



## Teacher's Guide

Copyright©2006 Center for Workforce Development, University of Washington

Page 1 of 6

# *Social and Ethical Issues in Nanoscience and Nanotechnologies*

### **Purpose**

- Introduce students to social and ethical issues (SEI) in nanoscience and nanotechnologies.
- Demonstrate SEI through case studies using popular films, books, or news stories.
- Stimulate discussion about SEI.

### **Level**

High School

### **Time required**

50-minutes

### **Advance Preparation**

#### Materials:

- Video from list of popular movies that incorporate some aspect of SEI in nanoscience/nanotechnologies (see suggestions below), or
- Excerpt from list of books (see suggestions below), or
- News article featuring NS/NT (see suggestions below)
- Accompanying presentation

Teacher will choose clips or excerpts appropriate to the class level that will serve as a spring-board for class discussion about social and ethical aspects of emerging technologies.

## Teacher's Guide

Page 2 of 6

### Teaching Strategies

1. Introduce topic by showing accompanying presentation
2. Watch clip of movie, read selection from book or read news article
3. Hand out discussion questions
4. Break into small group to discuss
5. Reconvene and discuss with entire class

General Nanotechnology and SEI Background (the following information is provided on accompanying slides):

#### *What is Nanotechnology?*

'Nano', from the Greek word for 'dwarf', is a prefix that refers to scale. In the same way that we use 'centimeter' to mean a hundredth of a meter ( $10^{-2}$ ), and 'millimeter' to mean a thousandth of a meter ( $10^{-3}$ ), a **nanometer** (nm) is a billionth of a meter ( $10^{-9}$ ). The diameter of a human hair, for example, is some 80,000nm. At the nanoscale, considered to be between 1nm-100nm, unique physical properties control behavior. Nanotechnology seeks to understand these properties, and to apply them in new materials, devices and systems.

#### *Importance of Nanotechnology*

Nanotechnology works at the scale of the basic building blocks of life - a strand of DNA is about 1nm wide, for instance. In contrast, a human red blood cell is 7 microns, or 7000nm, in diameter. At the nanoscale, boundaries between classical disciplines (physics, chemistry, biology, materials science) break down, and innovations can have unprecedented broad impact. Applications range from environmental remediation, to novel materials, to medical technology and beyond. If the development of nanotechnology is combined with advances in biotechnology, information technology, and cognitive science, these converging technologies have the potential to create transformative change on all aspects of society.

#### *What are Social and Ethical Issues in Nanotechnology?*

Science and technology do not occur in a vacuum but are shaped and utilized by social forces. Additionally, society is impacted by science and technology in ways that are difficult, if not impossible, to predict beforehand. Examples of social issues include societal changes such as workforce needs, human longevity and capability, ways of interacting with one another, and so on. Ethical issues include questions about a society's values and sense of right and wrong. For example, is it ethical for an insurance company to deny insurance to someone on the basis of having a genetic predisposition for a disease? Nanoscience and nanotechnology pose a host of social and ethical issues that will have to be addressed by society. Some of these issues include:

## Teacher's Guide

Page 3 of 6

**Privacy**—Developments in nanotechnology will likely contribute to more surveillance activity in society, e.g., smaller, hidden cameras in stores, cabs, restaurants, etc. What impact will this have on individual privacy? (Accompanying slides include examples of privacy issues raised by radio-frequency identification devices.)

**Military**—Nanotechnology may allow for the development of smaller, more portable, more lethal weapons. What implications does this possibility have for international security?

**Medical**—How might developments in nanobiomedical applications affect current standards of medical care? E.g., Since cutting-edge medical procedures are more expensive, these procedures may only be available to wealthier populations, insurance companies could refuse to cover the procedures, etc.

**Cultural**—How might nanotech change cultural practices? For example, the development of the cell phone had led to a cultural expectation (a norm) that everyone has a cell phone and carries it with them at all times. Is it possible (or desirable) to resist that type of cultural expectation?

**Economic**—What impact will developments in nanotech have on the workforce, both rendering some jobs obsolete and creating new types of jobs? What might the global impact of nanotechnologies be on the world economy?

### Discussion Questions

The below discussion questions are provided as examples of the kinds of questions that can be presented to students to discuss in small groups and as a class after viewing/reading the materials selected by the teacher. They are provided to stimulate discussion, and as such, do not include “right” and “wrong” answers. Similarly, some of the questions may not be applicable, depending on what type of media is selected for illustrating the social and ethical issues related to nanotechnologies. Feel free to add your own questions. A sample class discussion scenario follows.

1. Are any of the technologies shown/described/discussed in the movie/book/article currently available or do you think they will be available during your lifetime?
2. What, if any, social and ethical issues related to science and technology are raised in the movie/book/article?
3. Even though the portrayal is fictional, can the social and ethical issues portrayed apply to real life? If so, how?
4. Do you think scientists have a responsibility to consider social and ethical issues in their research? (See accompanying slide with questions for nano researchers to consider, obtained from <http://www.sei.nnin.org/intro.html>)
5. If not, whose responsibility is it to consider social and ethical issues related to science and technology?
6. Do you think science and technology favor a particular value system, cultural view, or ideological stance?

## Teacher's Guide

Page 4 of 6

7. What are some socially-accepted assumptions about science and technology? (e.g., scientific and technological advancement is always positive.)
8. What, if anything, can be gained by questioning these assumptions?

### Sample Scenario for Class Discussion after viewing clip from "Minority Report":

(The following discussion scenario refers to a clip from "Minority Report" in which Tom Cruise's character is running through a clothing store trying to escape apprehension for a crime he did not commit. However, the store sensors recognize him and greet him by name, asking him how he enjoyed his previous purchase and suggesting additional items, thus alerting his pursuers to his presence.)

Question: Are the sensor/identification technologies shown in the clip currently available or do you think they will be available during your lifetime? (E.g., facial recognition is currently under development and being discussed for use in airports.)

Question: What, if any, social and ethical issues related to science and technology are raised in this clip? (Lack of privacy, ubiquitous surveillance, etc.)

Question: Even though the portrayal is fictional, can the social and ethical issues portrayed apply to real life? If so, how? (The class should be able to come up with some examples of how privacy violations related to ubiquitous surveillance might affect them personally. For example, one group of students had experienced being videotaped at a concert without their knowledge and then having their parents find the video posted online.)

Question: Do you think scientists have a responsibility to consider social and ethical issues in their research? (Possible responses from students may include that scientists don't know how their research is going to be used, so how can they be held responsible for considering these issues? Others will say yes they do and the class might discuss how scientists could best incorporate these considerations into their research.)

Question: If not, whose responsibility is it to consider social and ethical issues related to science and technology? (Possible responses may include that policy makers, educators, scientists, social scientists, members of the public, students, etc. all have a role in ensuring that social and ethical issues related to science and technology are adequately addressed.)

Question: Do you think science and technology favor a particular value system, cultural view, or ideological stance? (It might be useful to ask the class to consider the Western origins of modern science and technology as well as the changing cultural values throughout history that have influenced funding, research direction, etc.)

## Teacher's Guide

Page 5 of 6

Question: What are some socially-accepted assumptions about science and technology? (e.g., scientific and technological advancements are always positive.)

Question: What, if anything, can be gained by questioning these assumptions? (Again, referencing the clip from “Minority Report,” class might discuss how scientific and technological advancements bring both unwanted consequences as well as conveniences.)

### Resources for teachers

Web sites:

<http://www.sei.nnin.org>

This site has information and resources on SEI for students and teachers. It is part of the National Nanotechnology Infrastructure Network.

<http://www.nano.gov>

This site gives information on the National Nanotechnology Initiative. There is a section for K-12 students and teacher resources.

<http://cns.asu.edu/>

Center for Nanotechnology in Society at Arizona State University

<http://www.cns.ucsb.edu>

Center for Nanotechnology in Society at University of California Santa Barbara

<http://www.nano-and-society.org>

Illinois Institute of Technology's Center on Nanotechnology & Society—site lists articles about nano in the news.

<http://nsts.nano.sc.edu/>

University of South Carolina: NanoScience and Technology Studies – Societal and Ethical Implications

<http://www.icta.org>

The International Center for Technology Assessment (CTA) website discusses many social and ethical issues related to emerging technologies.

Timely news articles about nanotech can be obtained through many of the above sites, particularly <http://www.nano-and-society.org/>, as well as a simple internet news search using the search term “nanotech” or “nano.” The CNS (<http://www.cns.ucsb.edu/>) offers a Weekly News Clips by email. Email Valerie Watson at [Valerie@cns.ucsb.edu](mailto:Valerie@cns.ucsb.edu) to subscribe.

## Teacher's Guide

Page 6 of 6

The below lists are provided as a resource for teachers to select examples of portrayals of social and ethical issues posed by nanotechnologies that are appropriate for their particular class. Please note that some of the material contained within the media sources listed below may not be suitable for the classroom. Hyperlinks have been provided linking reference to online information where available.

### Fiction

- David's Sling — Mark Steigler
- [Earth — David Brin](#)
- [Nano — John Robert Marlow](#)
- [Prey — Michael Crichton](#)
- Queen of Angels — Greg Bear
- The Gentle Seduction — Mark Steigler
- The Nanotech Chronicles — Michael Flynn

### Films

- [Face/Off \(1997\)](#)
- [Minority Report \(2002\)](#)
- [Godsend \(2004\)](#)
- [Resident Evil—Apocalypse \(2004\)](#)
- [Spiderman 2 \(2004\)](#)
- [SpyKids 3D—Game Over \(2003\)](#)
- [The 6<sup>th</sup> Day \(2000\)](#)
- [The Manchurian Candidate \(2004\)](#)
- [The Stepford Wives \(2004\)](#)
- [The Island \(2005\)](#)

### Television Series

- [Alias](#)
- [Star Trek](#)
- [Farscape](#)
- [Battlestar Galactica](#)