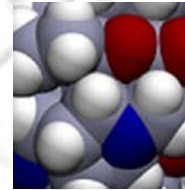
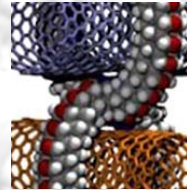
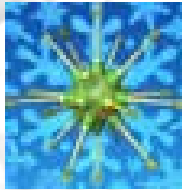
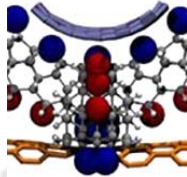
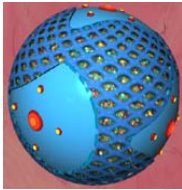


NANOTECHNOLOGY in the Workplace: Occupational Health Safety and the Environment



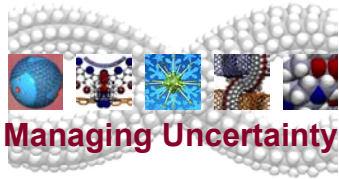
Managing Uncertainty

Kenneth A. Mundt, Ph.D.

**Securing the Promise of Nanotechnology:
Is US Environmental Law Up to the Job?**

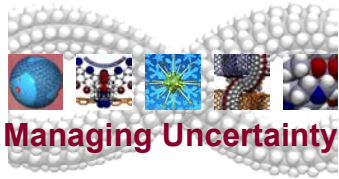
Washington, DC

May 25, 2005



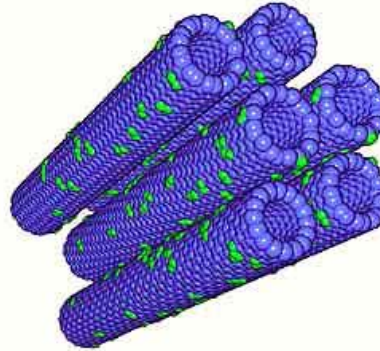
Workplace Issues - Overview

- Explosive growth projected in commercialization of nanotechnology products
- Hundreds of thousands of new and redefined jobs
- Substantial potential for exposures
 - Unseen materials
 - “Clean” workplaces
- Currently early stages of development - now is the time to define needs and proceed
- How should we proceed?

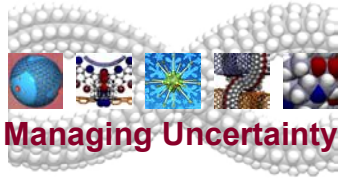


Key Questions?

- What do we know about these products?
- What rules and regulations exist?



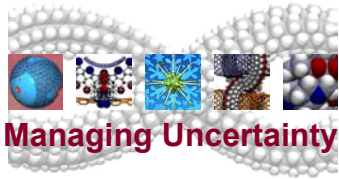
- We know very little about health effects (though many are laying the foundation)
- There are no laws in the US currently regulating nanotechnology



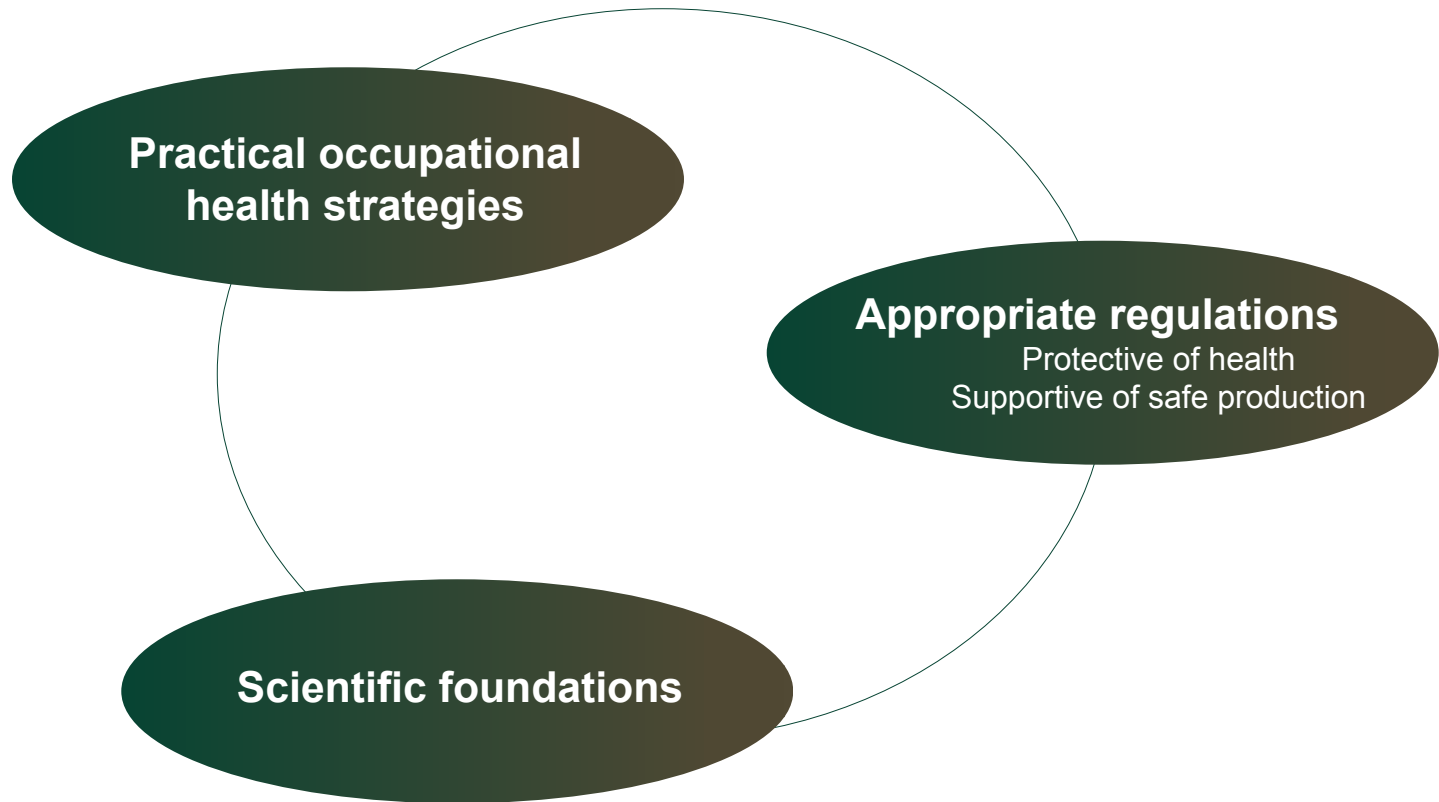
Motivation for Action

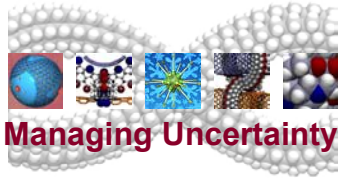
- Moral and ethical obligations to employees, society
- Good business practices
- Fear of future litigation (lessons learned from past transgressions)

- Additional pressures
 - Investors
 - Insurance Industry



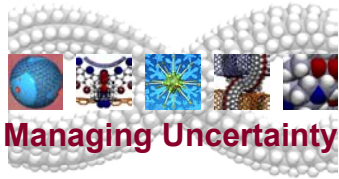
Model for Action





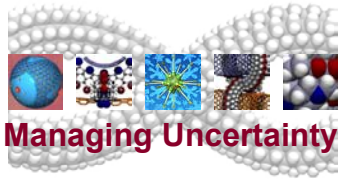
What is the Workforce?

- Current workforce mixed, technology-based
 - R&D operations
 - Large numbers of small facilities and labs
 - Universities and small enterprises
- Increasing shift toward piloting and ramping-up operations
- Full-scale production is projected to take years



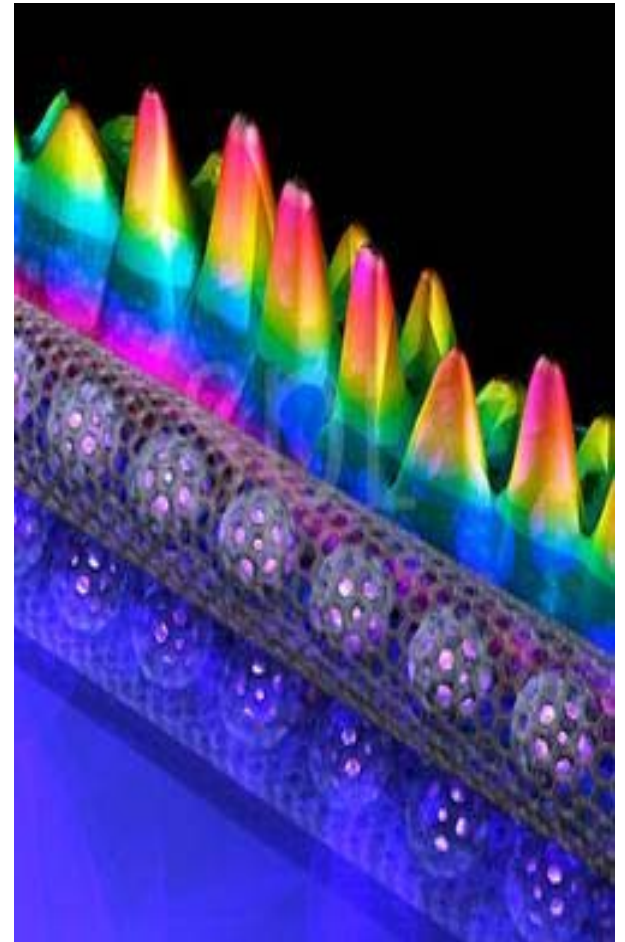
Nanotechnology is Everywhere - NOW

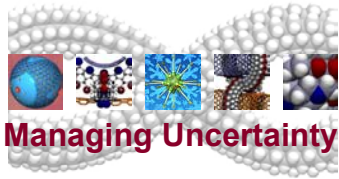
- Foods, additives, packaging
- Construction materials, coatings
- Defense, aerospace
- Energy production, storage distribution
- Environmental remediation
- Fibers, textiles
- Electronics, communications
- Consumer products, cosmetics, pharmaceuticals
- Health care



Potential for Nanoparticle Exposures

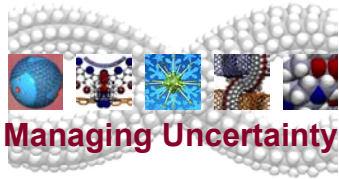
- Employees in all areas will have potential for exposure
- Workforce is at front line
- Current employees (and those soon to be employed) probably will have the greatest exposures
 - Possible lack of appropriate controls
 - Ability to measure limited





Exposure Potential

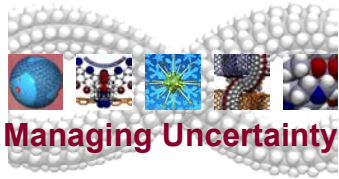
- Serious potential for harm if proper actions not taken
- Mass production just beginning
 - Automation prevalent
 - Relatively huge volumes
- Increased concern about upsets, exposure beyond immediate application/manufacturing site
- Larger potential volume of wastes to handle



Gateway to the Environment

- Employees needed in diverse work areas
 - Manufacturing
 - Transport
 - Application
 - Take-home exposures
 - Emissions
 - Waste streams
 - Product streams

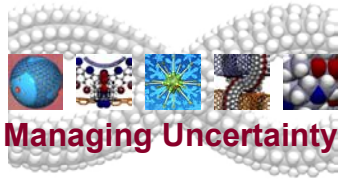
- Specific exposure and health issues will differ



Back to Key Questions

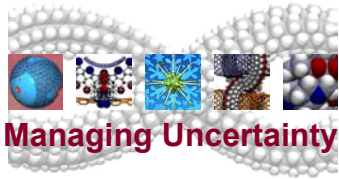
- What do we know (too little)
- Why?

- Scientific bases of toxicology, epidemiology (exposure assessment and risk evaluation) lagging behind
 - Inherently slower
 - Long-term effects subject to long latency periods
- Meanwhile, pragmatic approaches needed
 - Production could outpace protections
 - Not all materials will be problematic



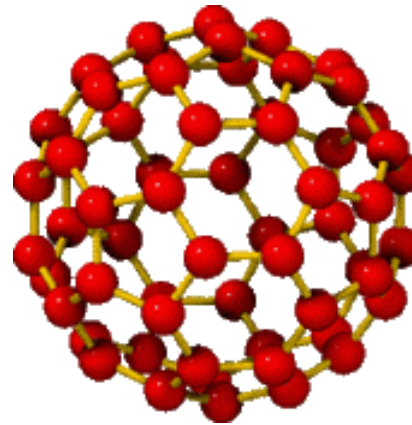
Practical Approaches to Managing Uncertainty

- Prioritization of issues
- Identifying pragmatic approaches
 - Classifying substances
 - Performance-based controls
 - Adaptations of existing successful approaches
 - Potent compounds model (pharma, biotech, microbiological)
 - Not all substances of equal concern
 - Unclear which are priority materials
 - Understanding is evolving
- Ability to be proactive vs. reactive
- Exposure reduction, control

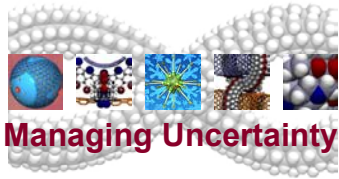


Pragmatic approaches

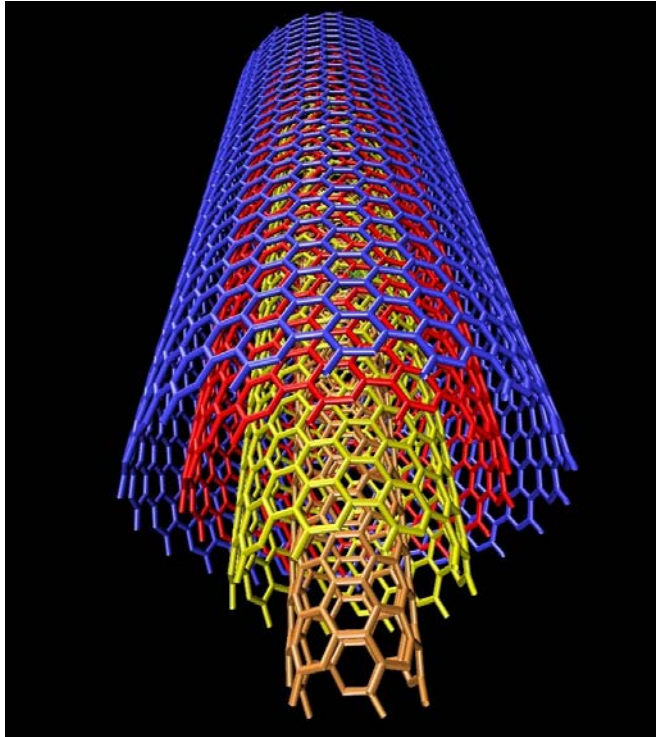
- Engineering control of exposure
- PPE and employee training
- Exposure monitoring
- Health surveillance



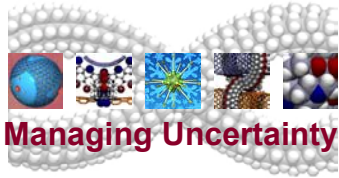
- Willing to adjust or pull the plug if necessary



Scientific Base



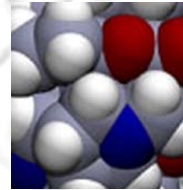
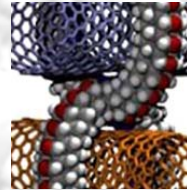
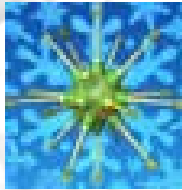
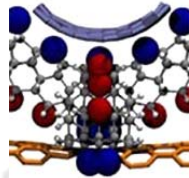
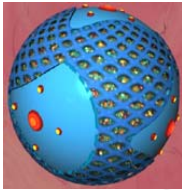
- Scientific foundation must be built in parallel to interim workplace measures
- Societal obligation to generate and publish scientific findings
- Necessary to support policy formulation



Conclusions

- Limited available science should not deter development of effective safeguards
 - Build on existing models
 - Err conservatively
- Multidisciplinary approaches preferred
- Objective communication of both risks and safety critical in an environment susceptible to sensationalism
 - Substantiated through science and practice
 - Not limited to scientific community

Thank You



Managing Uncertainty