and Technology

**CNS:** Center for Nanotechnology in Society

**NNI:** National Nanotechnology Initiative

**NSF:** National Science Foundation

**PCAST:** President's Council of Advisors on Science and Technology

**EHS:** Environmental Protection Agency

**ORD:** EPA's Office of Research and Development

**EPA:** Environmental Protection Agency

**IWGN:** Interagency Working Group of Nanotechnology

**FY:** Fiscal Year

**NIH:** National Institute of Health

**NIST:** National Institute of Standards and Technology

**NASA:** National Aeronautics and Space Administration

**NSTC:** National Science and Technology Council

**CEIN:** Center for Environmental Implications of Nanotechnology (UCLA)

**CEINT:** Center for the Environmental Implications of NanoTechnology (Duke)