Center
for the
Environmental Implications
of
NanoTechnology

CEINT

PIs: Mark Wiesner (Duke),
Greg Lowry (CMU), Kim Jones (Howard),
Mike Hochella (VA Tech), Rich Di Giulio
(Duke)

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EPA United States Environmental Protection Agency

Cooperative Agreement
EF-0830093

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NC STATE UNIVERSITY

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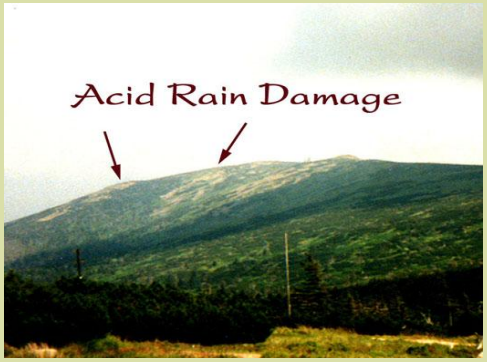
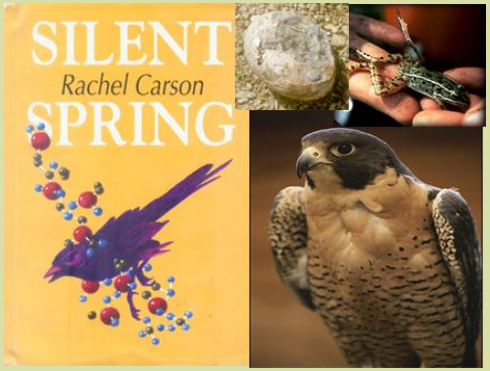
The Opportunity

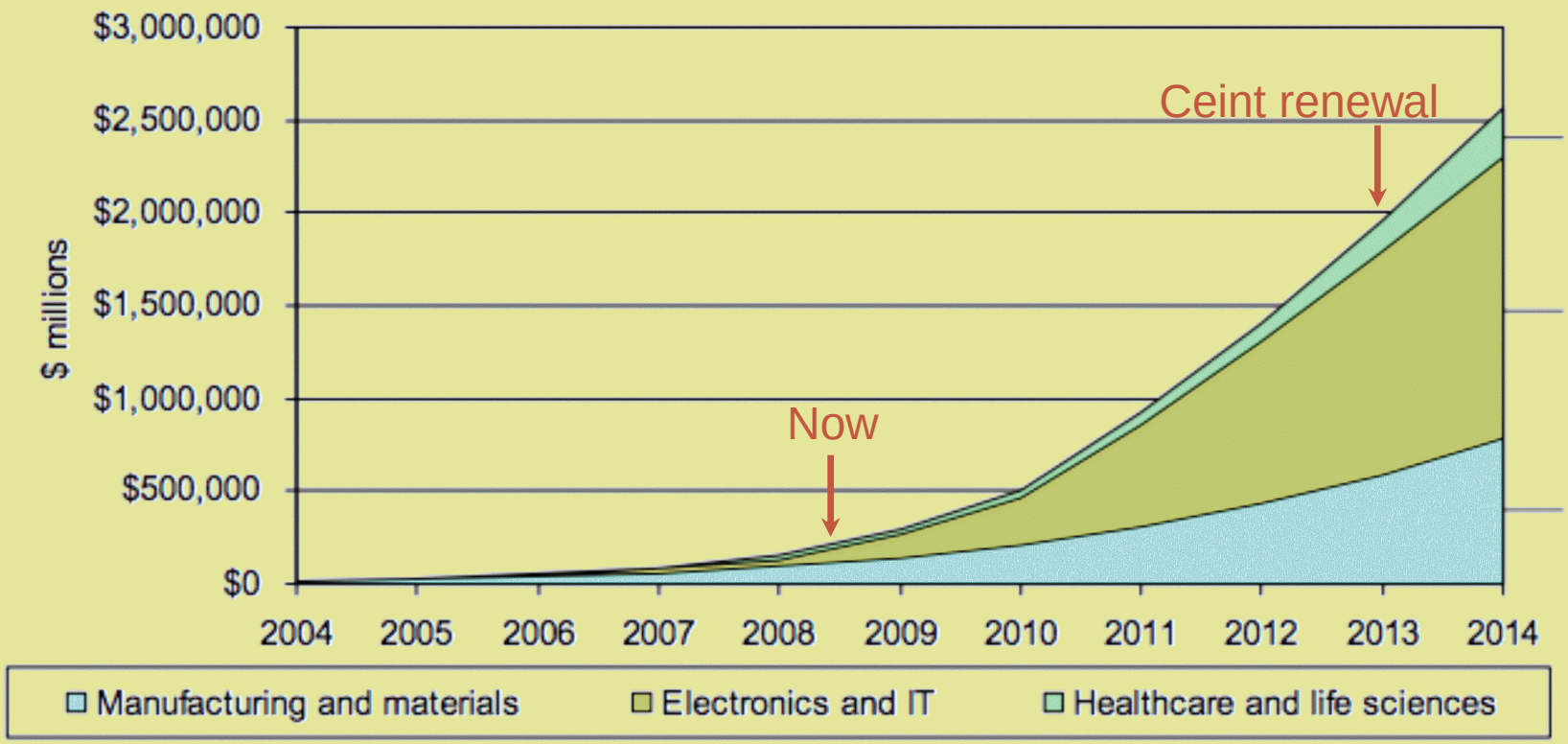
Ensure that nanotechnology evolves as a tool for sustainability





The Challenge

Which future do we prepare for?



Source: October 2004 Lux Research Report "Sizing Nanotechnology's Value Chain"

* Nanointermediates and nano-enabled products only; nanomaterials cannot be meaningfully broken down by sector.

Vision for CEINT

1. Elucidate general principles that determine nanomaterial behavior in the environment

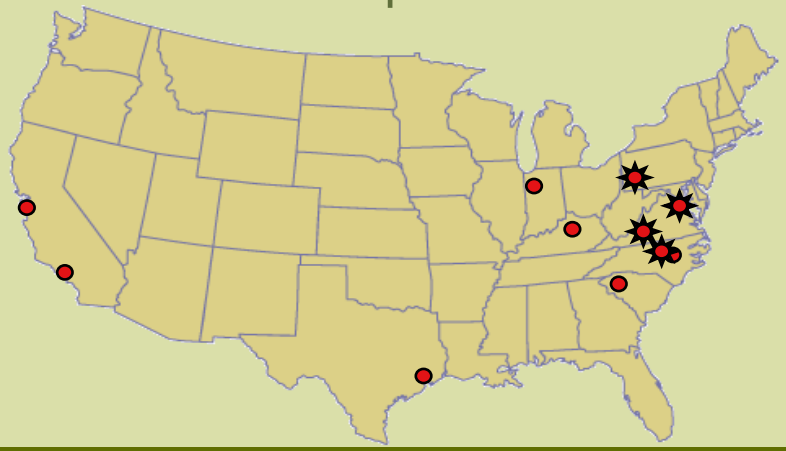
2. Translate this knowledge into the language of risk assessment

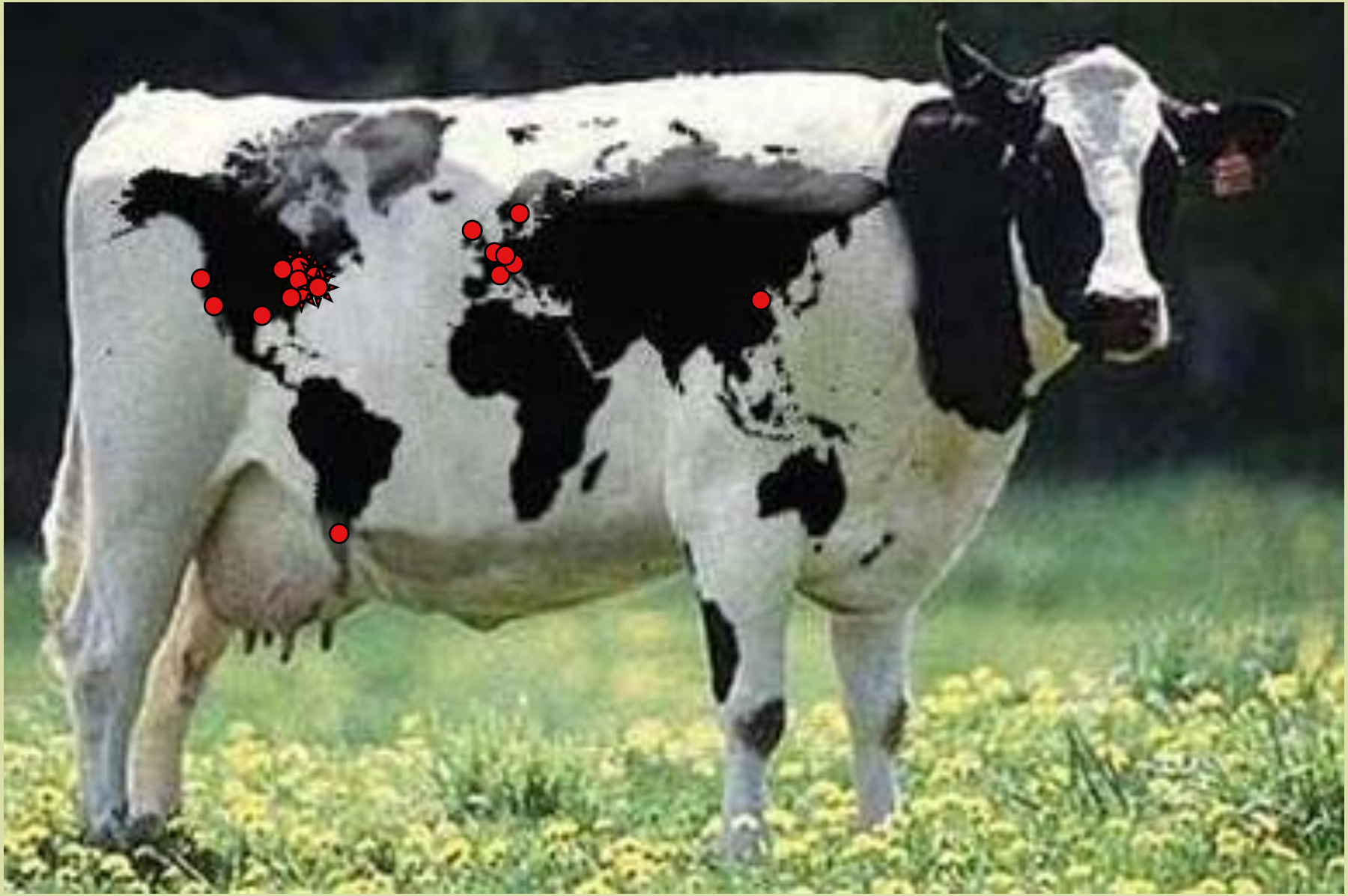
3. Provide guidance in assessing existing and future concerns surrounding the environmental implications of nanomaterials.

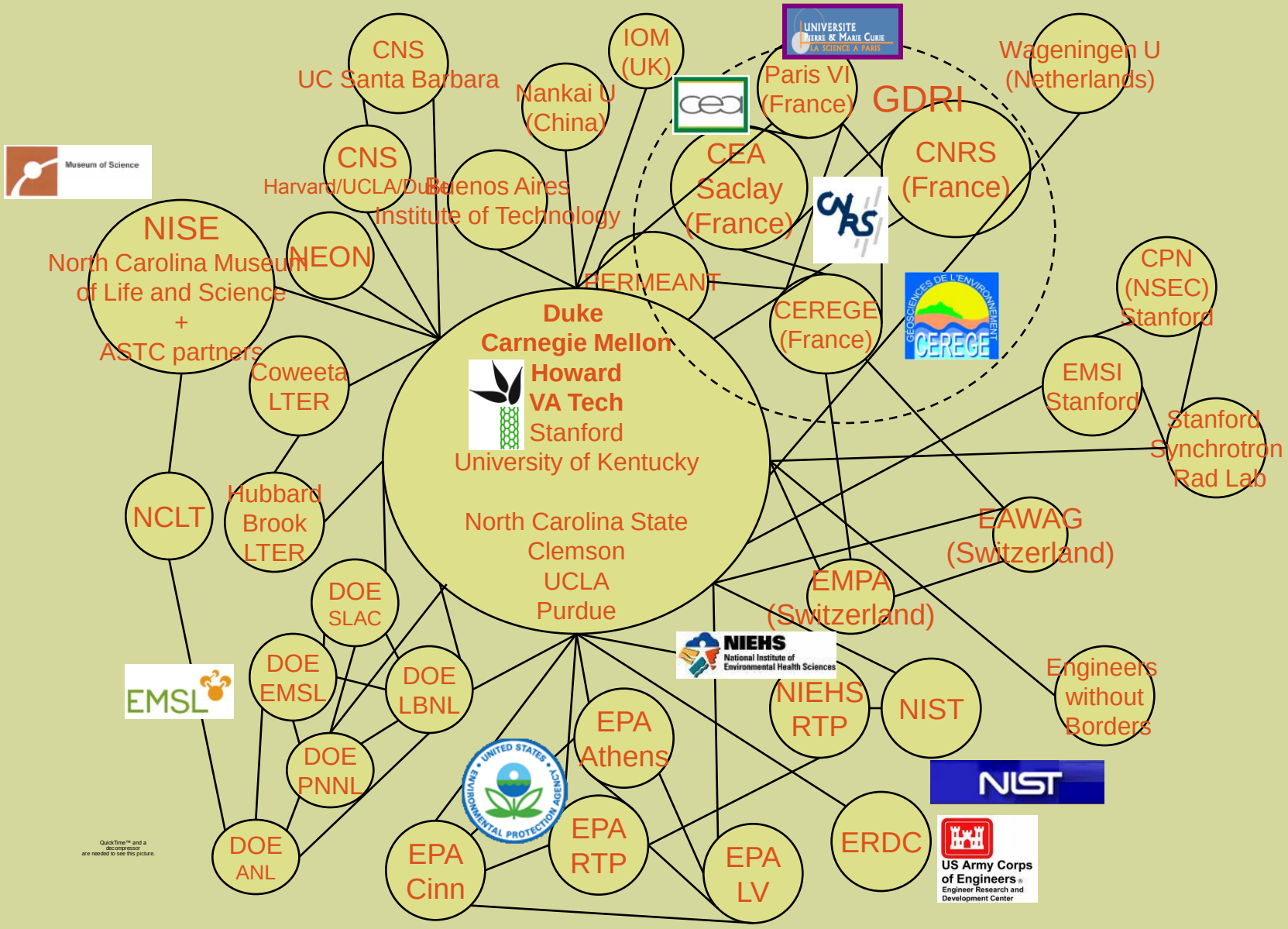
4. Educate next generation of scientists and engineers

CEINT by Numbers

- 4 Core Institutions: Duke, CMU, Howard, Va Tech
- 2 Additional Universities with single participants: U Kentucky, Stanford
- 4 currently un-funded US academic collaborations
- $14.4 M from NSF + EPA (57% of proposed budget)
- 5-years, renewable
- 25 faculty currently supported
- Collaborators from 5 US government entities
- Over 17 International partners on 3 continents- GDRI






Duke
Carnegie Mellon
Howard
VA Tech
Stanford
University of Kentucky
North Carolina State
Clemson
UCLA
Purdue
CNS
UC Santa Barbara
CNS
Harvard/UCLA/Duke
Buenos Aires
Institute of Technology
Nankai U
(China)
IOM
(UK)
Paris VI
(France)
GDRI
Wageningen U
(Netherlands)
CEA
Saclay
(France)
CNRS
(France)
HERMEANT
CEREGE
(France)
CPN
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Stanford
EMSI
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Synchrotron
Rad Lab
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(Switzerland)
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North Carolina Museum
of Life and Science
+
ASTC partners
Museum of Science
EMSL
NIEHS
National Institute of
Environmental Health Sciences
NIST
US Army Corps
of Engineers
Engineer Research and
Development Center
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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are needed to see this picture.

Learning Communities

Laboratory Rotations and Faculty Visits

partner institutions

government laboratories

International partners (Europe, Asia, South America)

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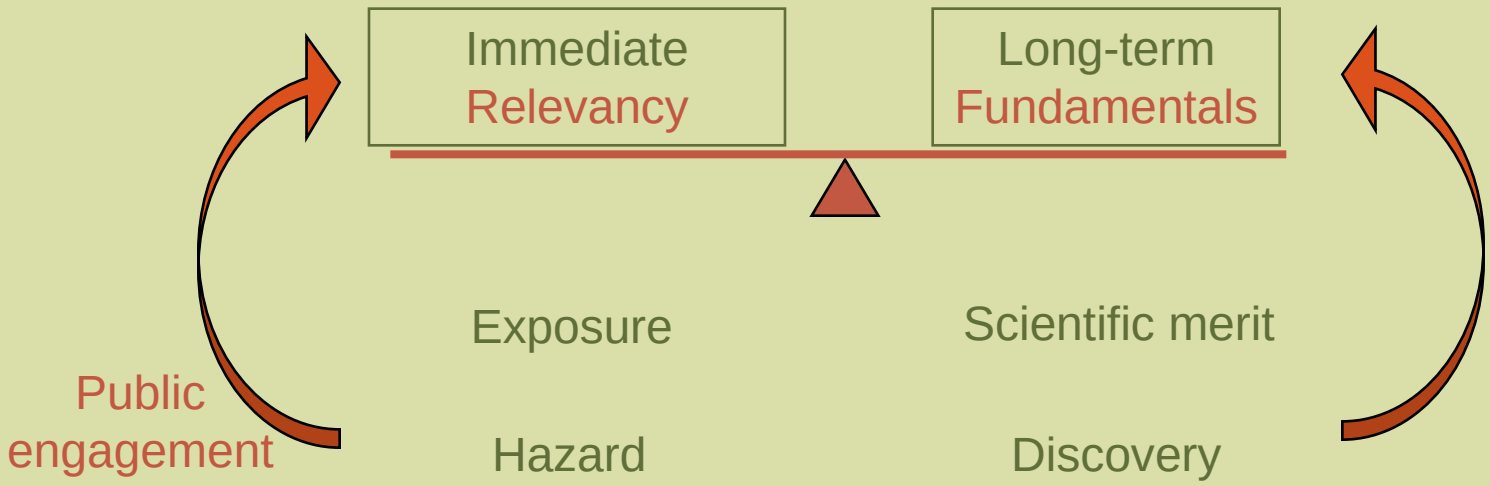
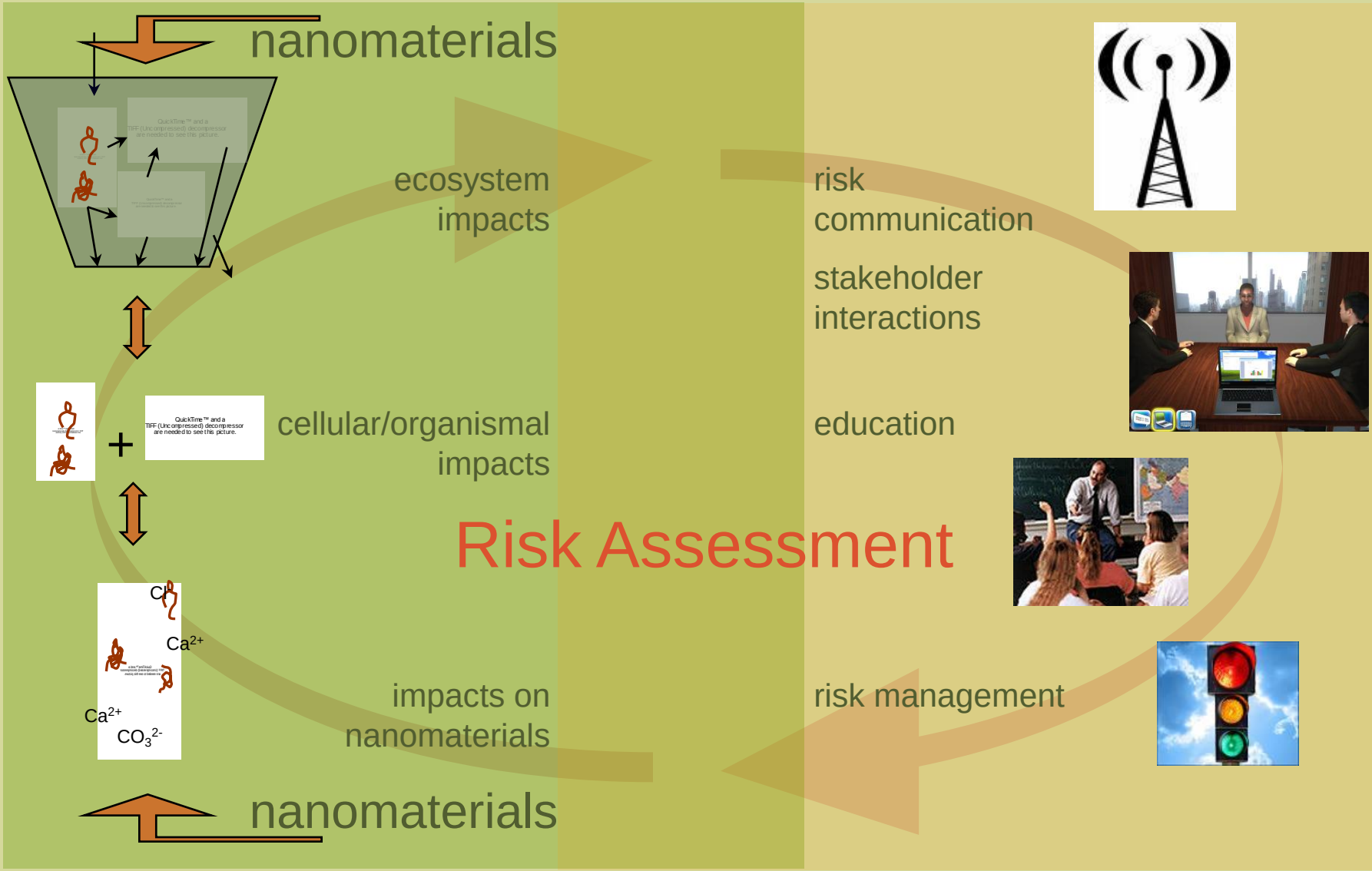
Balancing Center Impact



Conceptual Framework

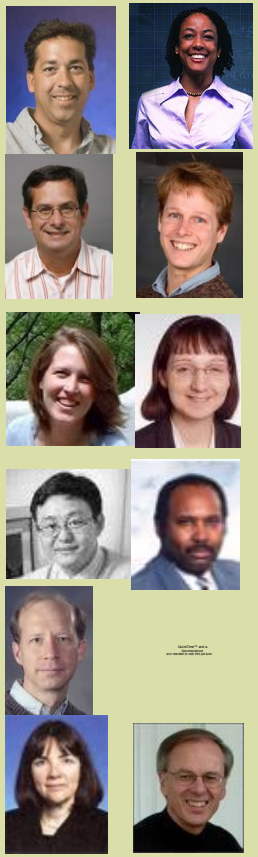


Key areas of strength in CEINT

- Environmental biology
- Ecotoxicology
- Nanomaterial transport & transformation
- Nano-Biogeochemistry
- Nanochemistry
- Risk assessment and societal impact
- Atmospheric particles
- Ability to interface with human health work

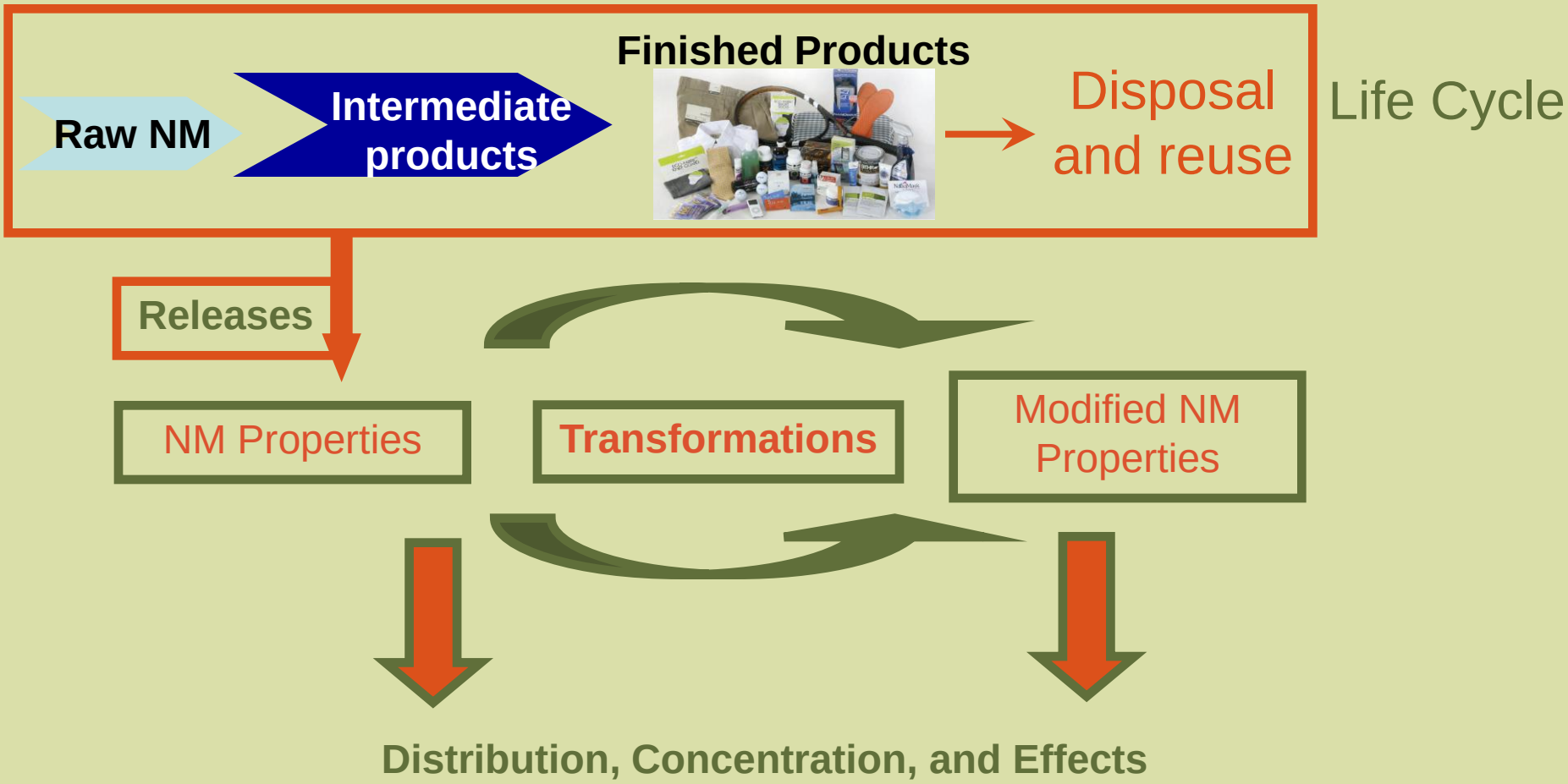
CEINT Research Thrusts

- Theme 1: Exposure, transport and fate
- Theme 2: Cellular/ organismal responses
- Theme 3: Ecosystem responses
- Core A: Manufactured nanomaterials
- Core B: Natural and incidental nanomaterials
- Core C: Modeling, Risk Assessment and Societal Impacts



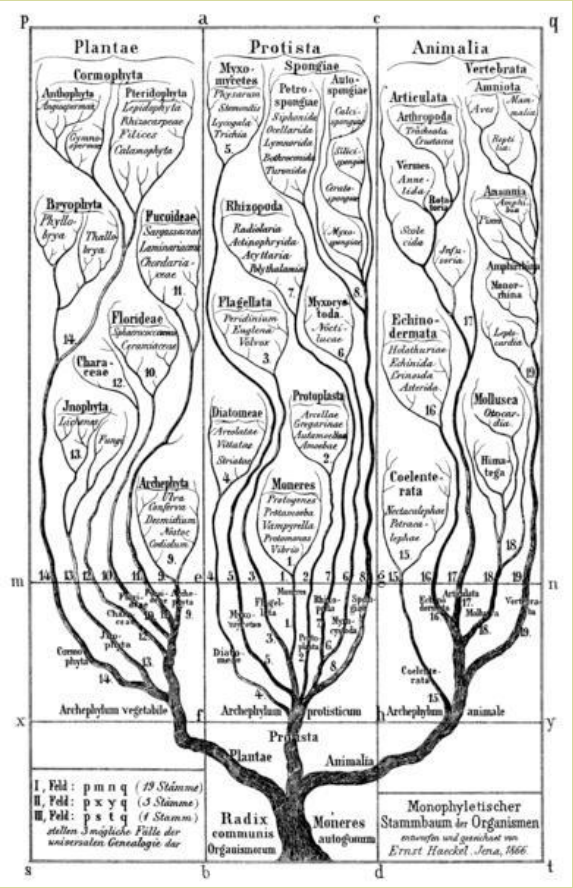
Theme 1: Exposure, Transport and Fate of Nanoparticles

- **Predict NM behavior from first principles**



Theme 2: Cellular and organismal responses

- Drivers of organismal uptake
- Impacts on organisms
- Mechanisms of toxicity
- Population-level effects
- Generational/ evolutionary impacts

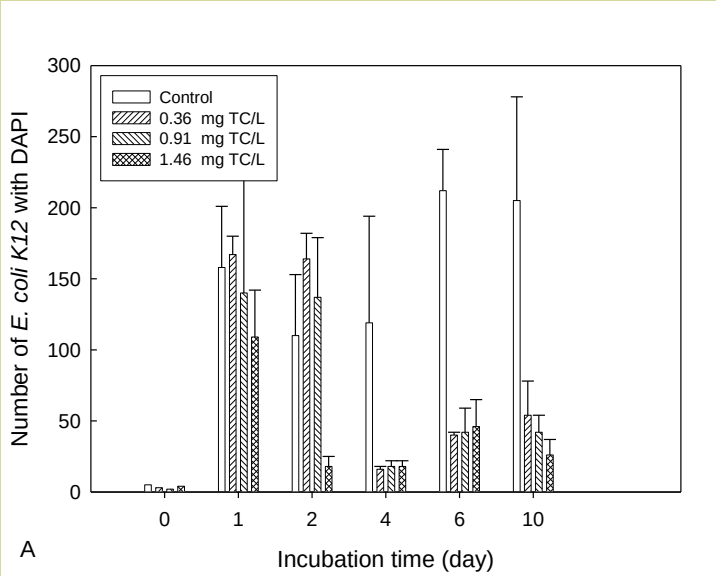


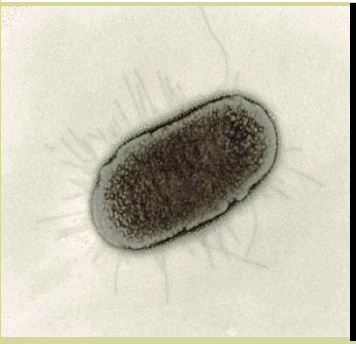
Theme 3

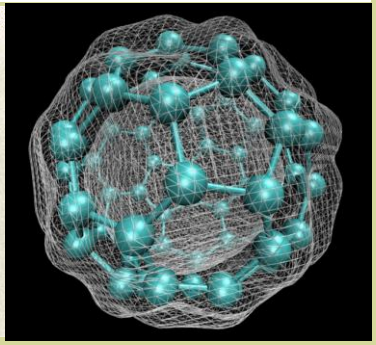
Ecosystem Impacts

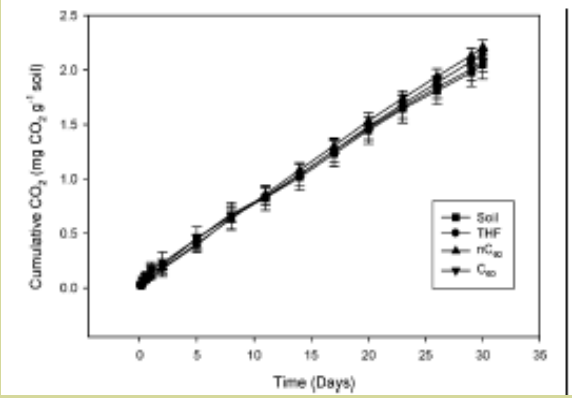
Ultimate Goal:

Predicting Ecosystem Impacts

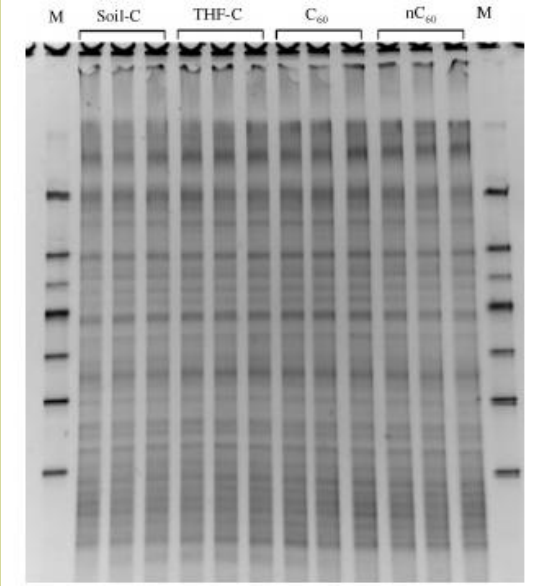








No Δ fxn

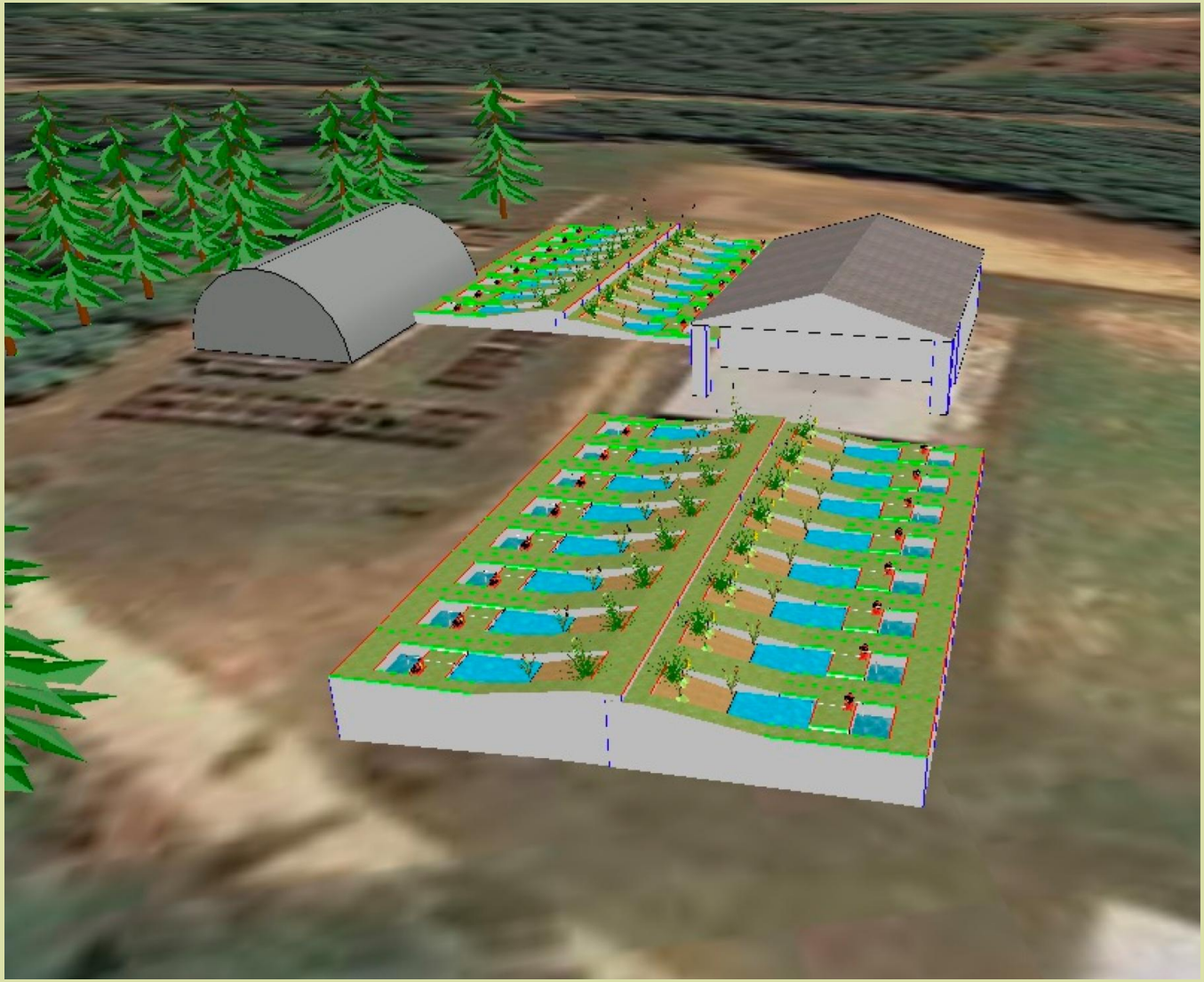


No Δ community

Pure culture – Chae et al. In prep

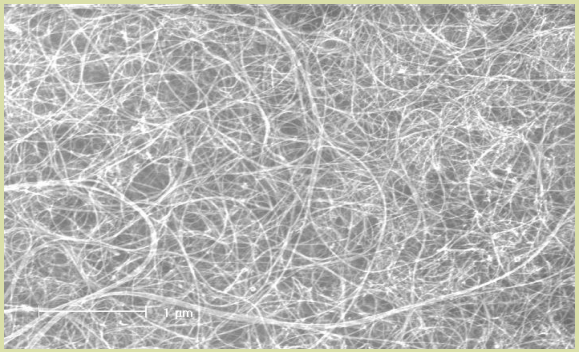
Real World – Tong et al. 2007 ES&T

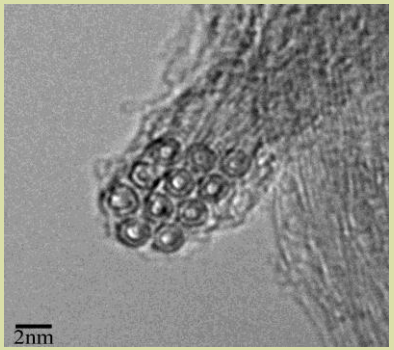
Mesocosms



Core A: **Synthesis and Fabrication**

Goal: Control of composition, shape, and size





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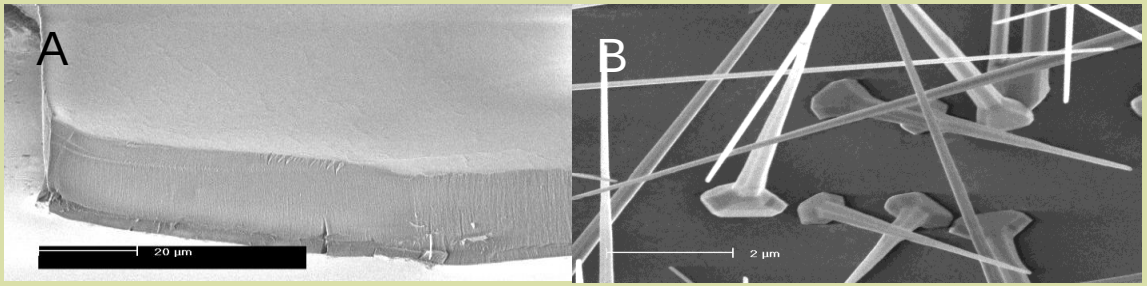
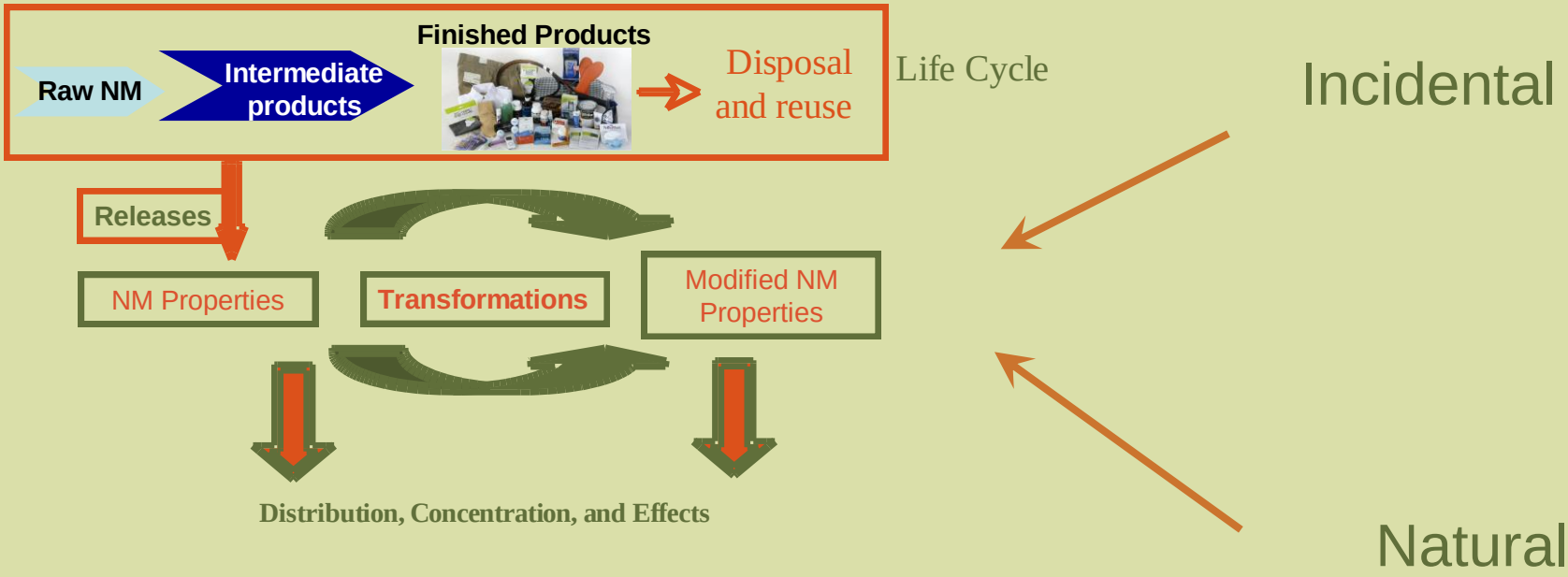


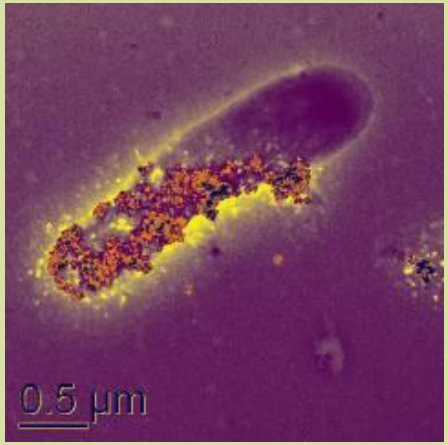
A: SEM image of aligned TiO_2 nanowires B: SEM image of ZnO nano nails (Liu, Duke University)

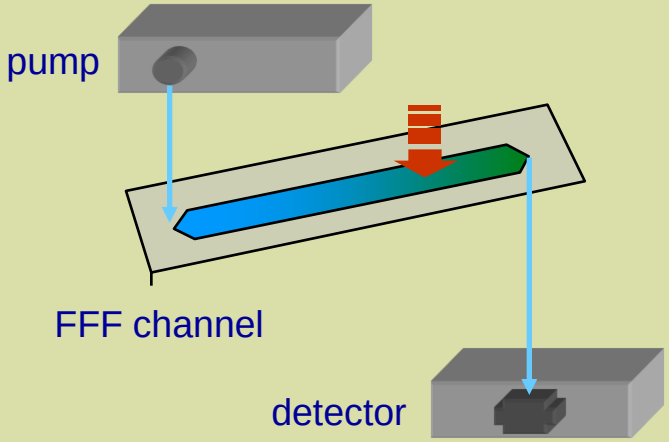
Core B: Natural and Incidental Nanoparticles



Core B: Natural and Incidental Nanoparticles

- Determine sources and characteristics of natural and incidental NP's in the environment
- Identify ways to distinguish between natural, incidental, and manufactured nanomaterials
- Develop and refine methods for measuring NP's in the environment

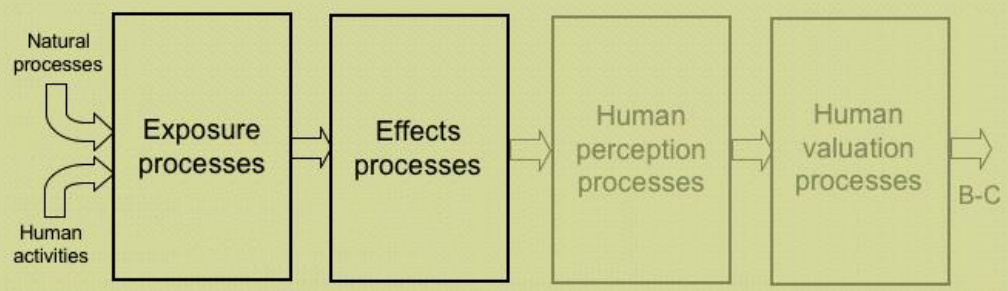




Core C: Risk Assessment, Modeling, and Societal Impacts

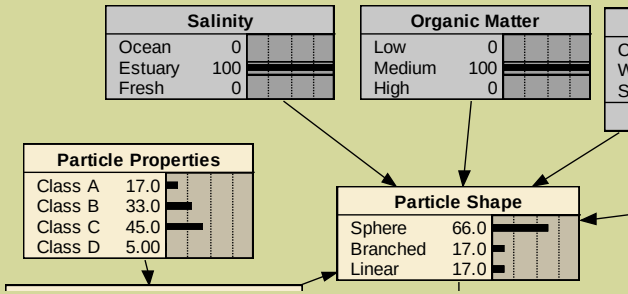
How does one deal with the pervasive high levels of uncertainty?

Conventional risk assessment

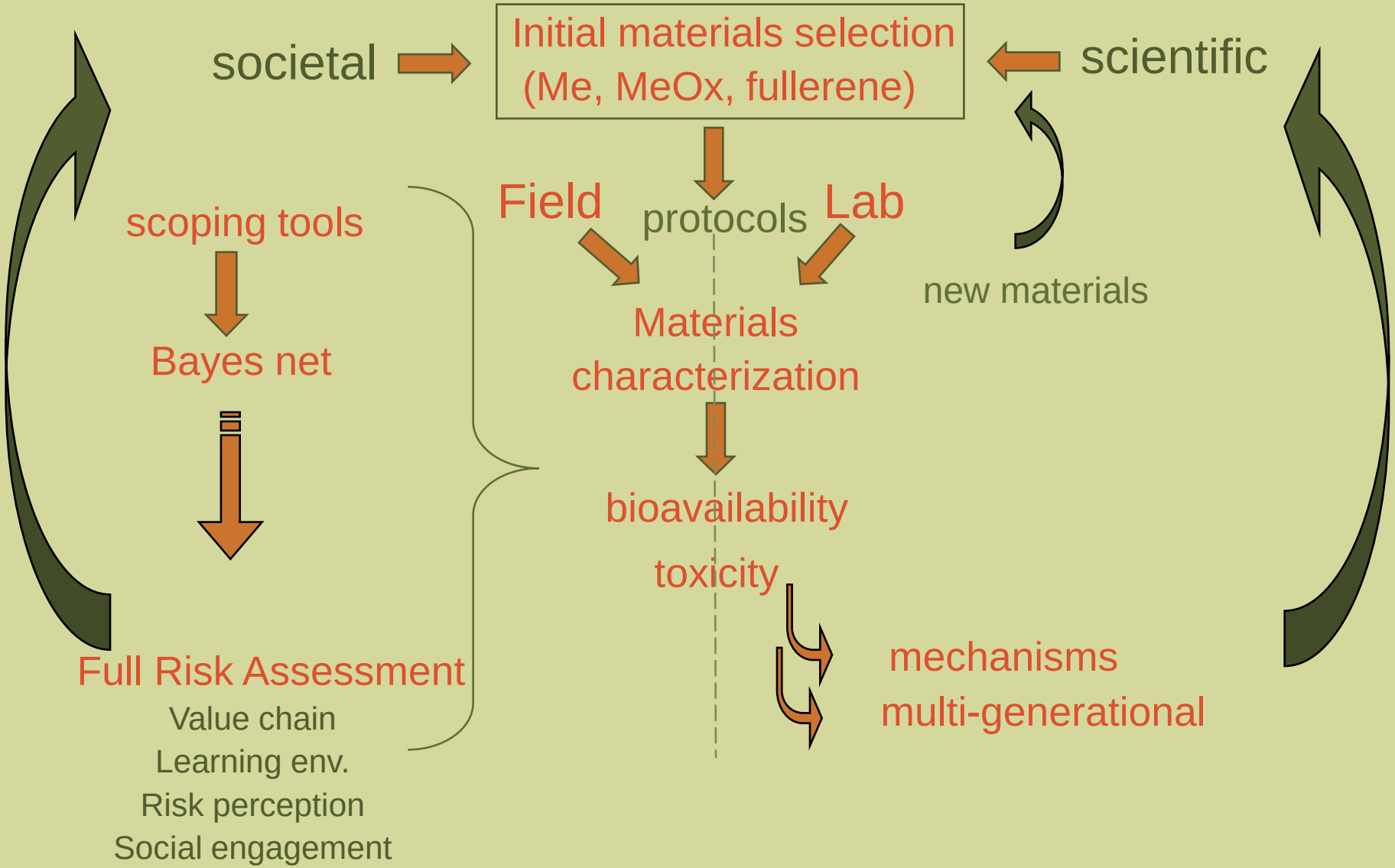


…other methods become necessary as uncertainty increases:

- Bayesian belief nets
- Multiple-model work demonstrated in the health domain.



Activities (as Proposed)



Collaboration with our sister center: UC CEIN

- Protocol development
- Nanomaterials
- CEINs annual conference (first to be held mid Sept 2009, Washington DC)

Thank You

CEINT

www.ceint.duke.edu