

# Nanotechnology



# and

# Society



**Charles Tahan**

*Physics Department*

*University of Wisconsin-Madison*

*APS March Meeting, March 22, 2005*

# The People

*NUE: An Integrated Approach to Teaching Nanotechnology and Society*

CT  
Physics

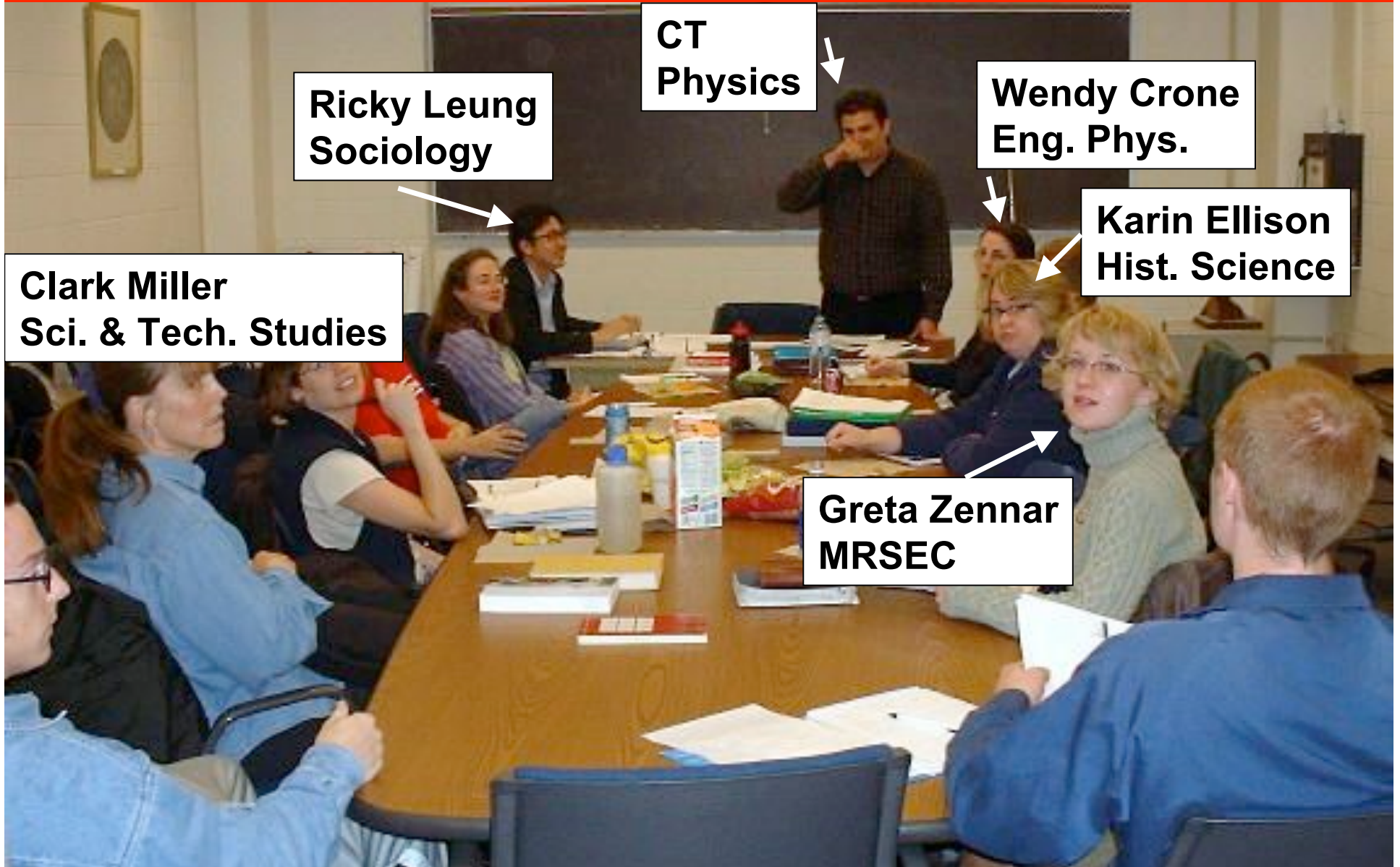
Ricky Leung  
Sociology

Wendy Crone  
Eng. Phys.

Karin Ellison  
Hist. Science

Clark Miller  
Sci. & Tech. Studies

Greta Zennar  
MRSEC

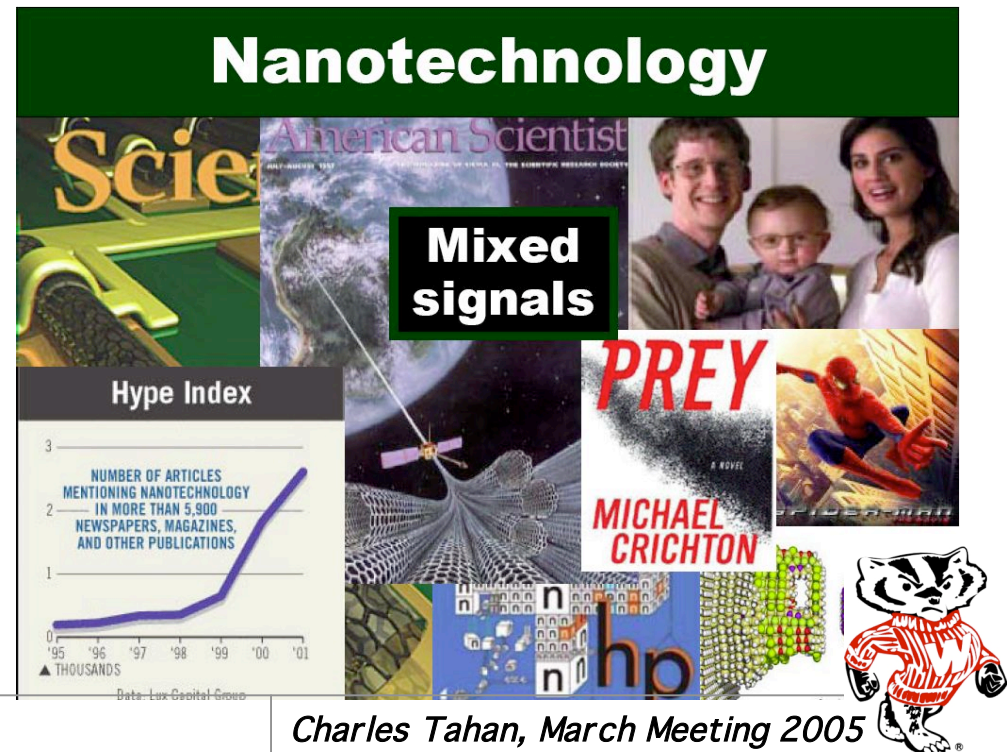


# Background

- Societal Implications of Nanotechnology
- Proposal for Nano & Society teaching at UW
- Undergraduate Course (Spring '05) *“Nanotechnology and Society”*
  - Sci. and Tech. Studies 201, 2 sections, 3 credits
  - 2 Graduate students: Ricky Leung (Sociology) and CT (Physics)

*“The National Nanotechnology Initiative sets aside \$80 million out of \$774 million for **education and societal implications** (\$30m), and environmental studies (\$50m) in 2003.”*

- M. C. Roco, NSF



# Preparation for Class This Spring

- Graduate Seminar last fall
- Introduction to materials - sociological texts/ nanotech readings
- “Clash of civilizations”
- Led by graduate students
- Chance to test active learning/discussion techniques



## Examples:

- Think-Pair-Share
- Jigsaw
- Town-meeting format
- Group discussion
- Black-board exercises
- ...

(Organized by G. Zenner,  
W.Crone, C. Miller, K. Ellison)



# My class

**STS 201:**  
Nanotechnology and  
Society, and Freshman  
(and Sophomores, and  
Juniors, and ...).

Freshman (4)  
Sophomores (11)  
Juniors (4)  
Seniors (4)

**Mixed class.**

Atmospheric & Oceanic Sciences  
Biology Undecided  
Biochemistry (4)  
Botany  
Business/Marketing (2)  
Chemical Engineering  
Communicative Disorders  
Computer Science/Eng. (5)  
Legal Studies  
Mathematics  
Nuclear Engineering (2)  
Pharmacy  
Zoology



# Pre-assessment

## PRE ASSESSMENT

### STS 201: Nanotechnology and Society

#### Section 84405

Please rate your comfort level with the following topics.

Very Comfortable      Comfortable      Slightly Comfortable      Not Comfortable

1. The science of nanotechnology.	<input type="checkbox"/> 0%	<input type="checkbox"/> 17%	<input type="checkbox"/> 48%	<input type="checkbox"/> 35%
2. Any science or engineering field.	<input type="checkbox"/> 36%	<input type="checkbox"/> 36%	<input type="checkbox"/> 28%	<input type="checkbox"/> 0%
3. Science and society issues.	<input type="checkbox"/> 21%	<input type="checkbox"/> 42%	<input type="checkbox"/> 33%	<input type="checkbox"/> 1%
4. Nanotechnology and society.	<input type="checkbox"/> 0%	<input type="checkbox"/> 22%	<input type="checkbox"/> 43%	<input type="checkbox"/> 35%



# Pre-assessment

***Where did you first hear the term nanotechnology?***

- |                     |                       |
|---------------------|-----------------------|
| 1. News/Internet/TV | 5. Sister's boyfriend |
| 2. This class       | Bill Clinton          |
| 3. Science fiction  | Feynman               |
| 4. Pop-sci          | A video game          |

***Define nanotechnology.***

- Study/tech of small particles/minute/very, very small tech (6)
- Study/design/manufacturing of products/objects at nanoscale (5)
- "...to make our lives easier/better/improve society" (4)
- Technology involving microscopic particles
- "minute scale"
- Technology on nanometer scale
- Modification and altering of nanoparticles or atoms (1)
- Larger than a single atom and smaller than a living cell (1)
- $10^{-9}$  meters (1)



# Pre-assessment

***Give three examples of nanotechnology applications.***

Really, Really Fast Computers/chips (7)

Carbon nanotube particles

Water resistant fabrics

Stain free pants (3)

Fiber Optics

Biotech (2)

Quantum Dots (2)

CPU lithography

Microchips

LCD screens

Stained glass (8)

Medicine/Medical things (4)

Surgery

Robotics

Synthetic diamonds

Nanobots (2)

Sensors and data acquisition

Agriculture (2)

Military

Sensors

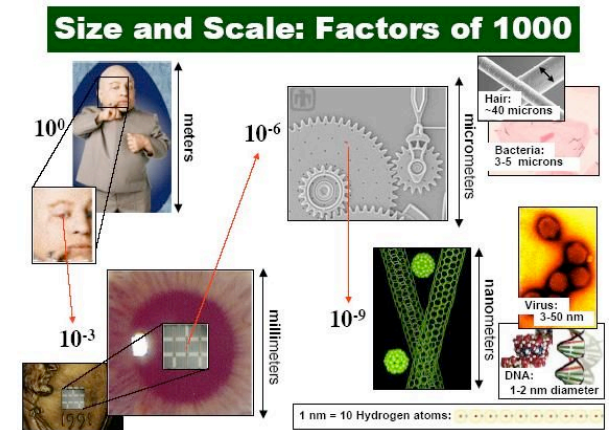




# Curriculum

## TEXTS:

- **Hand-made course reader** (sociological, science and technology studies, history of science, science policy, nanotechnology reviews)
- **Understanding Nanotechnology** (SciAm Press)



## Syllabus

1. Introduction to Nanotechnology and Society
2. Topics in Nanoscience
3. Nanotech in Culture
4. Revolutions and the History of Science and Technology
5. Technology and Society
6. *How Government Drives Technology*
7. Weighing the Risks
8. Policy Reports and Reviews
9. Thinking about the Future

## Congressional Mock

### Hearings/Town Hall Meetings

1. Nanotech Funding: Should the government continue funding of nanotechnology research?
2. Public Participation: Should the public have an active role in the evolution of nanotechnology? How?

## Research Project and Presentations

1. Summary report on a key nanotechnology, it's applications, and it's implications.
2. 25 students, 25 technologies.
3. Result: Pamphlet on Nanotechnologies for the lay person.

# Nanotech Example


## Quantum dot nanocrystals

- Bulk-“Nano” transition
- Optical properties: bandgap, photons
- Atom-like properties
- Bands become energy levels
- “Cool or Hot, Quantum or Not”

**Mighty Small Dots**

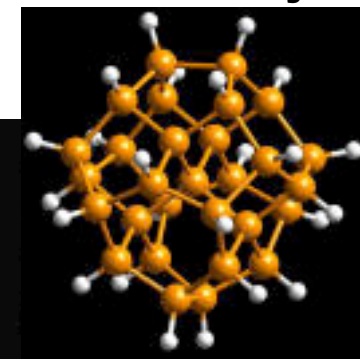
*... nanoscience and nanotechnology will change the nature of almost every human-made object in the next century.*

*—The Interagency Working Group on Nanotechnology, January 1999*



Howard Lee and his colleagues have synthesized silicon and germanium quantum dots ranging in size from 1 to 6 nanometers. The larger dots emit in the red end of the spectrum; the smallest dots emit blue or ultraviolet.

**Silicon nanocrystal**



# Nano+Society Example

## 6. How Government Drives Technology: **Military and Tech**

### *Reading:*

(Policy) **M. C. Roco**, *The US National Nanotechnology Initiative After 3 Years*, **Journal of Nanoparticle Research**, 6: 1-10, (2001-2003)

(Society/STS) **David Noble**, *Command Performance: A Perspective on Military Enterprise and Technological Change*, in **Military Enterprise and Technological Change** (Cambridge: MIT Press 1987).  
• **Performance, Command, Modern Methods**

(News) **D. Talbot**, *Super Soldiers*, in **MIT Tech Review** Oct 2002, 105(8): 44-50.

(Science) **Video: Institute for Soldier Nanotechnologies**

### *Working through it:*

Debates, Town Hall Meeting, Discussion, Essay

[Rumsfeld vs. Langdon Winner](#)

Charles Tahan, March Meeting 2005



# Research Projects

“Centers  
of  
Knowledge”

Professional article for a lay audience: science/societal implications.

(Matt) Nanofab/Manufacturing  
Nanofab: Inkjets/Dip Pen/AFM (Adam)  
(Racheal) Nanoscopes (STM/AFM) (Mike)  
NEMS

(Sweeney) Nanoparticles and Drug Delivery  
Cancer and Nanotechnology (Nicole)  
(Justin) Nanotech at UW Hospital (?) (Kaizan)  
Diagnostics/Lab on a chip

(Lynn) Many Faces of Carbon  
Carbon Fullerenes (Buckyballs) (Lianne)  
(Adam) Carbon Nanotubes (mechanical properties)

(Mark) Nuclear Nanobatteries (Mike)  
Solar Energy and Nano  
Nanomaterials (QDs in substrates) (Aaron)  
(Brent) Nanoelectronics

(Troy) Nanocrystals as QDs/Medical Imaging (Dong)  
(Adam) QDs on the Body  
Nanobiotechnology

Nanoparticles and nanocrystals: Synthesis and Toxicity  
Nanofiltration/ Sorting/ Water Desalinization  
Nanotech and Agriculture  
Nanocrystals as Catalysts

# Output

- Research Reports
  1. **Summary report on a key nanotechnology, it's applications, and it's implications.**
  2. **25 students, 25 technologies.**
  3. **Result: Pamphlet on Nanotechnologies for the lay person.**
- Curriculum materials / Course portfolio
- Did it work? (assessment)
  - T - 1 month to go
  - Write something up.

**Wisconsin Initiative on  
Nanotechnology and Society**

<http://www.lafollette.wisc.edu/research/Nano/>

<http://tahan.com/charlie/>

