



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology



# The Foresight Nanotechnology Challenges

Presented by Scott Mize  
President, Foresight Nanotech Institute

May 2005  
© Foresight Nanotech Institute 2005  
[www.foresight.org](http://www.foresight.org)

# Presentation Overview

---

- Foresight overview
- Long-term vs. short-term
- Foresight Nanotechnology Challenges
- Roadmap Initiative
- What's next?



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Foresight Overview - 1

- Founded in 1986 by Drexler & Peterson
- Created and popularized concept of “nanotechnology”
  - \_ Molecular nanotechnology (MNT)
  - \_ Molecular manufacturing (MM)
  - \_ Molecular machine systems (MMS)
- 4 books published, many inspired
- Foresight Guidelines
- Numerous white papers, articles, briefings, essays, ...
- Top 5 “nanotechnology” Web site



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Foresight Overview - 2

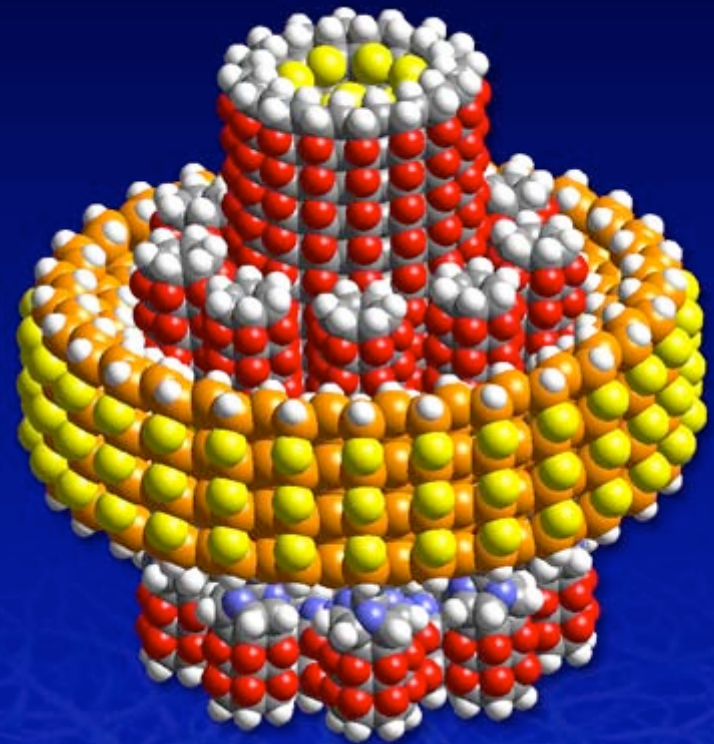
- 54 Foresight Update newsletters
- 12 major conferences
- Awarded 18 Feynman Prizes, several others
- Helped catalyze establishment of U.S. NNI
- Extensive placement in the press worldwide
- Leading public policy voice
- Reaches 14,000+ people via email
- Staff of 10
- Think tank and public interest organization



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Molecular Nanotechnology

- “Thorough, inexpensive control of the structure of matter based on molecule-by-molecule (i.e. atomically precise) control of products and byproducts of molecular manufacturing.”
  - \_ Molecular machine systems (MMS)
  - \_ Molecular manufacturing (MM)
  - \_ Assemblers
- “Nanoscale Engineering” and today’s building blocks are precursors
- Long term



# Foresight Mission

---

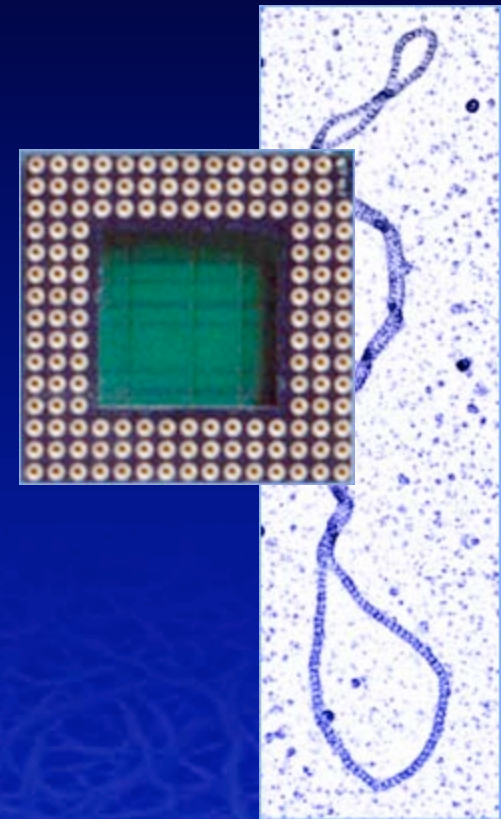
To Ensure  
the Beneficial Implementation  
of Nanotechnology



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Where Are We?

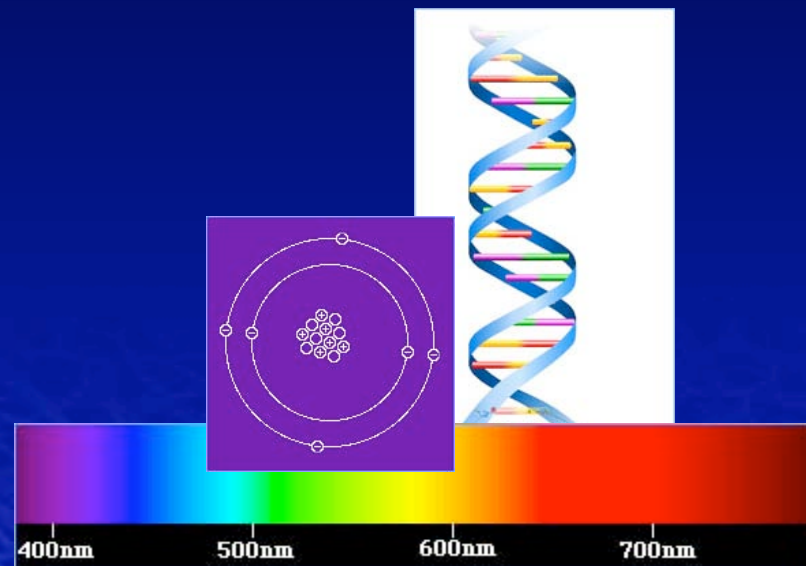
- VERY early
- IT before the integrated circuit
  - \_ Early 60's
- Biotech before recombinant DNA
  - \_ Early 70's
- Long term vs. short term



# Nanotechnology Definition

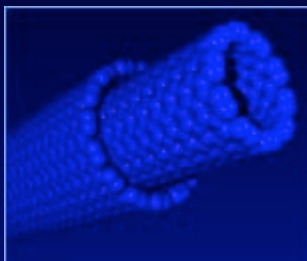
- MANY definitions
- Size gives rise to new properties
  - \_ Quantum effects
  - \_ New physical ratios/relationships
- Building systems based on new properties
- “Nanoscale Engineering”
- Short term

“The technology of structuring and controlling matter on the scale of ~100nm and below.”

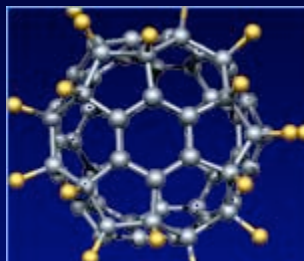


**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Today's Building Blocks



Nanotubes



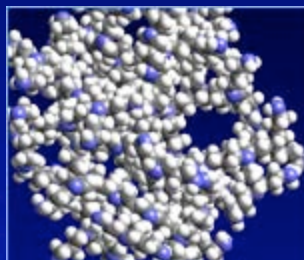
Fullerenes



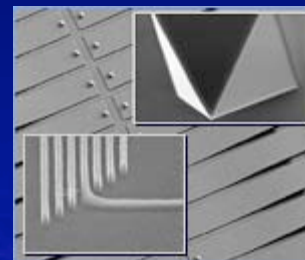
Nanoparticles



Quantum Dot



Dendrimers



Soft Lithography  
(Nano-imprinting,  
Dip-pen Lithography)



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Forbes Top Products 2004

- Footwarmers
- Washable mattress
- Golf balls and clubs
- Customized skin care
- Wound dressing for burns



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Forbes Top Products 2004

- Military-grade disinfectant
- Superhydrophobic spray
- Automotive glass treatment
- Joint and muscle pain cream
- Dental adhesive



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Focusing on Big Challenges

- Big Problems = Big Markets (most of the time)
- Focuses societal investments in R&D
- Significant incentive for financial investors
- Basis for diverse alliances of mutual interest
- What are the BIG problems/challenges?



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# The “Millennium Challenges”

- Developed by ACUNU
- Millennium Project
- 1650 experts worldwide over 8 years
- 15 Global Challenges
- Other similar lists
- Effort to focus humanity on big problems
- How can nanotechnology contribute?



American Council for  
The United Nations  
University



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Foresight Nanotech Challenges

1. Meeting global energy needs with clean solutions
2. Providing abundant clean water globally
3. Increasing the health and longevity of human life
4. Maximizing the productivity of agriculture
5. Making powerful information technology available everywhere
6. Enabling the development of space



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Global Energy Needs

## The Problem

- Global Warming
  - \_ CO2 concentrations have nearly doubled
  - \_ 3 of the last 5 years hottest in recorded history
  - \_ Glaciers receding worldwide
- Energy Demand
  - \_ 1.6 billion have no access to electricity
  - \_ 2.4 billion rely on burning of biomass
  - \_ Demand will increase approximately 50% by 2025
  - \_ \$16 trillion required to meet demand by 2030
  - \_ On track for only 10% renewable energy by 2025
  - \_ Fossil fuel consumption could double by 2030
  - \_ Developing world will surpass developed world



# Global Energy Needs

## Some Solutions

- Better fuel cells
- Better hydrogen storage
- Better solar cells
- Distributed energy generation and storage
  - \_ Re-inventing the power grid
- Higher efficiency devices - lighting, appliances, etc.



# Clean Water

## The Problem

- Water tables falling on every continent
- 1.1 billion don't have access to safe water
- 2.4 billion lack sanitation
- 80% of developing world diseases are water-borne
- Agriculture uses 70% of water
- 60% increase needed to feed 2 billion more by 2030



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Clean Water

## Some Solutions

- Inexpensive decentralized water purification
  - \_ Nanoporous materials
  - \_ Nanofibers
  - \_ Carbon nanotube and nanoparticle filters
- Environmental remediation



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Health and Longevity

## The Problem

- Infectious disease
  - Cause of 30% of deaths worldwide
  - 30 new highly infectious diseases in last 20 years
  - HIV/AIDS, SARS, Ebola, Avian Flu
  - Reappearance and resistance to antibiotics
  - Globalization has increased exposure
  - HIV/AIDS is most critical threat
    - 22 million killed, 42 million infected
    - Leading cause of death in sub-Saharan Africa
- Cancer
  - Over 500,000 U.S. deaths annually
  - Over \$1.5 million U.S. cases annually
- Life expectancy from 65 now to 75 in 2050
  - Could be significantly longer with anti-aging advancements
  - 2 billion people over 60



# Health and Longevity

## Some Solutions

- Inexpensive, rapid diagnostics
- New methods of drug delivery
- More effective anti-virals and antibiotics
  - \_ Easier to store and administer
- Faster development of new drugs
- Customized drug therapy
- Repair of DNA/cellular damage



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Agricultural Productivity

## The Problem

- Increasing demands for nutrition, shelter, water
- World grain harvest fell short last four years
- Biodiversity being destroyed worldwide
  - \_ 1,000,000 more species extinct by 2050
  - \_ 1/2 of forests and 1/4 of coral reefs are gone
  - \_ 9.4 million hectares of forest lost annually
- 8.9 billion population by 2050 (now 6.4 billion)
  - \_ 40% in India and China today
  - \_ 98% of growth in poorer countries
  - \_ 5 billion city dwellers by 2030



# Agricultural Productivity

## Some Solutions

- Inexpensive decentralized water purification
- Plant gene therapy
  - \_ Pest-resistant
  - \_ Require less water
  - \_ Higher yield
- Pest nanocides
- Precision farming - nanosensors



# IT Everywhere

## The Problem

- Need for “planetary nervous system”
- Widespread lack of access to:
  - \_ Communications
  - \_ Information
  - \_ Services and resources
- Leads to insurmountable barriers to:
  - \_ Education
  - \_ Democratization
  - \_ Economic Growth
- Need to coordinate collective action



# IT Everywhere

## Some Solutions

- Drastically reduced cost, increased performance
  - \_ Memories
  - \_ Displays
  - \_ Processors
  - \_ Solar powered
  - \_ Embedded intelligence
- Pervasive, self-configuring networks
- Pervasive computing and communications
  - \_ Increasing cross cultural understanding and cooperation



# Foresight Nanotech Challenges

1. Meeting global energy needs with clean solutions
2. Providing abundant clean water globally
3. Increasing the health and longevity of human life
4. Maximizing the productivity of agriculture
5. Making powerful information technology available everywhere
6. Enabling the development of space



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Roadmap Initiative

- Established method for coordinating stakeholders
- Vision for future end state(s)
- Articulates steps from current state to end state
- Illuminates what to focus on today
- Basis for research and commercialization agenda
- First roadmap on Productive Nanosystems



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# What's Next?

- Collaboration of all stakeholders
- Focus on technology solutions mentioned
- Roadmapping of possible solutions
  - \_ Basis for research and commercialization agendas
- Synergizing of technological and non-technological solutions



**FORESIGHT**  
NANOTECH INSTITUTE  
Advancing Beneficial Nanotechnology

# Resources

- Foresight Institute  
\_ [www.foresight.org](http://www.foresight.org)
- Millennium Project Global Challenges  
\_ [www.acunu.org/millennium/challeng.html](http://www.acunu.org/millennium/challeng.html)
- NanoBusiness Alliance  
\_ [www.nanobusiness.org](http://www.nanobusiness.org)
- Vision 2020 Roadmap for Nanomaterials  
\_ <http://chemicalvision2020.org/nanomaterialsroadmap.html>
- International Technology Roadmap for Semiconductors  
\_ <http://public.itrs.net>
- National Institutes of Health Roadmap  
\_ <http://nihroadmap.nih.gov>

