IPRO 341 – Midterm Report

March 9, 2006

Faculty Advisor
Prof. Janet Staker Woerner

Students
Ayo Ayodele
Saurabh Dass
Ankit Desai
Jason Frumkin
Jonathan Komyathy
Kevin Lerash
Jason Novak
Margaret Peterson
Bezaleel Robinson
Sagar Shah
George Skontos
Michael Stohl
Andrew Wilk
Sungwoo Yang

Introduction – What is Nanotechnology and how does it Work?

Nanotechnology was picked by IPRO 341 for a number of reasons. This is an emerging technology that has a number of rising benefits to many industries and also a rising number of potential risks and social implications that are fostering a lot of discussion in many communities around the globe. There are already a number of products on the market that are enhanced by the technology's potential and there is a rapidly growing amount of research and development entering in to the process of creating newer products.

Nano-particles have been around for a long time. As a matter of fact, a cup retrieved from the Roman Empire was found to appear green in regular light, and changed red when illuminated from the inside. This is due to nano-sized particles of gold and silver. However, researchers consider this to be an accident of the manufacturing process rather than some discovery way ahead of its time.

Thinking of the nano-scale began in 1957 – 1959 with Richard Feynman. He made a speech about thinking about particles at the nano-scale, and how much we could do with it. He is famous for saying we could store a whole encyclopedia worth of knowledge on the head of a pin. Cal Tech had the vision, but not the technology and they were reluctant to think out of the box or on a big scale.

Many years later in 1974, the word "nanotechnology" was first used by a man named Norio Taniguchi. He used the word to refer to "production technology to get the extra high accuracy and ultra fine dimensions". Also in the same year, two men by the names of Mark Ratner and A. Aviram of IBM proposed that individual molecules

may exhibit the behavior of basic electronic devices, allowing computers to be built from the ground up.

In 1980 researchers found that a chemical- thiol would spontaneously react with a gold surface to assemble in layers a few nanometers thick. This brought about the thinking that the possibility of building things from the ground up could actually be implemented in the future and could become a reality.

The Scanning Tunneling Microscope (STM) was invented in 1981. This microscope not only allowed nano-scale particles to be observed, but also to be controlled. It basically maps the tip of a point on an object, and a computer generates what is seen by the STM.

In 1985 the buckyball was discovered. This is a carbon nano-particle that is shaped like a soccer ball, and could survive collisions with objects at speeds of more than 20,000 miles per hour. This was a very useful discovery and paved the way for what can be accomplished with the help of nanotechnology.

In 1986 the Atomic Force Microscope (ATM) was invented. The technology maps the surface of an object much like a record player works. However, the tip of the needle of the ATM is only a few atoms wide. This allowed magnifications up to nearly 1,000,000 times. In this year, the Foresight institute also opened – an organization to provide education to the public and industries as to the benefits and risks of nanotechnology.

The next year, in 1987 two researchers proposed the idea of a single electron tunneling transistor (SET). Two years later, one would actually be made. The SET is not feasible to be used in current day electronics as the voltage variation from one

to another is too great. However, one day this could become the standard if this problem is ever overcome.

In 1989, researchers from IBM were able to manipulate atoms using the STM. They arranged individual xenon atoms on a surface to spell "IBM". This showed how accurate and precise scientists could be now with this emerging technology. 1991 marked the year that carbon nanotubes were discovered. These rolled up sheets of carbon are good semiconductors. They behave like metals, but conduct better than copper.

Zyvex, the first nanotech company was founded in 1997. Their goal was to be on the forefront of nano-manufacturing. In 1999 it was brought before congress that there should be a National Nanotech Initiative. By the year 2000 President Clinton announced the U.S. National Nanotech Initiative. In 2001, The U.S. opened the first center for military nanotech applications and research. In 2003, the social implications of nanotech were brought before congress.

Definition of Nano

- 1 nm = 1/1 000 000 000 m (10-9 m)
- Human hair is 50,000 nm in diameter
- The smallest object visible to humans is 10,000 nm
- 10 hydrogen atoms in line equals 1 nm

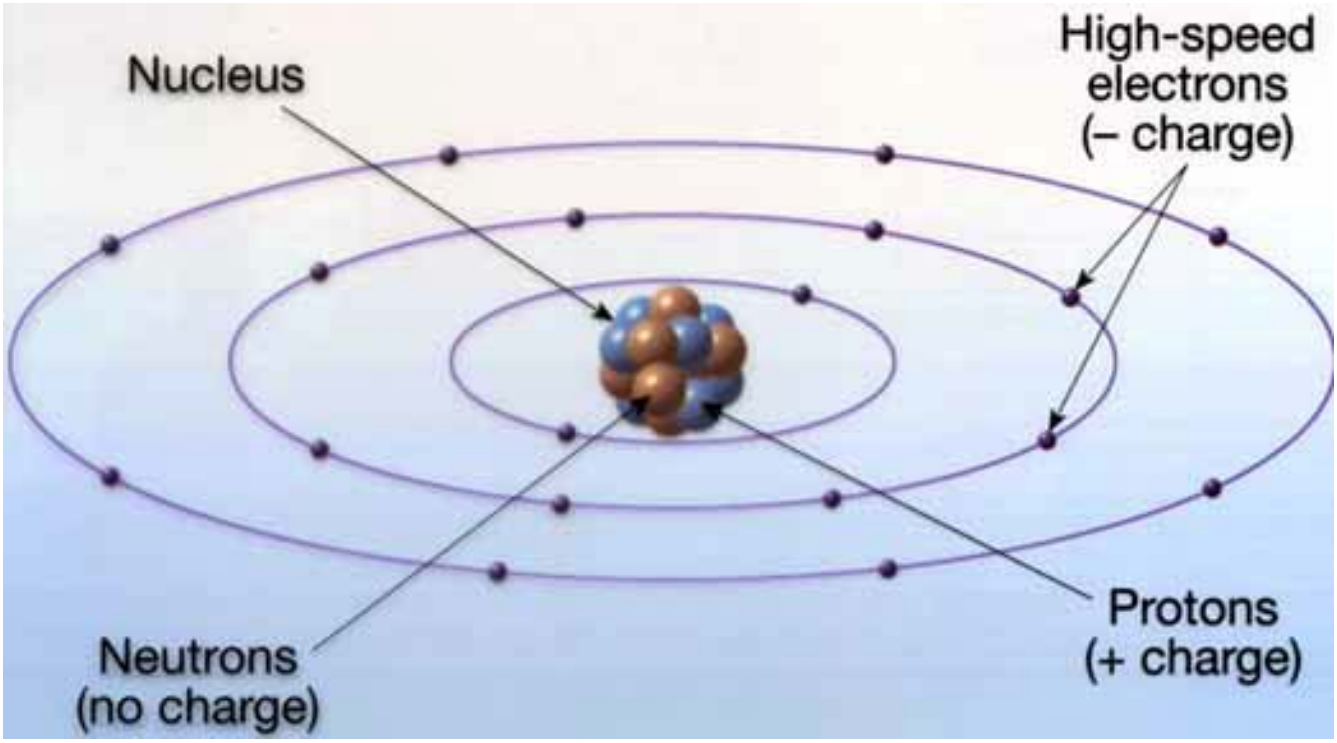
Definition of Nanotechnology

- Nanotechnology involves research and technology development at eh 1 nm-to-100nm range.
- Nanotechnology creates and uses structures that have novel properties because of their small size.
- Nanotechnology builds on the ability to control or manipulate at the atomic scale.

Fundamental Science behind Nano-technology

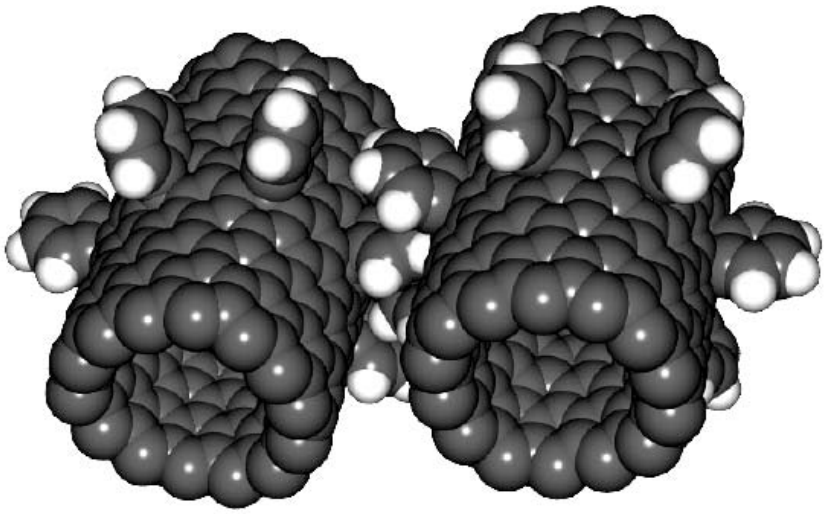
1. Electrons

Since electrons are responsible for the links, electrons are responsible of the chemical properties of molecules



2. Atoms & Molecules

Bonds are key to nanotechnology. They combine atoms and ions into molecules and can themselves act as mechanical devices like hinges, bearings, or structural members of machines that are nanoscale.

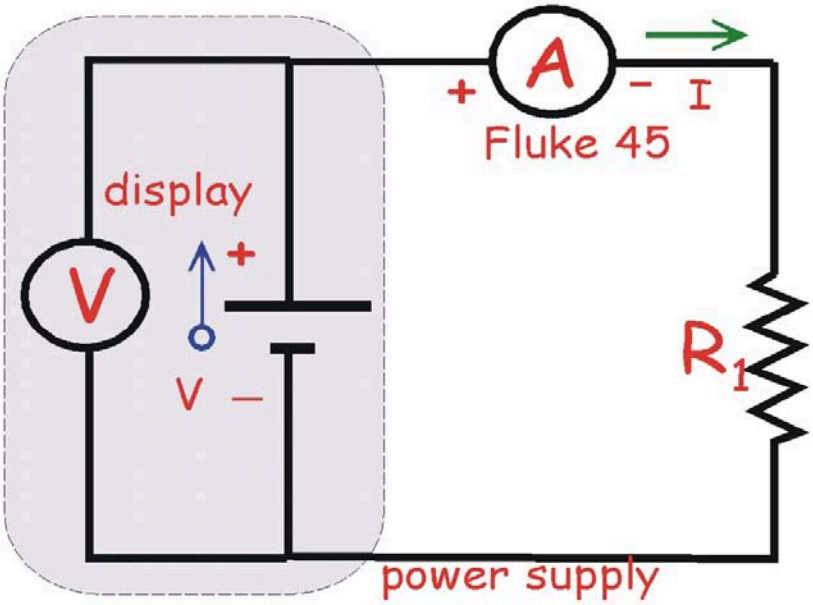


3. OHM'S LAW

- V=IR
- All integrated circuits obeys Ohm's law.

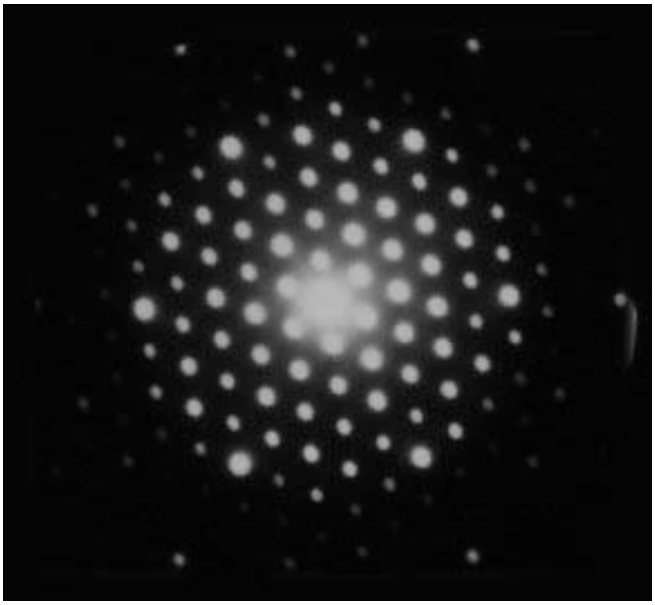
- Superconductor : R is almost 0 !
- Nanostructures (like CNT) : fails again!

→ Quantum Theory



4. Quantum Ideas

- Electrons → Wave + Particles properties
- Nanoscale → Not continuous, but quantized. Like a money. You can't split a penny (Quanta)
- Electron can jump between spaces. (Tunneling Effect)
- → STM (Scanning tunneling microscope)



Electron Diffraction

Tools of the Nanosciences

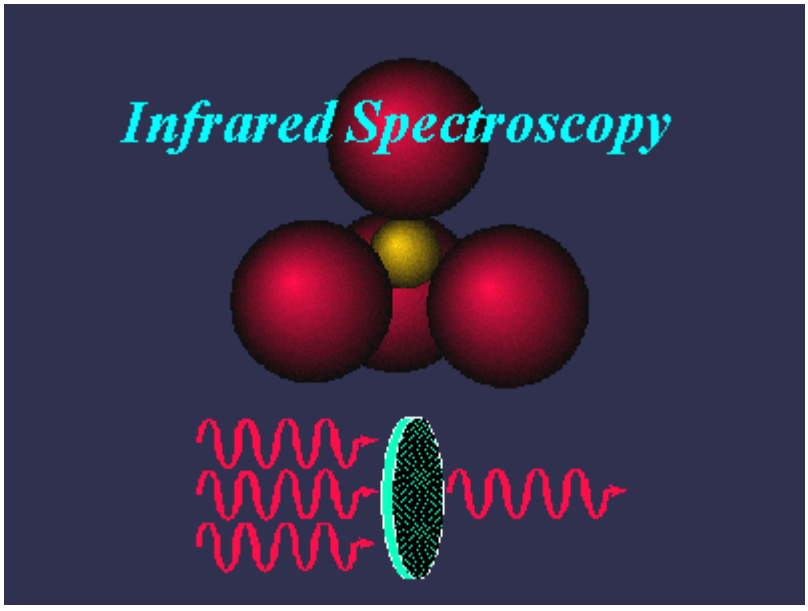
1. Tools for measuring Nanostructures
   - Spectroscopy
   - Scanning Probe Instruments

2. Tools to make Nanostructures
   - Scanning Probe Instruments
   - Nanoscale Lithography
   - Dip Pen Nanolithography
   - Self-Assembly
   - Nanobricks and Building Blocks

1. Tools for measuring Nanostructures

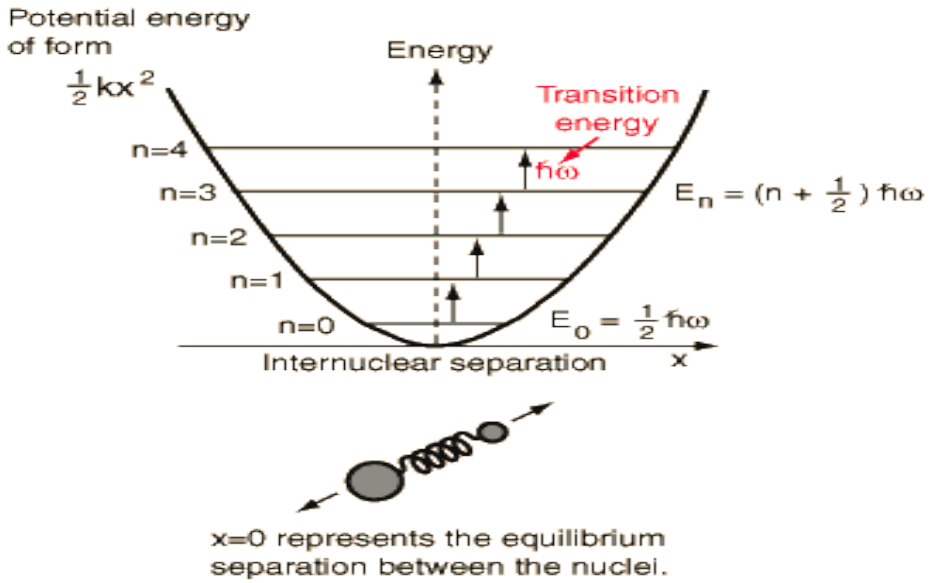
Spectroscopy

- Infrared (IR) spectroscopy
  Vibration occurs in molecules because the chemical bond between atoms in the molecules works like a spring. The strength of that spring determines how much the atoms vibrate. Certain molecules absorb light at certain frequencies, which increases their vibration. The frequencies of light that can be absorbed are all in the infrared range and therefore the method of analyzing this vibration is called infrared spectroscopy.



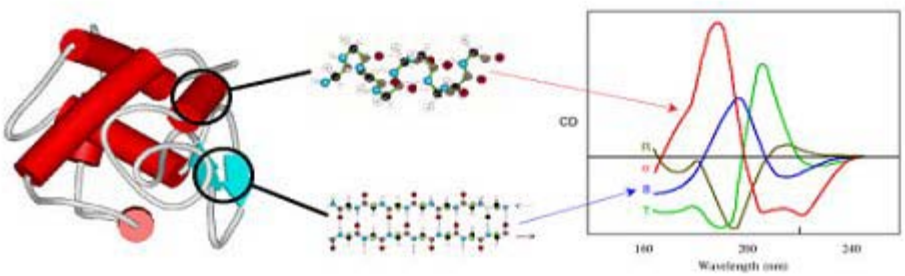
- Raman spectroscopy

As with Infrared spectroscopy, the energy in photons used in Raman spectroscopy can be absorbed by the chemical bonds between atoms, exaggerating the molecule's movement. However, when the chemical bonds relax, going back down to a lover level of movement, or vibration, they release a photon. The level of vibration that the bond relaxes to is what determines the frequency of the newly released photon. Analyzing the change in frequency from the original photon not only tells you what kind of molecules is in a sample, but also tells you about the condition of the sample.



- UltraViolet-Visible spectroscopy
  Molecules can also absorb ultraviolet light – and even visible light. Although the molecules in the sample could care less about the light, the electron gets excited. The electrons in each type of atom can only absorb light of certain frequencies, the spectrometer measures that frequency of light that passes through the sample, and the frequencies that are missing reveal the identities of the atoms and molecules in the sample.

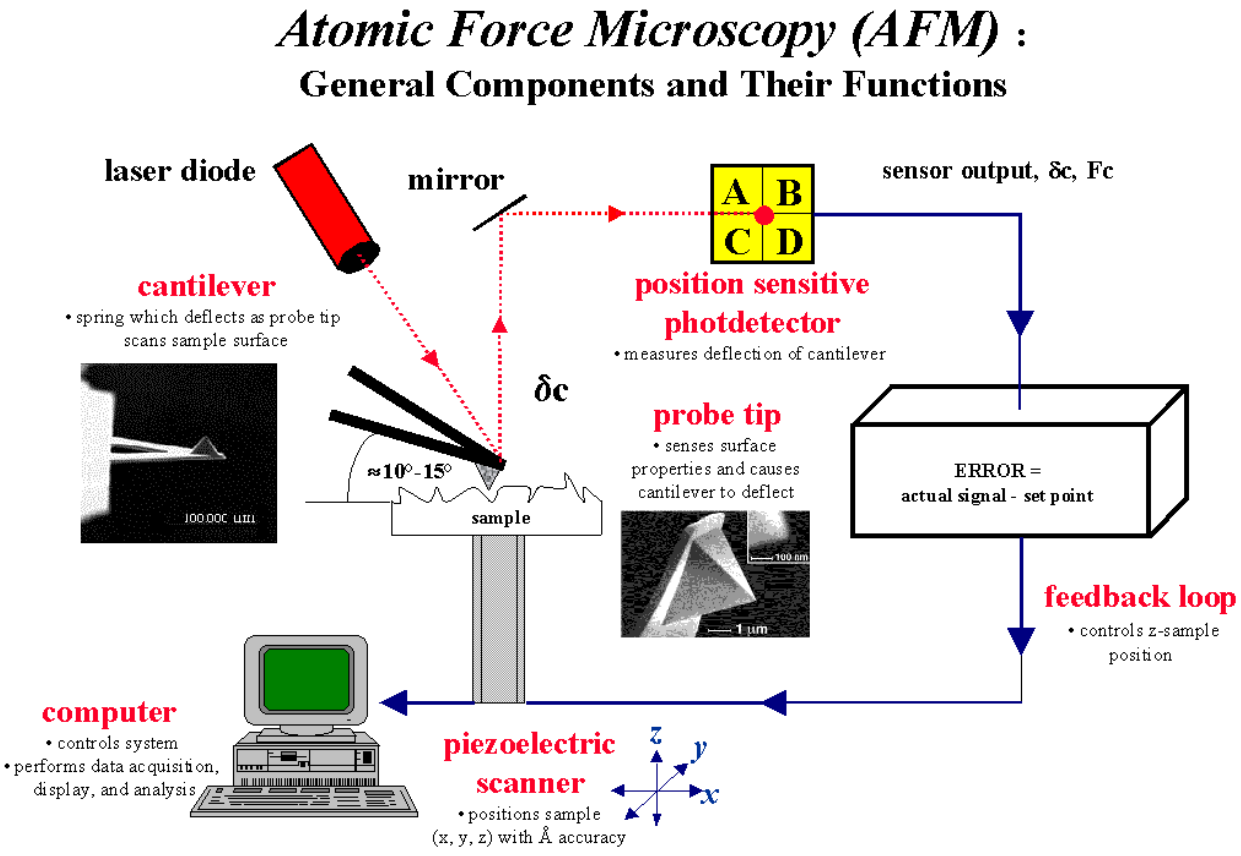
Different secondary structure types have characteristic CD spectra



Scanning Probe Instruments

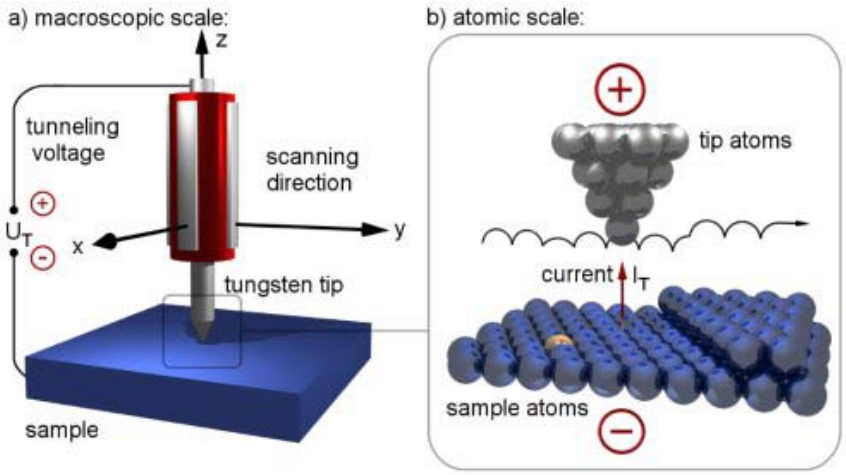
- AFM – Diffraction of UV, Like a finger

  An Atomic Force Microscope (AFM) scans the movement of a really tiny tip made of a ceramic or semiconductor material asit travels over the surface of a material. When that tip, positioned at the end of a cantilever, is attracted to or pushed away from the sample's surface, it deflects the cantilever beam, and a laser measures the deflection.



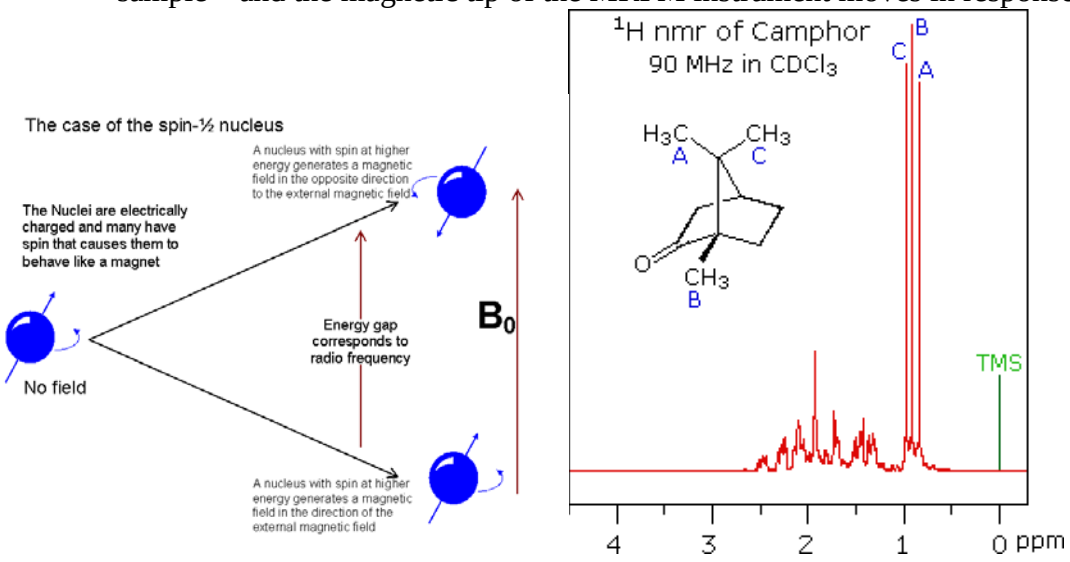
- STM – Difference of electrical current

  A Scanning Tunneling Microscope (STM) uses an electric current - which is called a tunneling current – that begins to flow when a very sharp tip moves near to a conducting surface and hovers at about one nanometer away.



- MRFM – Difference of magnetic properties

  A Magnetic Resonance Force Microscopy (MRFM) uses equipment similar to an AFM, with an important difference: The tip is made of magnetic material, and a special coil in the instrument applies a readio-frequencey (RF) magnetic field. Applying the RF field generated by the coil changes a quality called "spin" in the protons and electrons of the sample – flipping that quality back and forth. Each flip change the magnetic field generated by the atoms in the sample – and the magnetic tip of the MRFM instrument moves in response.

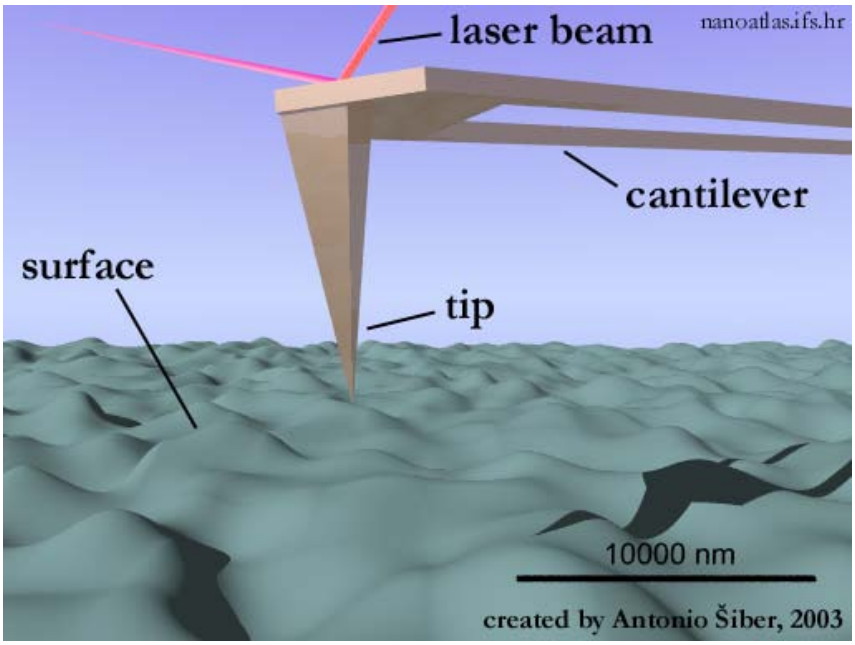


2. Tools to make Nanostructures

Scanning Probe Instruments

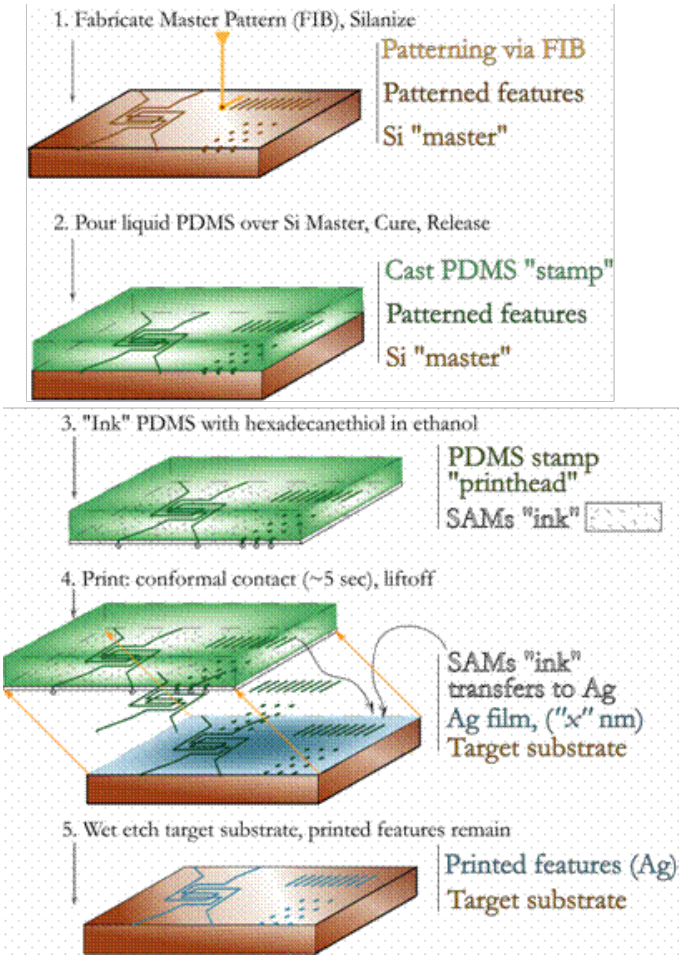
- Scanning probe instruments can be used not just to see structures but also to manipulate them.
- AFM tip → like a finger!
- Generally, small objects which could be either individual atoms or individual molecules can be moved on a surface either by pushing on them or by picking

them up off the surface onto a canning tip that moves around an puts them back down.



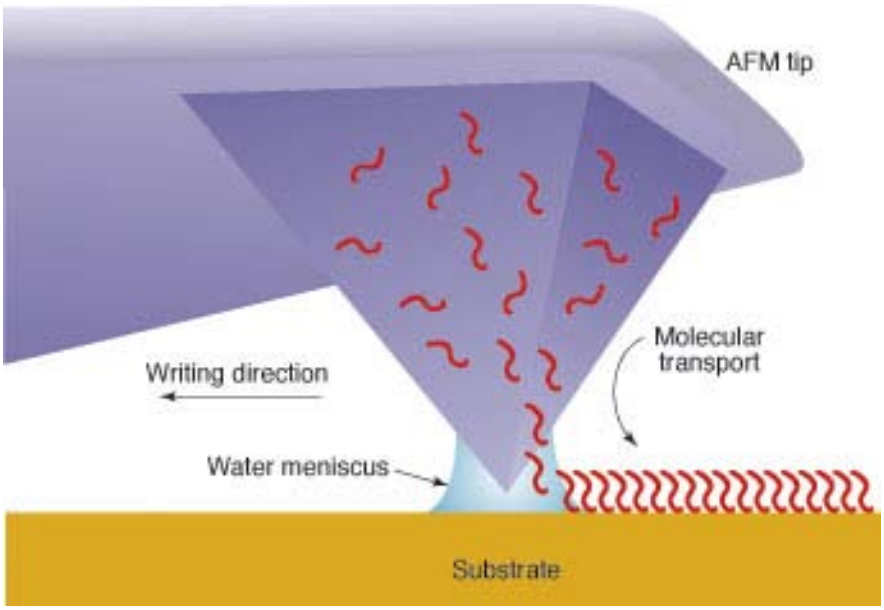
Nanoscale Lithography

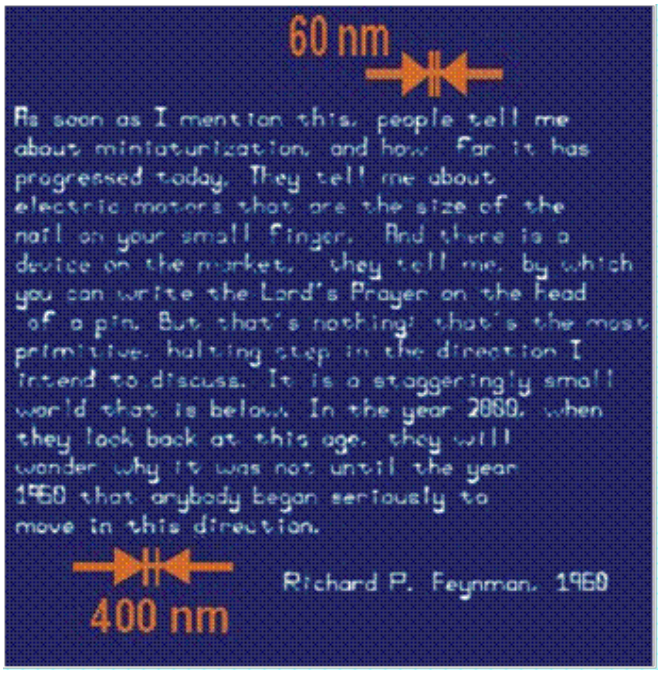
- Micro contact printing
- → Nano scale mask + Rubber stamp + Ink
- This method works in the same way as the rubber stamps that are still found in post offices. A patten is inscribed onto a rubber surface, and that rubber surface is then coated with molecular ink. The ink can then be stamped out onto a surface.



Dip Pen Nanolithography

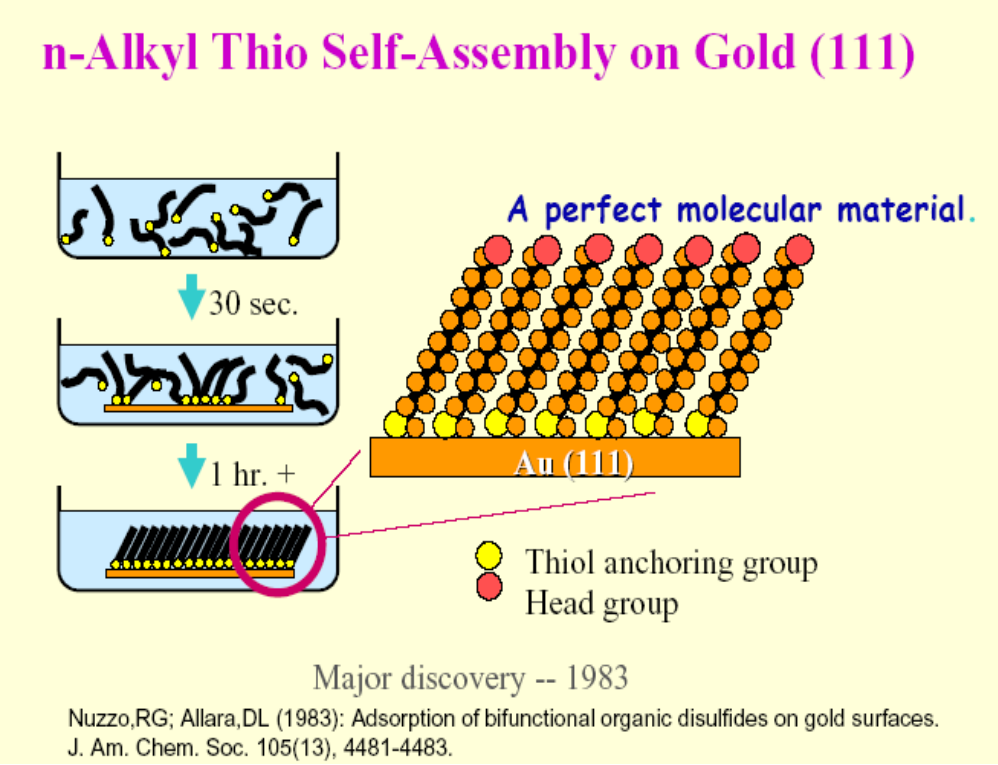
- Nanoscale Direct Writing
- AFM tip + Ink
- AFM tips are ideal nano-pens. In DPN, a reservoir of ink which are atoms or molecules is stored on the top of the scanning probe tip, which is manipulated across the surface, leaving lines and patterns behind.





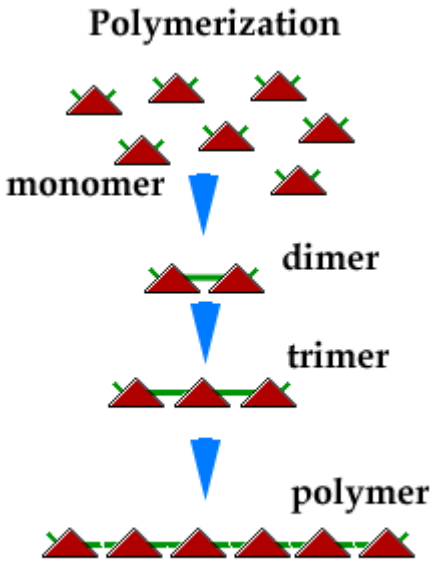
Self-Assembly

- The way nature creates something!
- Based on the properties of atoms & molecules (like hydrophobic, hydrophilic)
- The idea behind self-assembly is that molecules will always seek the lowest energy level available to them. If bonding to an adjacent molecule accomplishes this, they will bond. If reorienting their physical positions does the trick, then they will reorient. At its simplest, this is the same underlying force that causes a rock to roll down a hill. We can block its progress, but that requires active intervention.



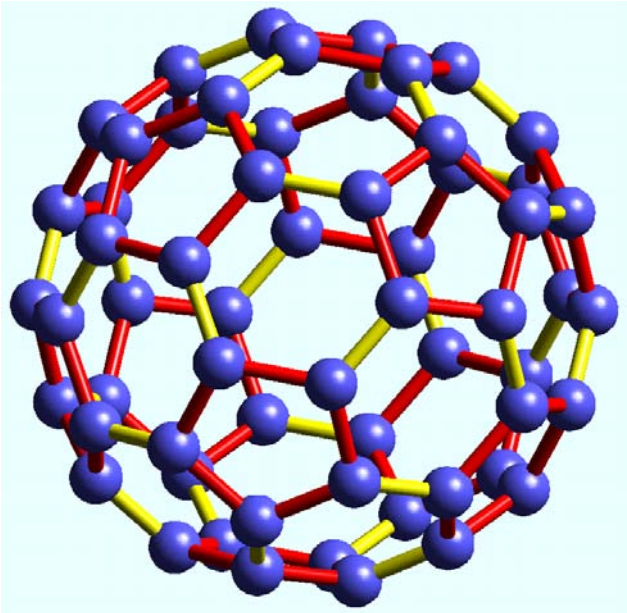
Polymerization

- Polymerization is a very commonly used scheme for making nanoscale materials and even much larger ones. Controlled polymerization, in which one monomer at a time is added to the next, is very important for specific elegant structures. Some researchers have developed a series of methods for preparing specific short DNA fragments. These are called oligonucleotides. The so-called gene machines use elegant reaction chemistry to construct specific DNA sequences.

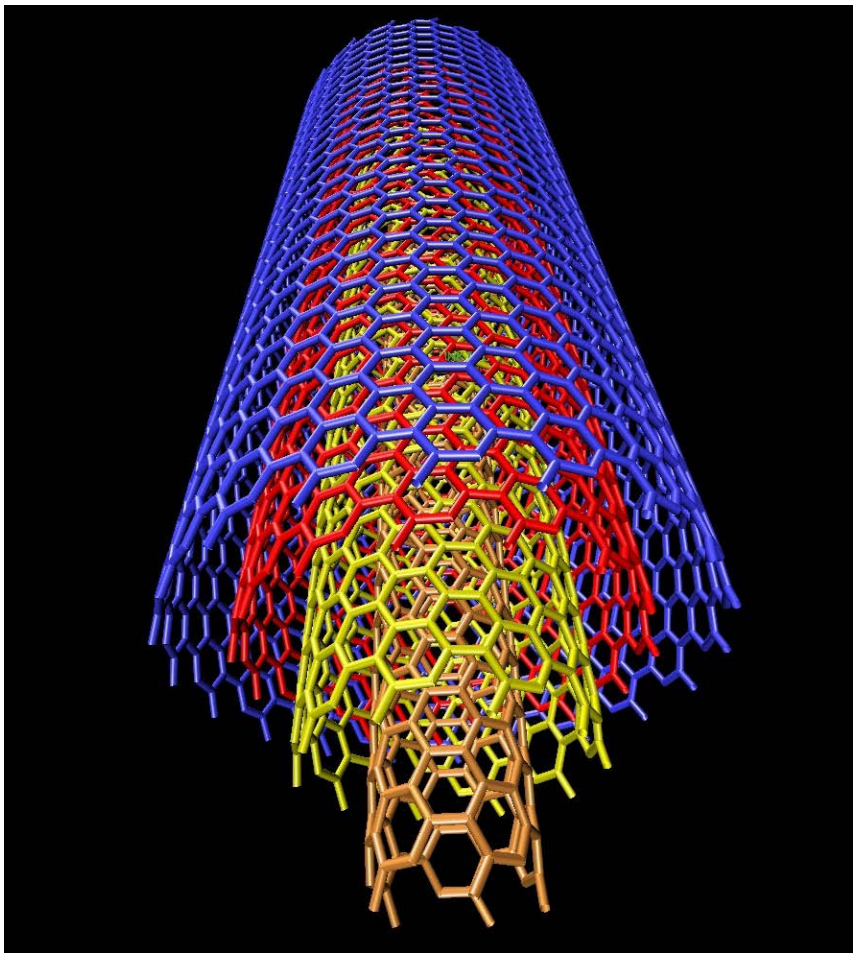


Nanobricks and Building Blocks: Nanostructures must be assembled from components. Individual molecules can be used as blocks.

- **Buckyball**
  Buckyball (Buckminsterfullerene) is a molecule containing 60 carbon atoms. Each carbon atom is bonded to three adjacent carbon atoms, just as in graphite. However the carbon atoms in a buckyball from a teensy-weensy sphere that is about 1 nanometer in diameter. Because one of the properties of carbon atoms is that they can bond to may other types of atoms, researchers can sue them to create customized molecules, useful in various applications. \



- **Nanotubes**
  Nanotubes are each a lattice of carbon atoms – with each atom covalently bonded to three other carbon atoms. Carbon nanotubes are basically buckyballs, but the end never closes into a sphere when they are formed. Instead of forming the shape of a sphere, the lattice forms the shape of a cylinder. Nanotubes come in a couple of varieties. They can either be sing-walled carbon nanotubes (SWNT) or multiwalled carbon nanotubes (MWNT). As if that weren't enough, carbon nanotubes also conduct heat, and have a high thermal conductivity. Some researchers predict a thermal conductivity more than 10 times that of silver. While metals depend upon the movement of electrons to conduct heat, carbon nanotubes conduct heat by the vibration of the covalent bonds holding the carbon atoms together; the atoms themselves are wiggling ground and transmitting the heat through the material. In a wire made of carbon nanotubes, electric current could zip through like a skater on ice. The impact of such wire on energy technologies could be big.



Hypothesis –Statement of primary issue with nanotechnology

The formation of IPRO 341 has emerged and built on the work completed by IPRO 341 – class of Fall 2005 in which that group researched many different emerging technologies as to clearly review how these technologies were adopted and the diffusion and migration within society. Continuing the work from last semester's progress, our IPRO has decided to address nanotechnology and the facets there of to discuss and research in terms of what the public knows and lacks about this emerging technology. The objective of this IPRO is to create a tool that will better educate the public's understanding of the potential risks and benefits that could be involved when using the nanoscale.

Within our IPRO it was of the utmost concern from the beginning of the semester that if we are to eventually develop some tool to educate the public's perceptions on this emerging technology then of course we must know the material ourselves and assess it accordingly. With this in mind, our group divided initially in to four sub-groups to necessarily research the different areas we had in mind that people would cover the broad spectrum of possible areas that nanotechnology could find itself in.

The four groups were split up according to research within Consumer Goods, Electronics, Medical, and Military. This allowed for us to research more specifically different areas that are to have this technology be a factor in guiding new products and when the research was done – which took approximately a week and a half – the groups presented their findings in PowerPoint presentations to the rest of the class. People were assigned to groups as follows:

- Consumer Goods – Andy, Bez, Kevin, and Sagar
- Electronics – Jason, Saurabh, Sungwoo

- Medical – Ankit, Maggie, Mike
- Military – Ayo, George, Jon

In order to take care of the daily and weekly tasks which are involved with the IPRO, we also split up accordingly as to who will hold which roles. The following is a list of who was assigned – voluntarily for the most part – to specific roles to take on during the course of the semester:

- Team Leaders
  - Maggie Peterson
  - Jon Komyathy
- Editors / Writers
  - Ayo Ayodele
  - Sagar Shah
  - Jon Komyathy
- Researcher
  - Ankit Desai
  - Sungwoo Yang
- Communication
  - Kevin Lerash
- Web
  - Andy Wilk
  - Saurabh Dass
- Minutes
  - Mike Stohl
- YahooGroups! / iKnow iGroups
  - Jason Frumkin
- Timesheets
  - Bez Robinson
- IPRO Liaison
  - George Skontos

Research and Analysis:

The research and analysis section of this report will provide you the actual research of the different sub-teams for the both research on applications of nanotechnology and research on distribution of information by providers. It will also discuss the methodology behind each task and the reasoning behind the approach.

Our team decided that it would be best to first understand the fundamental facts about nanotechnology and then to address areas where nanotechnology is potentially

going to be used, or already is being used. We divided ourselves among four groups and researched the applications of nanotechnology in each field:

- Military
- Medical
- Electronics
- Consumer Goods

By using this division we were going to research the basic facts on the following criteria for this section:

- What is nanotechnology?
- How is applied to this industry?
- Who are the stakeholders?
- Why should the public care about how nanotechnology will change this industry?
- What are some possible implications?
- Discussion of possible social, political and economic issues related to these industries.

Military:

- **Weapons**
    - Medical
        - Nano-bomb
            - Nano-materials cause massive lung damage
                - Particle size so small can get deep into lungs
                - Also come attached with other nasty chemicals
                    - Power plants
                    - Diesel
                        - Hydrocarbons
            - Nano-particles can get in through the skin
                - Enter blood stream and go straight to brain
            - No immunity to nano-particles
                - Too-toxic

- With Nano-bomb entire armies can be wiped out without even fighting

- DNA recognition
  - Nano-bots
    - Programmed to recognize certain DNA and self destruct
    - Nice clean assassination
      - Looks like stroke or brain hemorrhage
- Virus detection
  - Sensors able to detect biological weapons
  - Small size allows them to permeate barriers

- Conventional
  - Guns
    - Lighter
      - Allows troops to carry more ammunition
    - Self-guided bullets
    - Enhanced scopes
      - Nano-material LCDs
    - Automatic fire guns
    - Stronger
    - Primers for igniting bullets
    - Gunpowder
      - Nanoenergentics: energy flow manipulation between molecules
        - Superthermites
          - Increase chemical reaction by 1000x
            - Release more energy faster
            - Added to nanometals
      - Help reduce the cost of guns
        - Higher concentration of energy using less raw materials

- Bombs
  - Cave-buster bombs
    - Osama not safe anymore
    - 10 times smaller but 1000 times more powerful
      - Briefcase sized bombs can take down a whole building
  - Underwater bombs
- Nano-bots
  - Can eat through a bunch of metal, rubbers, and more

- **Armor**
  - Soldiers
    - Clothing
      - Stronger cloths
        - Stronger fabric
      - Sensory enhancing garments
        - Embedded with nanochips
      - Camouflage
        - Help blend in with environment
          - Help interact with environment
            - Brings stealth to a whole new level
      - Changes reflectivity and insulation
        - Protection in all weather and terrain
      - Clothing that can absorb or reject certain materials
        - Keep from getting poisoned
    - Nano-bots to help repair and heal you
    - Virtual Reality systems
      - More lifelike training
    - Lighter equipment
      - More agility on the battlefield
    - Solar powered energy
      - No more heavy batteries

- Vehicles
  - Sea
    - Advanced ceramics to ships
      - Higher strength plating that is lighter
      - Protection against corrosion
      - Protection against barnacle build up
      - Ductility as well as impact resistance
      - Stronger more efficient engines
        - Better crankshafts and propellers
        - Higher viscosity on hydraulics and oils
          - Nanotubes to move liquids
            - 3 meters/sec
  - Air
    - Nanocoatings for jet engines
      - Less wear and more service life
      - Stronger turbines
    - Superthermites
      - Fuel propellants for rockets and missiles
        - Since so much more energy missiles travel and tremendous speeds
          - Can't evade
    - Radar masking
      - Radar resistant nano-composites
        - Stealth
  - Land
    - Better diesel engines
    - Faster, Lighter more powerful tanks
      - More powerful gunpowder
      - Lighter armor plating
    - Air filtering
      - Nano screens will be able to trap poisons

        - More agile land force
            - No more clunky tanks and Hummers

    - Buildings
        - Stronger infrastructures
        - More reinforced buildings
    - Paints
        - Camouflage
            - Buildings
            - Sea
            - Air
            - Land

- **Costs**
    - $315 million in 2004
    - $276 million in 2005
    - $132 billion in 2006
    - 16 multimillion dollar grants to universities
    - $100 in nanotech computer research
        - Advanced sensors
        - Computer processors
        - Communication devices
- **Problems**
    - Redefines war
    - New arms control laws
    - Everything is more dangerous now

As you can see the Military proposes several uses for nanotechnology, some that will redefine warfare with positive and negative outcomes. For example, stronger armor can help save the lives of our soldier while deadlier weapons that are more precise can mean more lives can be lost in a time of war. The figures above explain the investment made by the government to research the different areas in military where application nanotechnology is being researched. You can also observe the increase in the amount of

money being funded towards this new technology the possible issues that could be raised if such technology is applied to military products.

Medical:

- Nanotechnology is difficult to address using existing regulations.
- A new law may be required to manage potential risks on nanotechnology.
- New mechanisms and institutional capabilities are needed.
- Regulations
    - Hardly any long term or toxicology studies are currently available
    - Body absorbs/filters particles but nanoscale materials defy these bodily processes
    - Potential hazards to humans/environment resulting from introduction to nano cannot be entirely excluded
    - Nanoscale particles have no problem penetrating the human body's blood-brain barrier, makes nanoparticles in environment so potentially hazardous
    - Angstrom Medica, first company to obtain FDA approval for a medical device involving nanoparticles created NanOss, which utilizes nanocrystals (billionths of a meter). Cracks have a much harder time forming between nanocrystals than with traditional hydroxyapotite. It has great strength upon implementation, and bone replacement materials. Plus it gradually is replaced by human bone
    - No current tests for nanotechnology; if risks arise they might be formed.
    - No international regulation on nano products.
    - FDA established Nanotechnology Interest Group (NTIG) to coordinate nano in a regulated fashion.
    - Some tests for nanosizing of drugs are available, but no reports on any adverse reactions related to this nanosizing.

- Legal
    - What is the extent to which the government should be involved?
    - Some issues that may and most likely will arise include but are not limited to:
        - Patents
        - Licensing
        - Trademarks
        - Copyrights
        - Capital/Structural Deals
        - Litigation
        - Safeguards
        - Shut-offs
        - Contingencies
- Ethical
    - Scientists want to throw everything out there, i.e. self replicating artificial nanobots.
    - Businesses think that this will hurt the industry and scare people away from nanotechnology. They think the risk will be hyper sensationalized, i.e. presented in a manner to arouse strong disinterest, through exaggerated details.

Applications of nanotechnology become tricky to take a side on when it comes to the medical industry. It seems that the potential benefits could outweigh the risks involved. Currently there is research being done on if nano particles could enter our body through the skin. There is evidence that they can enter our body through the intestinal track or through breathing them in. When medicines use tools such as nanobots, the risks

are higher. The medical field will see probably the most controversy because it all comes down to the ethical questions. Already there are many issues when it comes to decision making when releasing drugs into the market, for example if a company knows that a drug can cause a stroke, heart attack or other serious injuries to 3% of their consumers, should they release it if it's for a minor illness? What if the medicine can cure cancer? Such questions can be of concern because the "smaller" the technology gets, the "bigger" the potential risks and concerns.

Electronics:

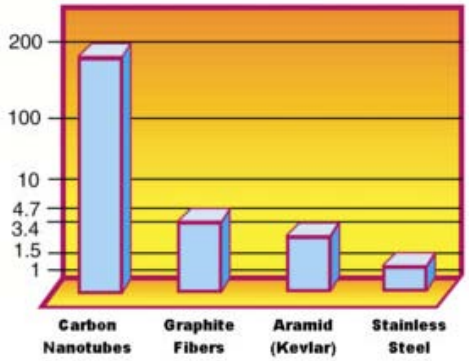
"Application of nanostructures in electronics is one of the most vibrant and challenging aspects of nanoscience. Indeed, charge transport on the molecular or nanoscale level draws on a whole set of new concepts that challenge our understanding of electronics." - Prof. Mark Ratner, Nanofabrication at Northwestern University

Electronics is currently the workhorse technology for computing and communications as well as a major component of consumer goods.

CNT (Carbon Nano Tube)

- Definition
    - Single-wall carbon nanotubes are a new form of carbon made by rolling up a single graphite sheet to a narrow but long tube closed at both sides by fullerene-like end caps.
    - However, their attraction lies not only in the beauty of their molecular structures: through intentional alteration of their physical and chemical properties fullerenes exhibit an extremely wide range of interesting and potentially useful properties.
- Properties
    - Metallic conductivity (e.g. the salts A3C60 (A=alkali metals))
    - Superconductivity with TC's of up to 33K (e.g. the salts A3C60 (A=alkali metals))
    - Ferromagnetism (in (TDAE)C60 - without the presence of d-electrons)
    - Non-linear optical activity
    - Polymerization to form a variety of 1-, 2-, and 3D polymer structures

- The chart compares the tensile strength of SWNT's to some common high-strength materials.
- Nanotubes can be either electrically conductive or semi conductive, depending on their helicity.
- These one-dimensional fibers exhibit electrical conductivity as high as copper, thermal conductivity as high as diamond,
- Strength 100 times greater than steel at one sixth the weight, and high strain to failure.
- Current length limits are about one millimeter.



- Current Applicat
  - Carbon Nano-tubes are extending our ability to fabricate devices such as:
  - Molecular probes
  - Pipes
  - Wires
  - Bearings
  - Springs
  - Gears
  - Pumps
- Future Applications
  - Molecular transistors.
  - Field emitters.
  - Building blocks for bottom-up electronics.
  - Smaller, lighter weight components for next generation spacecraft.
  - Enable large quantities of hydrogen to be stored in small low pressure tanks.

- Space elevator, Instead of blasting off for the heavens astronauts could reach the ISS as easily as they would a department store: “Next floor, LEO, watch your step please!”

Soft molecule electronics

- Using more traditional organic and organo-metallic molecules as electronic components offers some aspects that are more attractive than using nanotubes, including both relative ease of assembly and some of the control and recognition features that molecules permit.
  - Applications
  - Transistors
  - Superconductor
  - Switches in electronic device
  - Molecular assembler
  - Molecular memories
  - Molecular insulators
  - Molecular interconnects

Tools to make nanosciences

- Imaging
- AFM (Atomic Force Microscope)
- STM (Scanning Tunneling Microscopy)
- MFM (Magnetic Force Microscope)
- Patterning
- SAM (Self assembly monolayer)
- Micro-contact printing
- DPN (Dip Pen Nanolithography)
- Nanosphare lithography

Consumer Goods:

The first thing we need when learning about this subject is to know what nanotechnology is all about. Nanotechnology is a technology based on the nanoscale. Scientists are able to construct things from the ground up, by organizing atoms together

one by one, until a larger object is made. Scientists need to be careful about how often, and where they use this technology however, as it is not a fully tested, and trusted technology. Though, it sounds like working with particles on the nanoscale is a little far fetched, and sounds years away, it is already in use in some common products today. Many people in the public are not even aware of this. Some people say this is because the scientists are trying to keep the public unaware, and only want to introduce the technology if there are problems later on down the road.

To begin, there are already many products on the market that are utilizing nanotechnology in their products. The technology is being used in all fields; however the focus here is on nanotechnology in the field of consumer goods. For the sports person, the technology is being utilized in tennis balls that bounce higher, and in the strings on a tennis racket to make the racket stronger, golf balls can fly farther and straighter. A nano ski wax that is applied easier and smoothes the surface better. Also, some bowling balls utilize the technology to make them harder[1]. These products all allow each person in that sport that is competing to make the game more competitive.

For an average consumer, the technology is being utilized in areas such as adhesive bandages, where silver nano-particles mixed in the dressing area help to heal the wound faster. Drug delivery patches also utilize this technology, where nano-sized medicine particles are absorbed through the skin[2]. Cosmetic products are in the market, such as anti-aging creams, sunscreen, and general makeup also use nano-particles in their products[3]. Products arranging from harder, more durable plastics to stain repellant clothes, to self-cleaning bathrooms are all utilizing this technology. Nano-particles in the plastics can be used for enhanced durability are being used in car manufacturing. One known application is the step assists on vans and trucks[4]. The plastic incorporates the technology and makes the plastic more durable, and less prone to crack or break. Another plastic application is that of a “smart bag”. Similar to a plastic storage bag, the plastic will contain a section of nano-particles that will be able to sense if the food kept inside is still fresh or not. If the food is going bad, the toxins/ bacteria that start to build in the bag will

[1] www.nnin.org
[2] www.managedcaremag.com
[3] http://www.cosmeticsdesign.com
[4] www.azonano.com

interact with the surface, and change the color on a part of the bag to show the food is going bad[5].

One product that really caught our eye was researchers working on a self cleaning bathroom. Basically, the nano-particles are put on the surface of the walls, and under a certain UV wavelength frequency, the particles go active, and break down organic compounds and kill microbes, with even more cleaning effectiveness than bleach. Another benefit that results from the coating is that since the particles are so small, it causes no water to be able to stick to the surface, so the wall stays clean[6]. Stain free pants also utilize nano-sized fibers and particles to keep the pants free from staining. There are also socks in the creation stage that contain small silver particles, to keep the foot smelling fresh all day.

As you have just seen, there are a lot of products that are in the market containing nanotechnology, or that will be coming out shortly utilizing the technology, but you never hear too much on how this will affect the market, or our daily lives. With a product such as the self cleaning bathrooms come out, what happens to products that were once made for cleaning bathrooms? The bleaches, shower cleaners, and scrubbing compounds? That industry will eventually see a decline in their products being used. If the surfaces of the bathroom are coated by these particles that don't let water stick, or microbes, or organic matter stay around, and build mold/mildew/bacteria, there is no need to use products similar to bleach and the like. The same can go for stain free clothes, or the non smelling socks.

The technology can also make our lives easier though. Look at the smart plastic bags. This doesn't mean there would be any decrease in the use of the plastic bags, but this product could help the market by letting people know not to eat the food if the bag says it went bad. Less people have the chance of getting sick from eating bad food. Tougher/ stronger plastics can help create a product that is strong and durable, yet lighter weight. Strong plastics are also commonly used in applications such as bulletproof vests. A durable and stronger plastic could really put a police officer in a better position if he were shot at while wearing a stronger, more durable vest.

[5] http://fda.gov
[6] www.physorg.com

Regardless if nanotechnology will help the economy, or hurt the economy, we have to raise the issues of if it is safe or not. This is a big issue, and researchers most likely won't tell us the risks or dangers of it. Take for example, the nano-coated bathrooms. We will be exposed to those coatings during our everyday lives. How well are those particles attached to that wall? What if when removing the tiles, and/or cutting the bathroom tiles the coating goes into the air with the dust particles, and we breathe in the coating? These are some of the issues presently under attack. Some British researchers are strongly warning the public that we do not know exactly what happens with particles at the nano-scale, and that we must learn that many properties of materials change, and what is harmless at the macro-scale, could be harmful at the nano-scale. This is also why many people also worry about the cosmetics at the nano-scale. What can happen if too many of these particles absorb deep into your skin? We probably won't be able to rely completely on the government regulations, however each organization needs to think about the effects as well as the consumer needs to be aware of these issues, and take actions accordingly. It is just like the asbestos problem. Some brake pads currently still have some asbestos in them, and if the mechanics aren't taught about the precautions of how not to blow brake dust around, and wear a mask, etc. It will keep it safer for the mechanic. As long as the public is made aware of what could happen, and what precautions to take, it could lead to something that can revolutionize the world as we see it today.

Tougher regulatory oversight and new resources are needed to manage the potential adverse effects of nanotechnology, according to report assessing the impact of the technology. Increased regulation may add to the cost of developing the technology for use in packaging, food products and other non-food consumer goods. However, better regulation could also serve to help development by helping to calm public concern about the harmful health effects the technology may pose.[7]

"If nothing specific is done to manage nanotechnology's possible adverse effects, a range of undesirable developments could emerge for the public and industry," said

[7] http://www.foodproductiondaily-usa.com/news/ng.asp?n=65223-nanotechnolgy-epa
"Report calls for nanotechnology law", Ahmed El Amin

Terry Davies, in his report from the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars.

"The public potentially would be left unprotected, the government would struggle to apply existing laws to a technology for which they were not designed, and industry would be exposed to the possibility of public backlash, loss of markets, and potential financial liabilities," he stated. "However, all of these laws either suffer from major shortcomings of legal authority, or from a gross lack of resources, or both," he stated in the report. "They provide a very weak basis for identifying and protecting the public from potential risk, especially as nanotechnologies become more complex in structure and function and the applications become more diverse."

However, he noted that the political obstacles to passing new legislation are very large, though not impossible. The drawbacks of trying to fit nanotechnology under existing laws make the attempt worthwhile. To encourage beneficial applications of nanotechnology he suggests more funding for research, tax breaks, acquisition programs and regulatory incentives.

During the State of the Union Address, President Bush recognized the importance of nanotechnology: "I propose to double the federal commitment to the most critical basic research programs in the physical sciences over the next 10 years. This funding will support the work of America's most creative minds as they explore promising areas such as nanotechnology, supercomputing, and alternative energy sources."[8]

With respect to energy, as national economic and political interests are impacted by rising costs, nanotech promises to bring about new levels of efficiency for fossil fuel sources through nanoscale catalysts and filters. Nanotechnology also holds out the prospects of making fuel cells and photovoltaics more cost effective alternatives to fossil fuel energy.

At a time when expenditures on healthcare are escalating and the baby boomers will soon be entering their sixties, nanotechnology offers major improvements not only

[8] http://nanotechwire.com/news.asp?nid=2883
"Nanotechnology Changing the Face of Skincare"

through the pharmaceutical industry developing new drugs but also in the creation of more efficient drug delivery systems, new diagnostic tools, and prosthetics.[9]

All in all, there are many uses for nanotechnology in consumer goods. However, the public should be made aware of the risks that we enter when working with these particles at the nano-scale. The new products can offer a lot more than what some previous products have to offer, and if used correctly, and people are educated about the technology more, it will be a great leap toward the future.

If the people want to know, there should be a way for them to find out. But for example tennis balls, it would not be necessary to label it differently. The risks could be possibly be very small versus the benefits. But for items that can be consumed or any medical items might need to be labeled. There are people who disagree with genetic engineering, so they label different vegetables and fruits. So there are definitely going to be people against nanotechnology in their food, so such items should be labeled.

It seems that when looking at nanotechnology we seem to run into a common trend with consumer products. Each company markets their product differently or terms nanotechnology as "small technology" to stray consumers away from misconceptions. Maybe regulation should also be observed in a similar manner, each industry can be evaluated and can be assigned certain regulatory constraints so the public can be safe.

[9] http://nanotechwire.com/news.asp?nid=979
"Why Nano Now?"

Sources for Research on Applications of Nanotechnology:

Military:

There are no sources for this section

Medical:

1. http://www.imm.org/Reports/Rep018.html
2. http://www.foresight.org/Nanomedicine/#MedBioNanoArt
3. http://www.nanomedicine.com/
4. http://www.foresight.org/Nanomedicine/Respirocytes.html
5. http://www.washingtonpost.com/wp-dyn/articles/A49758-2005Jan30.html
6. http://www.rfreitas.com/Nano/FutureNanofabNMed.htm
7. http://www.ringsurf.com/info/Technology_/Nanotechnology/Applications/Medicine/
8. http://www.iso.org/iso/en/domains/WSC-MedTech/pdf/presentations/18%20Richard%20Moore.pdf
9. http://www.fda.gov/nanotechnology/faqs.html
10. http://www.human-evolution.org/nano_medicine.php
11. http://www.angstrommedica.com/images/Nanotech%20L&B.htm
12. http://www.yellowpress.com/Content/b100902.htm

13. http://practice.findlaw.com/feature-0604.html

Electronics:

1. http://www.pa.msu.edu/cmp/csc/nanotube.html
2. *Localized and Delocalized Electronic States in Single-Wall Carbon Nanotubes*
   T. Pichler, M. Knupfer, M. S. Golden, J. Fink, A. Rinzler and R. E. Smalley
   Phys. Rev. Lett. **80**, 4729 (1998)
3. http://www.sciencenet.org.uk/slup/CuttingEdge/May00/nanotubes.html
4. Dr. Sander Tans and Prof. Dr. Cees Dekker of the section Quantum Transport at TU Delft,
5. http://www.photon.t.u-tokyo.ac.jp/~maruyama/nanotube.html
6. http://jcrystal.com/steffenweber/JAVA/jnano/jnano.html
7. http://www.pa.msu.edu/cmp/csc/nasa/
8. http://www.pa.msu.edu/cmp/csc/simindex.html
9. http://mmptdpublic.jsc.nasa.gov/jscnano/
10. *A gentle introduction to the Nanotechnology*, Mark Ratner, 2002, Prentice Hall PTR
11. http://europa.eu.int/comm/research/industrial_technologies/articles/article_427_en.html
12. http://www.nano.gov/html/facts/appsprod.html
13. http://www.nano.gov/html/facts/MoreProds.htm
14. http://www.nano.gov/html/facts/whatIsNano.html
15. http://www.nano.gov/html/facts/faqs.html
16. http://www.mitre.org/tech/nanotech/nano_elect_ovw.html
17. http://public.itrs.net/Files/2003ITRS/LinkedFiles/ERD/NanoeletronicsRdmp.pdf
18. http://www.nanocompositech.com/nanotechnology/nanotechnology-applications.htm

19. http://www.nnin.org/nnin_nanoproducts.html
20. http://www.azonano.com/Applications.asp?Letter=E
21. http://www.ringsurf.com/info/Technology_/Nanotechnology/Applications/Electronics/

Consumer Goods:

1. http://nanonano.nsec.northwestern.edu:8080/nsec_plone/whatis/History/#
2. http://www.azonano.com/details.asp?ArticleID=1059
3. http://www.fda.gov/fdac/features/2002/502_food.html
4. http://www.managedcaremag.com/archives/0404/0404.biotech.html
5. http://www.azonano.com/news.asp?newsID=1354
6. http://www.cosmeticsdesign.com/news/ng.asp?n=65193-nano-cosmetics
7. http://www.physorg.com/news10609.html
8. http://www.nnin.org/nnin_nanoproducts.html
9. http://www.physorg.com/news4031.html
10. http://www.nsti.org/news/nanonews.html
11. http://nanotech.physorg.com/
12. http://www.nanotechnology.northwestern.edu/
13. http://nanotechwire.com/news.asp?nid=2883
"Nanotechnology Changing the Face of Skincare"
14. http://nanotechwire.com/news.asp?nid=979
"Why Nano Now?"

After we finished this part of our research we hit a wall because we were not able to identify the problem right away. But after a couple of weeks of discussion the team seemed to agree that the most fundamental issue about nanotechnology is the distribution of information. We all concluded this supported by our own frustrations in finding information on nanotechnology. If our team, which is already in an academic environment, had trouble understanding nanotechnology, due to the different perspectives and contradicting sources, what would the general public feel? So we then began our

research on the way information is distributed. We divided the team into sub-teams according to providers of information:

- Government
- Academic
- Commercial
- Independent

Having this dynamic division would allow us to see the perspective of the different areas where a person would retrieve information on nanotechnology.

The following is the criteria questions our sub-teams were asked to follow when conducting research:

- What is the mission statement?
- What is the content of the information?
- Is it pro or anti nano?
- How do they present their information?
- How are they funded?
- Can anyone access it?

The following research is presented in the format it was researched. Which means the research is individual works of the different members of the team.

Government:

Sagar Shah

National Nanotechnology Initiative, it "is a federal R&D program established to coordinate the multiagency efforts in nanoscale science, engineering, and technology."[10] The NNI uses government funding it is exploring nanotechnology and its implications. Most of its budget is dedicated to education of nanotechnology and further research and development. It seems to offer mostly positive information on nanotechnology, by segmenting their audience according to age and education when informing. Although the NNI discusses legal and ethical issues, it focuses on them in broad and simple terms.

- [10] National Nanotechnology Initiative http://www.nano.gov/index.html

Having on one webpage that states what issues are in and offers links to proposed grants and programs set up to explore societal concerns. But if observed, most of the programs and research dedicated to legal and ethics issues have a smaller budget than areas where education and development of nanotechnology occurs. The NNI is sponsored by the US government and is the first federally funded program that calls attention to nanotechnology.

Asian Nano Forum is "ANF`s Mission is to promote the research and development and industrialization in nanotechnology that educationally, socially, environmentally and economically benefit each economy by fostering the international network and collaboration The ANF Objectives are: 1) Promote human resource development by exchanging students, researchers and experts 2) Promote sharing information, resources, and experiences, i.e., R&D projects, basic infrastructure, etc. of each economy through the ANF network 3) Enhance public awareness and education ANF network member agreed to Share Information & Infrastructures, and Collaborate Research & Activities in the field of a) Standardization of concepts and measurements b) Social, environmental and health issues c) Education and human resource development."[11] The ANF is supported by 13 economies in the Asia Pacific region. They include Australia, China, Hong Kong, India, Indonesia, Korea, Japan, Malaysia, New Zealand, Singapore, Taiwan, Thailand, and Vietnam.
Most of the organizations from the countries are a mixture of government and private organizations that consist of scientists, research and development engineers as well as policy makers. The ANF views nanotechnology as a positive change in the world and promotes all aspects of research. It efforts to develop nano products though, it also calls for strong attention to standardization of nanotechnology through the involvement of policy makers from different countries.

Overall, it seems that United States is falling behind in taking the "initiative" on nanotechnology further than most countries have so far. For example, the United States

- [11] The Asian Nanotechnology Forum http://www.asia-nano.org/index.php

has funded the research and development of nanotechnology but it has given little regard to developing policy parallel to R &D. The NNI's focus on education of the new technology gives evidence of the fact that Americans are ill prepared for such an innovative technology and our country is still in education phase. But as we see with the ANF, while developing and investing money in research, they are creating networks of governments and private organizations from many different countries in an effort to develop policy and regulation.

I feel that the United States government can use the tactical approach of the countries involved in the Asian Nano Forum, by creating networks and joining forces with other countries devoted to nanotechnology we can assess the impacts and regulatory issues (as well as ethical) on a global scale. As we head towards globalization with full speed, the issues no longer can be discussed independently, but rather should be a cohesive effort made by several global stakeholders.

George Skontos

Upon visiting the National Nanotechnology Initiative (NNI) website you find yourself staring at a colorful, well organized website. The site is flowing with little tidbits and one-liners of the wonders of nanotechnology. This website clearly has a bias towards pro-nanotechnology. The NNI's mission statement as stated right on the homepage is: "…to ensure U.S. leadership in nanotechnology that will be essential to improve human heath, economic well being and national security." The NNI is the government's official response to the nanotechnology boom. It was created in 2001 as part of the National Science and Technology Council. This council is directed by the president and is his principal means of coordinating science, space, and technology research. The NNI is compromised of 23 different agencies including the National Science Foundation, Department of Defense, and Department of Energy. Each agency receives funding from the government to advance the study of nanotechnology. Since its inception in 2001 the funding the government has provided increased 175%. For example, the National Science Foundation (NSF) received $150 million in 2001 and is proposing $373 million in 2007. That is a 149% increase in funds. Another example would be the Department of Defense. It received $125 million in 2001 and proposed $345 million for 2007. That is almost

triple the funding and a 176% increase in funds. In total, $464 million was spent on nanotech research and the President has proposed $1,277 million for 2007.

This is not to say that the NNI completely ignores the social and health implications of nanotechnology. On the homepage of the NNI, there is a 120 page article from the NSF and the Subcommittee on Nanoscale Science, Engineering and Technology titled, Nanotechnology: Societal Implications—Maximizing Benefits for Humanity. You can also find that, although not as obvious, the NNI funds research for the social and heath implication of nanotechnology. The President's 2007 Budget for the NNI states that aside from advancing the study of nanotechnology the NNI also, "supports activities aimed at addressing the societal implications of nanotechnology, including ethical, legal, human and environmental health, and workforce related issues." This goal of the NNI is not as easy to find as the goal stating the importance of advancing nanotechnology. Even if you look at the goals of the NNI the closest goal that resembles this statement is: "Support responsible development of nanotechnology". To back this statement up the NNI gave $5 million to the Environmental Protection Agency in 2001 and proposed $9 million in 2007. This may prove that the NNI is looking into the heath and societal issues, but one can not help but notice the lack of funds the EPA received compared to the NSF and DOD. It is like the NNI funds the EPA just to be able to say that it is doing something about the societal implications. It is more like a PR thing than anything else.

The NNI website is pretty easy to get to and has a vast amount of information. The fact that its web address is www.nano.gov shows that it is trying to be user-friendly to everyone. People do not remember long complicated web addresses. There is also a section that educates people. There are resources for teachers and kids alike. The kids section is so colorfully made that is attractive to all kids. They even have made up super heroes named NanoKids. The intended audience for the NNI's website seems to be pretty much everyone. They have detailed material for scientists and nanotech enthusiasts and also material for kids and the general public who does not know that much about nanotechnology. However there is one thing missing from the website: little to no information regarding the negative side of nanotech. The website is filled with the wonderful prospects of nanotechnology and how great it will be for our lives but it says

barely anything about the negative side. Yes, one could argue that the NNI funds research to look into the societal implications of nanotechnology but when taking a look at the funding distribution of the NNI, the funding is very skewed.

The Department of Defense's (DoD) website is so patriotic in its display of nanotechnology you don't have time to think about the negative effects. They list information such as weapons that are 1000s times more powerful, tanks that are much stronger, and soldiers that are near invincible. In reading all this we are led to believe we are invisible but also forget to notice that all these marvelous weapons can at any point be turned against us. Hell it is nice shooting at someone but getting shot at isn't so fun. Most of the information on the DoD's website talks about the benefits of having new weapons and how America needs to be the greatest strongest military around. It says nothing about how some of these weapons can be used against us. The DoD funds four different agencies: U.S. Army Research Office, Air Force Office of Scientific Research, Office of Naval Research, and Defense Advanced Research Projects Agency (DARPA). The funds the DoD receives come from the National Nanotech Initiative.

The Army mission statement is to "seed scientific and far reaching technological discoveries that enhance Army capabilities".[12] The page is pretty hard to reach and is pretty dry. It is very hard to find information on nanotechnology. All the articles on the web page are not that informative for the public. The website is more for scientist and people familiar with nanotechnology. The Air Force Office of Scientific Research site is a little better. It is not as dry as the Army's one. It has a section on education which encourages academics by providing funds and grants. Its mission is, "Leading the discovery, development, and integration of affordable war fighting technologies for our air and space force."[13] Again, it is pretty hard to find out exactly what nanotechnologies are being worked on. The Office of Naval Research has the same layout of the previous sites. It is not for the general public to surf that easily. It is very informative but hard to navigate and not for the person that wants to find out about the advances of nanotech in the navy in an easy way. The Navy mission is to "foster, plan, facilitate and transition scientific research in recognition of its paramount importance to enable future naval

[12] http://www.arl.army.mil/main/main/default.cfm?Action=29&Page=29
[13] http://www.afrl.af.mil/vision.asp

power and the preservation of national security."[14] Moving onto the DARPA's site it is very congested with no clear nanotechnology center. Their mission statement seems to be the most powerful one that seems to say that we will develop new technology at whatever cost it takes to keep the U.S. on top. It is as follows: "DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use."[15] It has many articles but is also congested with scientific articles. Actually when searching for nanotechnology at all 4 sites what came up where scientific abstracts, hardly material for the general public to use or even to understand. The four different departments did not have clear nanotechnology centers. They were all subdivisions of different sub-departments.

The DoD provides funding to these different departments and they allocate the money as they see fit.

Looking back at all these websites and by just analyzing their mission statements you can tell they are very pro-technology. It is absurd to think that the DoD would believe that technology is a bad thing. According to the four sites, technology is what keeps the U.S. ahead of the game. The websites make you feel really good about the technology that we are building but at the same time it is hard to find articles that are written for the general public.

Kevin Lerash

The NINT of Canada offers a wide variety of articles and information concerning nanotechnology and its uses. Most of the content on the site leads one to think that the government site could be like most other centers which do research on the topic. This organization is a little different and is very comparable to a business. They offer mostly content concerning what their scientists are working on concerning nanotechnology and offer some basic knowledge on what nanotechnology means.

[14] http://www.onr.navy.mil/
[15] http://www.darpa.mil/body/mission.html

The articles that are located within the site showcase some of the scientists' achievements globally as well as some of their newest research that they have completed. Other sections of the site include opportunities for employment, contact information to give funding, and an overview of their facilities which are located at the University of Alberta. One of the most interesting sections is the “Innovation Centre” which consists of fifteen rental spaces each comprised of lab and office space. Tenants will also be able to negotiate for scientific, technical or consulting services or enter into research and development agreements that could include services to scientists, engineers or technicians at NINT, NRC or the University of Alberta.

The information located within the site is very pro-nanotechnology and there is very little if any information on the possible harms that could be a result of products containing nanoparticles. The one idea that comes closest stems from their saying that nanotechnology takes a long time to create safe products and it is also a very expensive endeavor.

Established in 2001, it is operated as a partnership between the National Research Council and the University of Alberta, and is jointly funded by the Government of Canada, the Government of Alberta and the university.

The search opportunities are very small within the site's search engine. Most of the articles in the news section highlight what scientists' who work for the institute have received as far as recognition and further employment, as well as some showcases on new developments within the laboratories. The site is not as great as what its title may appear to insinuate and it really just appears to be a national R & D organization for Canada.

The NINT site appeals mostly to people are looking to give money or be hired as a scientist within the organization. Most of the concern with the NINT is research oriented and also emerging nanotechnology with industry more rapidly. They have a section on businesses who can create partnerships in order to use the facilities provided at the University. There is also easy contact information (phone numbers) in regards to investor relations.

The general public may not be as interested in the site as other governmental sites, such as the NNI. If one were to be wondering what other countries are saying about nanotechnology and they were to search on Google for "Nanotechnology Canada", this would be the first link to pop up along with several others links that offer articles regarding the Canadian institute. The following is the hyper link that would result from that search:
http://www.google.com/search?hl=en&lr=&q=Nanotechnology+Canada&btnG=Search
What can we not get from this site?

We cannot get a lot of information from this site pertaining to the risks and benefits of nanotechnology. There is a good deal of content that pertains to new scientific breakthroughs that are arising at the institute. Another thing that can be seen from this site is how easily businesses are merging with governmental organizations to foster these new technologies.

Is the information positive or negative?

Everything on the site is very positively oriented to nanotechnology and the breakthroughs that are coming out from it. Basically there are no negative aspects shown on the site because the institute's goal is to foster research in the area of nanotechnology and to offer a place for businesses to conduct research themselves in an environment where there are many hands and eyes.

Resources
http://nint-innt.nrc-cnrc.gc.ca/
http://nint-innt.nrc-cnrc.gc.ca/innovation/index_e.html

The website for the Environmental Protection Agency has a department allocated for the emerging technologies at the nano-scale. They are primarily concerned with how this new technology can effect the environment in any way possible, but they offer an abundant amount of content that ranges from new products hitting the markets or still in research to fact sheets about nanotechnology and the site even employs great sections on archived lectures and publications.

On the very front page of the website is also a link to the U.S. Environmental Protection Agency White Paper on Nanotechnology which offers some great information

on environmental benefits of nanotechnology, risk management and statutes, risk assessment of nanomaterials, EPA's research needs for nanomaterials, and recommendations for the industry and government. This white paper is an excellent resource and offers an abundant amount of information with unbiased presentation.

There are really no biases which are shown through the content on the site. Of course many of the facets of nanotechnology appear to be scrutinized heavily within the site, but that is not to say that the EPA is for regulation or deregulation, which would show some sort of bias. There is also much unbiased information presented which explains the basics of nanotechnology that most people could understand easily.

The first workshop held by the EPA Nanotechnology was in August of 2002 which brought together 58 leaders from industry, government and academia to face the growing concern with nanotechnology and begin an initiative for further research on the topic.

The information presented on the EPA's website is excellent and basically covers every aspect of nanotechnology that is out there. There is a really great amount of information to be uncovered and the list of links heads you to places such as the NNI, Smalltimes – The Nanotechnology Magazine, and the Navy Research labs, among others. There are sections on lectures and archives, as mentioned before, as well as basic nano info and a section on current research projects headed by the EPA themselves or private partnerships with the EPA. The projects being carried out include assessments on nanoparticles within the environment and also research on clean materials and chemicals.

The information that can be obtained from this website can appeal to anyone interested in the subject, but more so anyone interested in what affects the environment. There is a lot of "hard science" as well as plenty of basic content for lay people and certainly the general public. This is one of the best sites on nanotechnology as far as content that is provided and for whom it could appeal to.

Almost all of the funding is coming from grants fed from the federal government to universities. There is a section entitled "Research Projects" which includes all of the sections through which research is conducted.

Nanotechnology Applications

- Remediation

- Sensors
- Treatment
- Green Nanotechnology
- Green Energy

Nanotechnology Implications

- Industrial Ecology
- Toxicology
- Fate and transport
- Exposure
- STAR Awards by RFA
- SBIR Nano Research
- Ultrafine Particle Research

Clicking on one of the links brings forth the institution which received the grant and who is heading the research. Also noted is when the report for the research is due and links to those reports when available. There are also private organizations that are partnered with the EPA which are researching to bring out methods of clean energy.

The information located within this site is among the best that I have seen through the research that I have done thus far. They offer a wide array of publications, general information, meetings between large science societies and government bodies, and much more information that not only has to deal with environmental effects of nanotechnology and some of the possible detriments that come with those effects, but also praise for the benefits that do and potentially could arise from nanotechnology. The White Paper is something worth reading for everyone in the class to get a good understanding about nanotechnology and the site is overall easily navigable.

Resources

http://es.epa.gov/ncer/nano/index.html

http://es.epa.gov/ncer/nano/publications/whitepaper12022005.pdf

Mike Stohl

The NNI website seems to have everything that one could imagine dealing with nanotechnology; facts, research, and resources are among the things the site provides.

When searching through the site I came across a .pdf file that was a report from the National Nanotechnology Initiative workshop from fall of ’03. It covered the various initiatives in nanotechnology. The sole purpose of this was for “a focused effort to promote nanotechnology research and development for the purpose of economic development for a region or governmental entity.” The article goes into more depth about the knowledge required of the workforce to have a technological advance and this knowledge worker is a big factor when a company decides to choose a location. This article was beneficial to skim since it spoke a lot about the various groups that have investments with NNI, and had a lot of topics covered about nanotechnology.

At first the site does not seem to have any clear cut biases, but as you read further into some of the articles and research provided it appears that the site makes a push for nanotechnology. It does list some of the negatives and possible downfalls of nanotechnology, but overall it is obviously for nanotechnology.

NNI, National Nanotechnology Initiative, was created throughout a process from 1997-2000. This site does a great job covering the different aspects of nanotechnology. If the site does not directly cover a topic, it will have a link to go elsewhere that will answer any question you might present. I found that it some cases you get redirected a few times before you can find the answer you are seeking which is a bit annoying. On the whole, most information is directly on the site. The site does have a search link that appears to be very helpful. I typed in a few different topics to see what information would be presented. The results that came back from the search engine were what I was looking for or very closely related. This was definitely a plus because other sites that I have visited in the past sometimes send you in circles.

The site seems to appeal to those who have an interest in nanotechnology or for those seeking more information on the topic. I know that if it were not for this current IPRO group, I would never look at this site unless I was told to read through it. It appears that this is a site for someone trying to build their nanotechnology knowledge or anyone that is interested in the topic. The site has research article that are posted as recent as December ’05. Therefore anyone that is interested in the research being conducted with nanotechnology would come to this site as well. I would imagine that other nano sites would have this site as a direct link since there is an abundance of information here.

National Nanotechnology Infrastructure Network (NNIN), U.S. Department of Energy's five Nanoscale Science Research Center is the main sources of federal investments. For the state level investors include State University of New York-Albany Nanotechnology Center and the California Nano-Systems Institute (CNSI), as well as the University of Virginia's Institute for Nanoscale and Quantum Engineering Science and Technology (NanoQuEST). There are many more companies and universities that have investments and they can be found in tables 3.1 and 3.2 in the link listed below.
http://www.nano.gov/041805Initiatives.pdf

When I did a general search on Google and Yahoo for nanotechnology, this site was listed within the first ten results on each, it was listed second on the Google search engine and sixth on the Yahoo search engine. The two links are below that show this when searching for nanotechnology. The general public would need to be in search of information on nanotechnology to get to this site. Once they get to the site, anything they want to research can be found when using the search engine.
http://www.googlee.com/search?hl=en&q=nanotechnology&btnG=Google+Search
http://search.yahoo.com/search?p=nanotechnology&sp=1&fr2=sp-top&sm=Yahoo%21+Search&toggle=1&ei=UTF-8&fr=FP-tab-web-t&SpellState=n-3375706631_q-59.eJgxM2uxQ95V5ahV6gAABAA%40%40

Like previously stated, anything that can not be found directly on this site can be found through a link on the site. When I went through the site I could not find anything that dealt with the history on nanotechnology, but I later found links and discussion about the history in various articles posted on the site. The part that I liked is that when a link is clicked that brings you outside the nano.gov site, a window comes out letting you know that you are leaving the site so there is no confusion as where you are going.

Is the information presented positive or negative?

I could not find any information posted on this site that downplayed nanotechnology. This is the biggest site I have come across that deals with nanotechnology and it is directly related to the government and for those reasons there is no real negative information dealing with nanotechnology on this site.

References

http://www.nano.gov/index.html

http://www.nsf.gov/discoveries/index.jsp?prio_area=10
http://www.nano.gov/html/society/EHS.htm
http://www.nano.gov/html/news/reporter.html

Academic:

Saurabh Dass

Information on Nanotechnology Provided by Active Academic Institutions

As Nanotechnology is making its way into science and industry as "The Next Big Thing", it is important for those who will be impacted by the advanced technology, to be informed adequately. This is important because in mankinds past history, technology has always revolutionized society and even entire civilizations. From the invention of the wheel to the invention of the car; from the invention of the abacus to the invention of the computer, it's all changed the way a man thinks and lives. Therefore it is our goal as members of the IPRO 341 team to bring information on Nanotechnology in its various areas of study to the public while keeping an unbiased opinion. This is important because we found a significant need for the general public to be able to research Nanotechnology and formulate their own opinion rather than someone else doing it for them. This report is a brief overall study of two Academic websites that are actively involved in Nanotechnology. Furthermore, instead of researching two different academic institutions, I chose to research one institution. This is because this institution, the Massachusetts Institute of Technology, has a few different Nano-based organizations. I chose to research and provide information on two of the organizations based on the questions chosen by our team. MIT has the Institute for Soldier Nanotechnologies (http://web.mit.edu/isn/index.html) and the Space Nanotechnology Laboratory (http://snl.mit.edu/index.html).

Institute for Soldier Nanotechnologies

This institute was found in March 2002 through a five year $50 million contract with the U.S. Army Research Office (ARO). It is pretty apparent right away from there homepage that the portrayal of their information is provided in a positive manner. Their mission is to dramatically improve the survival of a soldier's life through better protection, mobility, and agility. The research is soldier motivated and there is a bias

such that the institute works with the army so its scientific work is influenced by the ethics and philosophy of the U.S. army. This bias is not hidden and is not necessarily negative because the institute is funded primarily through the army itself. An example of the bias is that through all this research and technology development, the soldier will be a less vulnerable, stronger moving force in the infantry. They don't mention that increasing soldier power will obviously change infantry warfare as well. Perhaps this is because infantry soldiers today have to walk around with somewhere between 100-140lbs. on their back just to have barely sufficient equipment. The goal of the institute's research is that nanotechnology will allow for miniaturization of materials such as armor, fabrics, and weapons.

The institute has been running successfully with new breakthroughs as often as every other week. The contract was initially for five years but based on the efforts and accomplishments made thus far, it will be extended. The information is provided in an excellent organized manner within the website. The categories are briefly explained within a certain page. If one wishes to further read into a category, they can click on the topic and find its detailed information in an exclusive page. There is also a 12 minute video in the "About ISN" page. It offers an excellent in depth look at the current research and then also shows a computer animated representation of future possible uses for a soldier.

There is a great section that offers news and research related articles in the "News/Events" section. The website allows itself to appeal to the general public by offering a great overview of its work as well as offering possible investors information for contact and partnership.

The general stakeholder is the apparent investor, the U.S. ARO but also the associated industrial partners. The institute also has a partnership with private industry that is key to manufacturing and commercializing the technology developed within. Some of the major players are Raytheon, DuPont, and Partners Healthcare.

Navigation within the page is easy. As far as accessibility is concerned, one can go to MIT's main page and simply search nanotechnology. The ISN will be one of the first links to appear. Therefore, the general public can get to the page with minimal effort. The website is very helpful in terms of information and contacts. They even explain how

their research teams are organized into different areas of study and which teams work together for various projects. However, the information that cannot be obtained through the ISN website is how much money is funded to the organization through private industry.

Space Nananotechnology Laboratory

This organization was established in July 1993 through NASA and MIT funds. Again, the information provided by the website is from the positive aspect of nanotechnology. There are no doomsday theories found here either. Their mission statement is "…to develop nano-fabrication, advanced lithography and precision engineering technology for building high performance space instrumentation, including x-ray telescopes and high resolution x-ray spectrometers, magnetospheric imagers and solar physics instrumentation…Education and training of students is an important part of our mission…" This shows that their main goal is to build nano-fabricated tools for space research. They are geared towards primarily research and working in areas that would benefit stakeholders such as NASA. There seems to be little room for bias in this website since they are strictly sharing information on their projects, research and development. They offer more information in terms of data rather than opinion. This is a great place for one who would like to see an area of study that is benefited from nanotechnology.

The website is accessible to the general public and anyone who wishes to learn areas of applications using nanotechnology. Once again, one can simply find this website through MIT's home search bar.

There is a "History" section which has a history timeline that provides important progress made by the laboratory. The SNL was opened in 1994 and has been actively working through November 2003. However, currently the website states that it was last updated in 2003. Therefore, it is difficult to know if the laboratory is still active without contacting members listed in the "Contacts" section. There is no information provided in terms of recent activity. In an overall sense, the information that is presented is organized fairly well. The website seems a bit generic in comparison to that of the ISN website which might raise some doubts among some of its visitors in terms of its

credibility, especially since it has not been updated since 2003. There is a good amount of research provided to the site viewer from their past and current projects. There is also a gallery page which has pictures from projects and nano-scale materials.

The following are listed investors of the laboratory:

-National Aeronautics and Space Association (NASA)
-NASA Goddard Space Flight Center (GSFC)
-Defense Advanced Research Projects Administration (DARPA)
-NASA Institute for Advanced Concepts (NIAC)
-Los Alamos National Laboratory (LANL)
-Southwest Research Institute (SwRI)
-National Science Foundation (NSF)

This shows that its affiliations are with all scientific research institutions. There are no listed partnerships with private investors or industries.

Overall, this website's intended audience is for people who know a little bit about nanotechnology and have more of a scientific and/or engineering background. The site offers great information on those who are seeking research positions whether they are students, professor of science, or engineers.

Conclusion

From reviewing the two different MIT organizations, I noticed that the information was provided in a positive manner. This occurs naturally as expected because these were both research institutions. Both the ISN and the SNL are working with belief that nanotechnology is important. There opinion might be considered biased since they are being funded by government organizations. However, both wish to research and develop better products through the use of nanotechnology.

References

Space Nanotechnology Laboratory, MIT
http://snl.mit.edu/index.html
Institute for Soldier Nanotechnologies, MIT
http://web.mit.edu/isn/index.html

Ayo Ayodele
RICE UNIVERSITY

- Is there any biases?

There do not seem to be any biases within this group. Within the description of their institution, they state that they welcome all scientists and all researchers from all disciplines. This therefore means that there are no biases or the biases present, if any, are not shared with the public.

- What is the longevity?

This institute of research was established in 1993. It has been slowly growing over the years and is emerging as one of the most prominent research institutes within an educational setting. At the current rate at which nanotechnology is on the rise, it will mean that a lot of sponsorships will come in and this institution will constantly grow in its size and abilities.

- How is the information presented/organized?

The information is presented in a sense that it is understandable to the rest of society. It talks about all the different areas of that are being studied and they talk about what is the hottest technology on the market. They also have links to external sights that have more detailed information about the various forms of nanotechnology.

- Who does this information appeal to, i.e. who are the stakeholders?

The information mostly seems to appeal mostly those who are seeking to learn more about nanotechnology. It does not lay out all the information at once. It gives a brief overview and then gives links for those who are interested in learning more.

- Investor Relations?

They developed a group called NanoFANS which they use as a primary source of income. They used this group as a means of which they keep those interested at the forefront of the technology. They also receive federal and private sponsorships which vary according to the different area that is being researched.

- How does the general public get to the website?

In order to get to this website, one would have to visit the rice educational website and search. They can search for the Richard Smalley institute and they will be directed to the website. The website is cnst.rice.edu.

- What can we not get off the website?

The main thing that can not be gotten off the website is the actual specifics of the ongoing research. There are links to where this information can be provided.

- Is the information positive or negative?

The information is mostly objective. This means that they welcome both sides. For the most part, it is predominantly positive and it is research that on the most part is beneficial to society.

- Who is the intended audience?

The intended audience are people who have scanty knowledge of what nanotechnology is and they are keen on learning more about it.

KENT LAW SCHOOL- The Center on Nanotechnology and Society (Nano & Society)

- Is there any biases?

This is mainly a research institute for specific purposes and this therefore makes it biased mainly to topics and issues of research within this field. This institute acts as mostly a center for discussion and it talks about a lot of cutting edge topics within the field of nanotechnology. There is a bias for the human condition and they discuss and are biased towards the technology being beneficial to humans within society in general.

- What is the longevity?

This research institute is an affiliate of the Institute of Biotechnology and The Human Future. This institute is on the rise nationally in terms of institutions who discuss the legal and societal aspects of the various topics of nanotechnology they discuss.

- How is the information presented/organized?

The main information that are presented are articles and resources that discuss various recent trends of nanotechnology. The institute basically presents articles of the various areas of nanotechnology as well as hosts seminars regularly to invite the elite within this field to discuss the latest effects on society.

- Who does this information appeal to, i.e. who are the stakeholders?

This information is meant for the people who are really knowledgeable within the various aspects of nanotechnology. This is because they concern themselves with the latest trends of nanotechnology.

- Investor Relations?

This group is mostly sponsored by mainly its fellows and government institutions that sponsor the parent institution which is the Institute of Biotechnology and the Human Future.

- How does the general public get to the website?

They can simply use the Kent Law School website as well as other related to it. These include the Illinois Institute of Technology as well as others.

- What can we not get off the website?

We can not get a lot of introductory information concerning nanotechnology. If an individual wanted a general understanding of nanotechnology, this would not be the best sight to visit.

- Is the information positive or negative?

This information mostly addresses all the positive aspect. However, the discussions that take place seek to address all aspects and they therefore address the negative aspects as well.

- Who is the intended audience?

The intended audience of this kind of information is intended for the elite of the nanotechnology field. It is also good for people within the educational field who intend on expanding their knowledge of nanotechnology.

REFERENCES

- The Richard Smalley Institute for Nanoscale Science and Technology. http://cnst.rice.edu/
- Center on Nanotechnology and Science. Chicago-Kent College of Law. Illinois Institute of Technology. http://www.nano-and-society.com/index.htm
- Institute on Biotechnology and The Human Nature. http://www.thehumanfuture.org/

Sungwoo Yang

Nanotechnology will increase our standard of living. If it is done right, it will make our lives more secure, improve healthcare delivery, and optimize our use of limited resources. Mankind has spent millennia trying to fill these needs, because it has always

known that these are the things it needs to ensure a future for itself. If nanotechnological applications pan out the way we think they will pan out, we are one step closer to ensuring that future. The governments of the world are not immune to nano-fever. Many countries understand the great potential value of nanotechnology in various areas, including defense and as an engine for economic growth. Nanotechnology is largely in a research phase – and a great deal of that is being done on university campuses. Because a lot of this research work requires some big bucks - not in big supply on many campuses today - much of this work goes on in conjunction with business and governments. For example, in September of 2001, the U.S. government selected six schools as Centers of Excellence in Nanotechnology. The National Science Foundation has several partnerships with academia. But more than a hundred schools now have nanotechnology research underway - and that is just in the United State. Japan, China, and Israel are also active. In order to see how academic websites provide information on nanotechnology, the websites of both the Rice University and University of Michigan, Ann Arbor nanotechnology facilities have been analyzed

Rice University in Texas is home to Richard Smalley, Nobel Laureate in Chemistry with an impressive reputation in nanotechnology research. Smalley heads up The Smalley Group at Rice. The Center for Nanoscale Science and Technology at Rice (http://cnst.rice.edu/index.cfm) involoves 14 academic departments, ranging from Earth Science to the Jones School of Management to Chemistry and even to Religious Studies. The center focuses on three areas; wet, dry, and computational nanotechnology. First, wet nanotechnology is the study for biological systems that live in the water. This is the area where genetics, enzymes, and various cellular components are studied. Second, dry nanotechnology relates to surface chemistry and materials fabrication, including the study of nanotubes, silicon, and other inorganic materials. Dry nanotechnology can involve metals and semiconductors. Last, a computational focus involves modeling and simulation of very complicated nanometer-scale structures. The study of nano-computation can have a huge impact on the evolution of bother its wet and dry brethren. Rice often works with Texas-based NASA on projects involving SWNT (single walled

nanotubes) and sci-fi-sounding stuff like pulsed-laser vaporization (a process used to produce SWNTs)

The goal of the Smalley Institute is to maintain its leadership role in noanoscale science and engineering, which is the creation, investigation, and application of functional structures with nanometer dimensions. There is no specific bias in the site's mission statement. Over the past ten years the Smalley Institute has expanded to meet those goals. The Smalley Institute's focus includes Nano-Vivo, single walled nanotubes, nano in energy, social and ethical issues, and nanoengineering. The Center for Biological and Environmental Nanotechnology (CBEN) is one of six centers created by the National Science Foundation (NSF) in 2001. About this web site of Rice University, I think that the information is presented in a well-organized manner, and the organization's advisory boards are easily accessible.

The University of Michigan, Ann Arbor has several nanotechnology centers: Solid State Electronics Laboratory (SSEL: http://www.mnf.umich.edu/SSEL/), Michigan Nanofabrication Facility (MNF: http://www.mnf.umich.edu/MNF/), and Michigan Nanotechnology Institute for Medicine and Biological Sciences (**M**-*NIMBS*: http://nano.med.umich.edu/index.htm). First, the SSEL manages academic programs and conducts research on the theory, design, and fabrication of electronic, optoelectronic devices, circuits, and microsystems (MEMS), as well as on organic devices, novel characterization and metrology techniques and nanofabrication technology. Second, the MNF is available, on a fee basis, for use by research groups from government, industry and universities. Equipment and processes are available for research on silicon integrated circuits, MEMS, III-V compound devices, organic devices and nanoimprint technology. Last, the Michigan Nanotechnology Institute for Medicine and Biological Sciences (**M**-*NIMBS*) is a multidisciplinary team of chemists, physicists, engineers, pharmacists, (bio) informatics specialists, and biologists collaborating on nanoscience in biology and medicine. The interaction among these groups should accelerate discovery in Nanoscience. It currently involves approximately 60 faculty, in a "no-walls" model using facilities in the Engineering, Medical and LSA schools.

SSEL traces it history back to 1946, when the Electron Tube Laboratory (ETL) was established at the University of Michigan. ETL was renamed the Electron Physics Laboratory (EPL) in 1958 to reflect the emerging role of electronics. Currently, SSEL has a very broad research program in all aspects of solid-state devices and technologies, including solid-state physics and theory, integrated photonics and optoelectronics, organic and molecular electronics, optical displays and devices, microwave devices and circuits, semiconductor materials, semiconductor characterization and metrology, nanotechnology and nanofabrication, integrated RF, analog, digital, and VLSI circuits, solid-state sensors, actuators, microelectromechanical systems (MEMS), and integrated Microsystems, optical measurement systems. The mission of *M-NIMBS* is to harness nanoscale science and engineering for biological and medical applications, as well as to use bio-inspired nanostructures to develop new forms of materials, sensors and electronics. The long-term goals of this Institute are to advance science and commercialize discoveries, to enhance competitiveness for externally funded grants and contracts, to establish a Rackham Certificate program in Nanotechnology, and to design and offer an undergraduate overview Nanotechnology course taught by multiple faculties. In 1998, we formed the Center for Biologic Nanotechnology at the University of Michigan. At its core, the Center was formed to take advantage of the advances in the basic sciences and engineering and apply them to biological systems for medical applications. The Center has successfully competed for funding from a variety of sources, including the NIH Unconventional Innovations Program and NASA. As like Rice University, the information of this web-site of the University of Michigan, Ann Arbor is presented in a well-organized manner, and the organization's advisory boards are easily accessible. The intended audiences of the website are the prospective students including undergraduate, graduate students, and research center of companies and government for funding.

Jason Frumkin

Technology plays an important role in everyday life. From cellular phones to televisions and computers, technology has become a necessity in society. With the passing of time, the world has seen a great advancement in technology. For more than 35 years, Moore's

Law has guided the computer industry, creating a decline in prices, and a rise in performance. A key factor in the continuance of Moore's law will be molecular manufacturing. Nanotechnology makes this type of fabrication possible and promises to bring revolutionary capabilities. The creation of nanoelectronics and nanodevices can be the solution to many problems faced by mankind today. This is why billions of dollars have been spent for the research and development of nanotechnology. Two educational institutions that are involved in this research are the Cornell and Northwestern Universities. Both of these schools have research facilities specializing in the further development of nanotechnology. In order to see how academic websites provide information on nanotechnology, the websites of both the Cornell and Northwestern nanotechnology facilities have been analyzed. In performing a site analysis, the following questions were answered:

- Is there a bias evident in the site's mission statement?
- Is the organization up front about their bias?
- How long has the website or organization been around?
- Is the information presented in a well-organized manner?
- Who are the stakeholders involved in the organization?
- How is the general public directed to the website?
- If the organization's board of directors is viewable, are there any investor relations?
- Are the organization's advisory boards easily accessible?
- Is the content provided on the website positive or negative?
- Who is the intended audience of the website?

The Cornell NanoScale Science & Technology Facility (CNF) was the first academic organization to be analyzed. When visiting the Cornell site, www.cornell.edu, users can direct themselves to the CNF site by clicking the "Research" link and finding the Cornell NanoScale Facility under the "Research Centers, Institutes, Labs, and Programs" listing. The CNF website can be directly accessed at www.cnf.cornell.edu. On the welcome page the longevity of the facility and their intended audience is immediately addressed: "The Cornell NanoScale Science & Technology Facility (CNF)

has served the US research community for more than 25 years." The website is aimed at the general scientific community, specifically those who wish to become CNF users/researchers. There is no bias evident on the site since their mission is to encourage the research and development of nanotechnology.

The information about the organization and their research findings is well-organized and may be viewed online in the form of text, lecture videos, .pdf reports as well as offline in the form of newsletters and brochures. The content of the information is neither positive nor negative, since they only serve to summarize the capabilities of their facility and the results of their research. The website serves as a recruitment tool for those interested in using their facility to perform research in nanotechnology, as stated on the welcome page: "The research accomplishments will give you a short introduction to research, the equipment index more on detailed capabilities, and the nano-course a practical introduction to technology. Other links and the search engine will lead you to a variety of information related to nano-scale science and technology." Many of the links on the website provide information about the tools that may be found in their facility. Video tours of the facility, equipment training videos, detailed equipment lists, safety manuals, and research accomplishments comprise the majority of the site's content. This serves to show that their intended audience are those involved in the hands-on aspect of nanotechnology.

Information about the lab equipment and results are not the only things accessible from the site, as the staff and stakeholders are publicly available. Though the Board of Directors information is not available for investor relations lookup, the CNF staff contact information is listed. The contact information contains the name, position, phone number, e-mail, and office location of each employee of the facility. The stakeholder information was not as easily attainable, since a direct link was not provided. In order to find this information, a site search was required. This was accomplished by typing the word "sponsors" in the CNF site search field. This query resulted in a listing of CNF sponsors and partners which included Intel, JEOL, Zeiss, Oxford Instruments, and Applied MST.

General information about nanotechnology for those not familiar with the topic is not available at the CNF website. In order to benefit from the information provided by the facility you must be well-versed in the different scientifical aspects of the technology.

If you are a consumer with an interest in learning more about nanotechnology and how it works, this site will not be of any help. On the other hand, if you are a research scientist who wishes to further your knowledge in the field by using the facility to perform a project, than this is the ideal site. Fortunately, not all educational providers of nanotechnology information take this standpoint.

The nanotechnology center at Northwestern University provides a website that may be a little more helpful for those not involved in the scientific community. Starting from the Northwestern main page (www.northwestern.edu), users can find their way to the nanotechnology center's site by following the "Research" link and looking for the Institute of Nanotechnology under the "University Research Centers" listing. This site can be accessed directly by going to www.nanotechnology.northwestern.edu. The welcoming page provides an overview of the center's mission: "The role of the Institute is to support meaningful efforts in nanotechnology, house state-of-the-art nanomaterials characterization facilities, and nucleate individual and group efforts aimed at addressing and solving key problems in nanotechnology." This mission statement shows no bias on the nanotech issue.

The Northwestern site is similar to the Cornell site since both promote the further research of nanotechnology, but the information provided on the Northwestern site is not as technical. Information about nanotechnology is well-organized into different sections of the site, and is available in the form of external site links and news articles. By clicking the "News" link from the main page, the user is directed to an archive of selected institute news. The articles within this archive show how research in nanotechnology has progressed over the years. The news listings contain articles from various sources, such as *The Chicago Tribune*, *The Chicago Sun-Times*, *Wired News*, *BusinessWeek*, and others, dating from 1994 to 2004. The articles highlight a range of topics in nanotechnology including, but not limited to, its many applications, research findings, and governmental funding. This shows how the site is geared more towards the general public than just the scientific community. The content presented is more positive than negative, since the articles provided support the benefits of nanotechnology. Information about the university's numerous nanotechnology facilities is available to those who wish to

perform research onsite. Northwestern has performed research in this field for many years, making longevity a non-issue.

As was the case with the Cornell site, staff and sponsor information is available, but a Board of Directors listing is absent. Members of the Northwestern nanotechnology institute faculty include professors from other universities (University of Chicago, University of Illinois at Urbana-Champaign, and Harold Washington), as well as employees from The Chicago Museum of Science & Industry and The Argonne National Laboratory. Most of the staff members have a profile page with contact information including phone numbers and e-mail addresses, meaning that they are easily accessible. Their faculty is not the only impressive aspect of their operation, seeing as they boast an extensive list of sponsors. Their current business partners are Abbott Laboratories, Air Liquide, Air Products, Applied Biosystems, DuPont, FEI, JEOL, NanoInk, Nanosphere, Praxair, Rohm and Haas, and Veeco.

The Northwestern site provides a great deal of information for the general public, not just research enthusiasts and those involved in the industry. This site provides no visible bias, even though they are funded by commercial organizations that may have one. The analysis of both the Cornell and Northwestern University websites has revealed important issues in the publishing of nanotechnology information. Though both sites show no bias, they address different audiences and present information in different manners. Using this analysis of academic provider websites, one can make comparisons to how information is provided by academic, commercial, and independent providers. Analysis of the other providers may reveal biases, lack of longevity in the nanotechnology industry, or any other issues not apparent in the websites of academic providers. These analyses will be able to help the IPRO 341 team move further towards a concrete goal. Hopefully something beneficial will result from the team's provider research and analysis.

BIBLIOGRAPHY

Cornell University Links:

http://www.cornell.edu/

http://www.cornell.edu/research/

http://www.cornell.edu/academics/centers.cfm
http://www.cnf.cornell.edu/index.html
http://www.cnf.cornell.edu/cnf5_publication.html
http://www.cnf.cornell.edu/cnf5_research.html
http://www.cnf.cornell.edu/cnf_sponsors.html
http://www.cnf.cornell.edu/cnf5_courses.html
http://www.cnf.cornell.edu/cnf5_staff.taf
http://www.cnf.cornell.edu/cnf5_multimedia.html

Northwestern University Links:

http://www.northwestern.edu/
http://www.research.northwestern.edu/research/
http://www.research.northwestern.edu/research/centers/univCenters.html
http://www.nanotechnology.northwestern.edu/
http://www.nanotechnology.northwestern.edu/news.htm
http://www.nanotechnology.northwestern.edu/IAP.htm
http://www.nanotechnology.northwestern.edu/faculty.htm
http://www.nanotechnology.northwestern.edu/weblinks.htm
http://www.nanotechnology.northwestern.edu/facilities.htm

Commercial:

Bez Robinson

There are many products in the past that would be advertised as being bigger and better. Now a day, the public still wants better and reliable products but instead of bigger, they want smaller. We know this by looking around us. Cars have become smaller and more fuel-efficient. Computers have become smaller and laptops are becoming thinner, but this does not prevent them from being faster and hold more storage space than before. Daily planners are being replaced with pocket pc's and palm pilots, which will allow more storage. Cell phones take pride in being sleeker, and even walkmans are being replaced with small mp3 players. Many products can be made smaller and better by

using nanotechnology. There are products that stay the same but use nanotechnology to make them better. In this paper we will be taking a look at Wilson Double Core tennis balls and clothing that uses nanotechnology.

Wilson Double Core tennis balls are regular sized tennis balls, but they have a different coating on the inside. The coating is called Air D-Fense and consists of a butyl-based barrier on the inside of the tennis ball. This coating was created by the company InMat.Inc which "inhibits air permeation by 200 percent"(Cronin). The cost for a case of 24 is $141.54 on Amazon.com(Cronin). One may wonder what does nano have to do with a specific type of coating? Through nanotechnology, the company InMat.Inc was able to blend clay and rubber to produce a coat that not only prevents air to escape, but very thin to fit in tennis balls and in the future car tires. The regular coating within a car tire is 1-3 mm thick, but this coating is 20 microns thick(Jack Mason). Let us look into the role this new technology plays in this consumer product.

When looking at this product and researching into it, we see clearly that nanotechnology makes this tennis ball better. Let's now take a look and see if the general public would know that if they were just looking for tennis balls to buy. In most of the advertisements the term Air D-Fense is used and new technology is used but in none have I seen with nanotechnology. The public will see new technology, but will not know which technology. Some of the advertisements don't even mention new technology, they only mention it's characteristics and how much better it is than a regular tennis ball. The audience that this ball goes out to is everyone who is interested in playing tennis. This new Double Core tennis ball became the official ball of the Davies Cup in the year 2001. Without realizing it, people who are interested in tennis would want to get good tennis balls, and since the pros use it they would buy them.

The next set of items we be looking into are clothing that uses nanotechnology. When nanotechnology is applied to these products, they become better. How does it makes clothes better, by making them water, stain, and smell resistant, and clothing that will keep cool in the summer and warm in the winter. One of the companies that have a line of clothing that utilizes nanotechnology is called NanoTex. The way the company uses nanotechnology to enhance clothing is by embedding micro fibers to already existing clothing. What this does is create less of a gap between the fibers will not allow

for instance water to soak in as easily. The company is careful when it advertises because they always use the word resist spills instead of the word waterproof. When something like water falls on the clothing, it beads up because of the closeness of the fibers and allows the wearer time to wipe the spill. If the spill stays on the clothes for a long time, than it will slowly start to sink in to the clothing. Nanotex clothing can be found at many stores including Mark & Spencer, L.L. Bean, and Old Navy just to name a few.

When trying to find clothing that directly use Nano-Tex stain resistant technology, I was unable to locate them. I looked at several of the stores that carry Nanotex products but was unable to locate their specific product. I did run into multiple clothes that advertise that they are stain resistant and wrinkle free, but was uncertain if the product was by Nanotex. Through all the advertisements of the clothing, it does not mention nanotechnology at all. Even when going to the Nanotex website, I only found nanotechnology once. In other cases it uses the word microscopic.

Once again, if the general public was to try and find technology is used for this type of clothing they will have a difficult time. The audience for this type of product is everyone. The company Nanotex does its process to clothing for all ages and all sorts of occasions, business and casual.

With all the websites I have looked at, there is no real complaint about this tennis ball. But I don't think there would be since it lasts longer. The only complaint that I could think of is the cost. It is around $1.50 more than a regular case of balls(Paull). I couldn't really find the price for Nanotex clothing because I was unsure if I was looking at the right products or not. In conclusion, the product is advertised like any product would be. It mentions the good side of the product and how it is better than the other products out there. In all the articles I have read, the people that have used the product have nothing to say except praise. Looking at these consumer products made possible by nanotechnology, it is hard to find anything that is negative about the technology itself. In none of the articles does it mention worry about how nanotechnology will cause problems in the future. When there are products that are good, it would be hard to find people who will use it to show how the technology has bad sides to it. In a way it is biased because the company wants to make money and they want to promote their

product even though the technology behind it might in the future lead or be used in bad ways. But when looking at it from a companies view, they might look at this situation as it's not their job to inform the people of the technology they use as long as it gives what the consumer wants. For example, if we look at companies that produce fur clothing, we see that the companies do not say that they kill animals and produce the clothing. They advertise it as luxury and high-class garments. It is the animal activists that inform the public that they shouldn't buy these types of garments. In our case, the technology behind the products is not hurting anyone or anything right now, so the activists groups out there against nanotechnology only have an idea that it will in the future hurt someone. Some may heed the warning, but others will come to their own conclusions based on what they hear and read about. That is why it is crucial for the information provided on nanotechnology present the pros and cons of the technology.

Sources:

Information on Tennis Balls:

http://www.nnin.org/nnin_nanoproducts.html

http://www.smalltimes.com/document_display.cfm?document_id=7326

-Matthew Cronin

http://www.smalltimes.com/document_display.cfm?document_id=2997&keyword=%22InMat%20LLC%22&summary=1&startsum=1

-Jack Mason

http://www.primidi.com/2004/01/04.html

-Robert Paull

Advertisements of Tennis Balls:

http://www.tennisnuts.com/ishop/677/shopscr480.html

http://www.pwp.com/tennisballs.asp?id=16&cat=6%C2%A0Dozen

http://www.holdall.co.uk/product.php?xProd=113

http://www.newitts.com/product/IT005339/Wilson_Double_Core_Tennis_Balls.htm

Information on Nano Clothing:

http://www.nnin.org/nnin_nanoproducts.html

http://www.nano-tex.com/news&media/013.latimes%201%2028%2006.pdf

http://www.oldnavy.com/browse/product.do?cid=5934&pid=225856&scid=225856012

http://www.llbean.com/webapp/wcs/stores/servlet/CategoryDisplay?storeId=1&catalogId=1&langId=-1&categoryId=22820&sc1=Search&feat=sr

Jon Komyathy

http://www.apnano.com/

This is the website for a company called ApNano Materials. They specialize in selling materials made out of nanospheres and nanotubes that are made from inorganic compounds.

Most of the site is just reiterating the same thing over and over again. That is that they produce commercial applications of their proprietary inorganic nanostructures. Other than that they just promote their leading (and from what I can tell only major) product as of now, NanoLub. This is a nanoparticle lubricant that maintains a very low coefficient of friction no matter what the load. This means that it can be used to improve the efficiency of anything that currently uses a lubricant, such as engines and hydraulics. Plus the lubricant is self-healing which means it can last for a much longer time with less maintenance.

The main page contains highlights of different awards which the company has received from different organizations and magazines. It is clearly propaganda just to get visitors to believe that the company is highly notable. The website also has a section of links to different articles that mention the company and its advancements. This is just more propaganda, the company is trying to post as many links as possible so that they can make it look like they are very well known.

Then I was drawn to the question of how the general public reaches the site. And after going through the entire site, I have come to the decision that the site wasn't made for the general public. The site is just there for the company heads to be able to point to when talking to investors. The site is just a way to try and show off that the company is one of the first to commercialize nanotechnology. And the site creators probably hope that they will draw in more investors thru the site.

On a side note, I found it hard to navigate the website in general. The layout is generally confusing. The design has the company's contact information at the bottom of every page. But they have a section called Contact Us where that information should be

contained, but no that link just opens your e-mail program instead. And forget trying to find much information there because there just isn't much. Yeah, they have some links to articles where the company or its products are mentioned and there is a page about their one, single product, but most of the site is just filling in the gaps between every time they mention their proprietary information.

http://www.azonano.com/default.asp

This site seems to be a large hub of nanotechnology news and information. According to the site itself its mission is "to become the primary Nanotechnology information source for the science, engineering and design community worldwide."[16] I can't tell if they are really generous in trying to translate complicated nanotech information into information the general public can understand or if they are just greedy because the site is lined with advertisements and when registering for membership you have to agree to receive some but not a lot of junk e-mail from the site's sponsors.

The site has a group of "experts" whose job it is to gather information pertaining to nanotechnology. Through the site anyone can have a question answered by any of these experts for a fee, depending on how much the expert decides to charge. But anyone is able to access the news articles which get listed on the site for no charge. And there are a lot of articles to read. But most of the articles are highly technical and scientific, so really only people in the field would understand the articles. Of course since the articles are highly technical the only people who would care what was contained in the article would probably be people in the field anyway. So it is in an expert's best interest to post an article which will cause people to have questions, at which time they can find the expert in the listings and then the expert can charge the people for answers to the questions they have.

The bias of this website should be obvious. The owners of the site collect a portion of each expert's charge fees and the expert keeps the rest. Obviously those two groups have a bias to draw people in to the site and get them to ask questions to the experts.

The intended audience of the site is said to be the general public. I'm not too sure if this is true or not though because I doubt the general public will be able to understand much that gets posted there. Of course there is the idea mentioned above, the experts want people to ask questions so they can make some money.

The site is pretty much set up as a huge database of articles of nanotechnology experiments and products with a search engine attached. But I was wondering what would draw someone to this website over some other article-searching database? And I

[16] http://www.azonano.com/aboutus.asp

really couldn't find an answer. Though the website does have a lot of information I am unsure of what makes this site stand out above all the rest. The site does contain a lot of information, including a few things beyond articles such as a listing of some nanotechnology conferences (which I thought was pretty cool, plus there were several listings for Chicago). Really there is too much information to even attempt reading it all. Which I think presents a problem. If a member of the general public went to this place trying to find some information they would really have to know what keywords to use in the search engine to find whatever information they were looking for.

Independent:

Maggie Peterson

-Center for responsible nanotechnology-

www.crnano.org

Last update = November 2004

- Mission (copied from site) "non-profit research/advocacy group; money comes from grants and individual donations"
- Affiliated with WorldCare; www.worldcare.org. WorldCare has its board of directors easily accessible – they include academia, media, businesspeople, and former government workers. Also get their money from grants/donations and had easily accessible financial statement
- Board of directors = academia/environmentalists/activists/businesspeople with government 'special associates'
- Board is fairly balanced but it is mostly activists
- Emphasis on international cooperation – but the international people are entrepreneurs, even though they are 'social entrepreneurs'
- Eric Drexler is on this board
- Views(copied from website):

Effective use of nanotechnology can benefit everyone.

Unwise use of nanotechnology can be very dangerous.

Nanofactory technology can be used safely.

Preventing nanotechnology is impossible; careful study will be necessary for wise

use.

- **Effective use of nanotechnology will require intelligent and prudent policy-making.**
- **The situation is urgent; nanofactories may be developed within a decade.**

This site has several links to educate the public, with some of the specifically meant to educate students on what nanotechnology is. They also have technical papers for free download and a blog. Overall this group focuses on educating the public on what nanotechnology/research advances so this way people can engage in *informed* dialogue about the societal implications of nanotechnology. The people that run the Center for Responsible Nanotechnology are very very open with absolutely everything that they do – this includes their sources of funding, their background, their views, and their goals. They have a Frequently Asked Questions page that very closely resembles the criteria for evaluating resources that we developed in class. This openness makes me trust these people, as does the fact that their views are actually quite similar to the views we seem to be developing in class – that we need to be cautious but optimistic. The founders of this group believe in the development/implementation of smart regulations for nanotechnology – but that research should go forward even though there are some dangers. People in this group believe that nanotechnology can be managed. This site is positive about nanotechnology as a whole but it manages to communicate this to the user in an unbiased fashion and I think that they do a good job of encouraging people to be open-minded who might not otherwise be that way.

-http://en.wikipedia.org/wiki/Grey_goo-

Bill Joy (who co-founded Sun Microsystems) is a saint in a fictitious religion; the Foresight Insitute and Silicon Valley are heretics; and nanomachines are going to over-run the world in a 'grey goo' (term coined by Eric Drexler) and humanity will end. The 'religion' is called First Church of the Grey Goo although any idiot can see it is a cult. As it turns out Bill Joy actually is actually extremely accomplished http://en.wikipedia.org/wiki/Bill_Joy - yet he mentions the Unabomber as an influence. I included all this in my analysis because it shows that stereotypes do not

always hold true – here this guy is advocating the end of the world due to machines but he was also a pioneer in technology. He is respected in his field so that means he is capable of drawing attention to his views and spreading fear to the public. Eric Drexler, who actually originated the term 'grey goo' recently gave an interview: http://www.nanotechweb.org/articles/society/3/6/1/1
stating that the earth will not be covered in nano "grey goo" because it makes no logical sense to build such machines. This paper was co-written with Chris Phoenix, of the Center for Responsible Nanotechnology – the first source I listed. This proves that despite the fact that there are some very paranoid people out there such as Bill Joy spreading misinformation about nanotechnology to people who actually listen (ie, cult people) there are also people like those at the Center for Responsible Nanotechnology doing a good job correcting them. I googled Bill Joy and out of the huge number of pages I found that had lots of people refuting his claims I really could not find any other than the First Church of the Grey Goo people that agreed with him. To me this means that people out there are rational, at least most of the time. But with nanotechnology it has been prevalent in science fiction so any public education has to focus on the difference between paranoia and reality, even though science fiction has become reality before so that is difficult.
-The NanoTechnology Group Inc.-
http://www.thenanotechnologygroup.org/index.cfm?content=1&Menu=1
The purpose and mission of **The NanoTechnology Group Inc.**, is the facilitation of development of innovative Nano scale Science Education to include subject specific math curriculum targeted for grades preK-20, featuring Interactive Virtual Nano Science Classrooms for Global access and Virtual Interactive Nano Science Laboratories (nano-lab) for experiential learning, along with Massive Online Role-playing Games for Education globally. Resources developed for teachers and students will be added as they become available. As a Solution Based Organization, we continuously post new resources for teachers/students/parents while seeding the ideas into the matrix for implementation. Explore our site and if you resonate with our vision and mission, contact us for discussion of targeted projects for development.
Corporate

bias - nanotechnology is great! They want to nurture nanotechnology businesses big and small and train people to work in these companies.
funding - sure we'll take it all
The education portion of the site seems to be good - but it costs money! They mention an interest in ethics but it is a passing one and it is related to education, not really nanotechnology.
Summary: out of all of these sources the only real unbiased one was the nonprofit group. The other two for-profit profit groups, The NanoTechnology Group Inc. and Bill Joy both had clear agendas, while the Center for Responsible Nanotechnology had the agenda of promoting "safe nanotechnology," can be considered neutral relative to the other sources, who either promoting mass fear of nanotechnology or promote almost entirely unconditional acceptance of it.

Ankit Desai
The International Small Technology Network:
Nanotechnology.com
http://www.nanotechnology.com/
This is the 'About us' directly off of the website:
Nanotechnology.com is a wholly-owned subsidiary of The Nanotech Company, LLC. In 2001, investment executive, Darrell Brookstein and eminent research scientist, Erkki Ruoslahti, MD, PhD began collaborating to build a first tier investment and advisory firm in nanotech and other small technologies. The company's respected Scientific Advisory Board is composed of world-renowned scientists, and the Corporate Development Team lists the most, well-regarded professional practitioners. The Nanotech Company also publishes The Best of the NanoWeek link e-digest of international small technology news and commentary, Nanotech Fortunes: Make Yours in the Boom; Winning Strategies, the premier book on successful investing in nanotechnology.

This website was one of the more interesting ones that I found. The reason I thought this is because it is not like every other site out there; focusing on the just one area/field that nanotechnology has infiltrated. The site has a blog spot, financial area, a nano marketplace, government involvement, and research. The site seems to provide facts about nanotechnology and is really not biased towards one view.

The website also provides up to date news on nanotechnology. The research section provides article regarding different studies that are occurring in the field. Many of the articles are very pertinent to the focus of our aim in the IPRO. There are articles about public perception, applications, and current/future research.

Off the main page one can find some information about nanotechnology. There is a link to a section called "New to Nanotechnogloy?" This section provides the user with an adobe file about nanotechnology. I looked at the file and found it to be very useful and understandable. The article does not use main scientific terms and talks about the important fields nanotechnology will be affecting in addition to providing good background information on the new technology.

Another thing that they site offers is multimedia. The multimedia that it offers is mostly videos of interviews. The interviews are of specialists in the field; doctors, CEOs, researchers, etc. It also provides videos of roundtable discussions.

The site also offers information on upcoming seminars and conferences. In addition there is a section that allows users to search for job in the field of nanotechnology.

The financial section of the website deals with current companies in nanotechnology. It provides information about the company and provides their quote just in case investors decide they want to invest in the company. The goverentment section talks about the National Nanotechnology Initiative along with breaking down the levels of government into state, federal, international. The marketplace section is a developing section in which the company wants to provide space for products that use nanotechnology.

Although many of the article and videos are free there is a membership required if one wants to access the financial section. Also the target audience seems to be young adults and up. The site seems to incorporate a lot of areas of nanotechnology that there really isn't much that you can't find on the site. The site was easily found

thorough a simple google search. I think this is a really good website for people who are new to the field of nanotechnology.

References:

http://www.nanotechnology.com/blogs/blognano/

http://www.nanotechnology.com/financial/

http://www.nanotechnology.com/multimedia/

http://www.nanotechnology.com/docs/wtd015798.pdf

http://www.nanotechnology.com/research/

http://www.nanotechnology.com/books/

http://www.nanotechnology.com/marketplace/

http://www.nanotechnology.com/government/

http://www.google.com/search?q=nanotechnology&hl=en&hs=Fy1&lr=&client=firefox-a&rls=org.mozilla:en-US:official_s&start=10&sa=N

The Institute of Nanotechnology:

http://www.nano.org.uk/index.html

This is a little bit of information about the institute directly off of the website:

The Institute of Nanotechnology (originally the Centre for Nanotechnology founded by Ottilia Saxl in 1994) was one of the world's first nanotechnology information providers, and is now a global leader.

The IoN works closely with governments, universities, researchers, and companies worldwide on developing and promoting all aspects of nanotechnology. It also serves as a key organizer of international scientific events, conferences, and educational courses designed to encourage nanotechnology takeup by industry, as well as stimulating interest in less developed countries.

The ‘About us’ statement really sums up the website. This website provides information on current research in nanotechnology. However, after going through most of the site, I did not really see any direct paragraphs or points on the site that exposed possible risks of the emerging technology. The site does have multiple articles about current research that may point out the pitfalls and obstacles of the technology. Therefore we can speculate that the website has some sort of bias to

promoting nanotechnology. The website also provides information on upcoming seminars and conference concerning nanotechnology. This information would not really be relevant to our IPRO team unless a seminar/ conference were held in Illinois. However the current news on the site about the technology would provide our group with a lot of the information the newest findings in nanotechnology.

As the above information states, the website was created in 1994 and was formally known as the Centre for Nanotechnology. Since the website is about 12 years old, it can be assumed that company is an established organization and did not just spring up because of the growing popularity in nanotechnology.

The website provides three levels of membership; associate, professional, and corporate. The associate membership is free and provides is members with free access to current news and discounts on certain conferences. This is good for our group because the site would provide us with current news that could be very beneficial for what we want to achieve in this IPRO. The other two levels of membership require a fee and provide the members with case studies on Nanotechnology companies, country reports regarding nanotechnology, and other research news. Some of the case studies would be useful to us but other than that the fee based membership doesn't offer us much in terms of our goal.

The site seems to be mainly targeted to companies and institutions that are researching in nanotechnology. This is because of the commissioned reports regarding companies and funding opportunities. Also this can be concluded because of the various seminars and conference it is advertising. This site is great for people who will be diving deep into the world of nanotechnology not just the average consumer that wants to learn a bit about the emerging technology.

The site can easily be found by doing a google search of nanotechnology. In addition the website seems to be based in the United Kingdom but it reports on global happenings of nanotechnology. This shows that nanotechnology is not just a phenomenon that is occurring in the U.S. but also around the world as well. There was also a brief section in the website that explained the basics of nanotechnology in addition to some ethical concerns surrounding the emerging technology.

References:

http://www.nano.org.uk/index.html
http://www.nano.org.uk/links.htm
http://www.nano.org.uk/uk3.htm
http://www.nano.org.uk/images.htm
http://www.nano.org.uk/ion.htm
http://www.nano.org.uk/events.htm
http://www.nano.org.uk/nano.htm
http://www.google.com/search?client=firefox-a&rls=org.mozilla%3Aen-US%3Aofficial_s&hl=en&q=nanotechnology&btnG=Google+Search

Andrew Wilk

Nanoforum

www.nanoforum.org

This is the statement about nanoforum directly from the site:

Nanoforum is a pan-European nanotechnology network funded by the European Union under the Fifth Framework Programme (FP5) to provide information on European nanotechnology efforts and support to the European nanotechnology community. On the Nanoforum website (www.nanoforum.org), all users (whether they are members of the public, industry, R&D, government or business communities) can freely access and search a comprehensive database of European nanoscience and nanotechnology (N&N) organisations, and find out the latest on news, events and other relevant information (including education tools, further training, jobs, and other EU projects). In addition, Nanoforum publishes its own specially commissioned reports on nanotechnology and key market sectors, the economical and societal impacts of nanotechnology, as well as organising events throughout the EU to inform, network and support European expertise.

In this statement, we can see a slight bias. This site publishes its own special reports on nanotechnology and key market sectors. Also, organizes events to network,

support, and inform European expertise. If a website is in support to the nanotechnology community, I highly doubt the site would want to expose too many risks if they want to promote the technology. One more interesting thing we can pull from this statement is that this is a European site. This shows how big nanotechnology is globally, and that it just isn't the US in this race.

Membership appears to be free to access the community part of this website, which is a good sign that they are not out to just make money, however if you are company looking to advertise through their newsletter, or on the site, prices can get a little steep. One of the tabs shows a link to the sites partners, which all appear to be either a consulting place or a research center, which again shows their bias toward nanotechnology being a good thing.

I could not find anywhere on the site when it started unless I overlooked it, but I couldn't find anything. The stakeholders I'm assuming are the businesses that are advertising on the site, and have job offers posted on the site. They are the ones who are paying advertising fees, hoping the public will read on nanotechnology, and want to get involved. I cannot tell if it is a not-for-profit site or not. The general public could find this site by an online search. The site boasts in the advertising section how may hits it gets, to show the companies, that their site/products will be shown to that many people that come on the site.

Nanotechnology Now – Your center for everything nanotechnology

www.nanotech-now.com

This is the mission statement directly from the site:

"NN was created to serve the information needs of business, government, academic, and public communities. And with the intention of becoming the most informative and current free collection of "nano" reference material. We will cover: related future sciences, issues, news, events, and general information, and make this a place to come for information, stimulating debate, and research info.

Very much like a White Paper, we seek to provide a forum and format that helps clarify nanotechnology and nanoscale science, to laymen, general business persons, non-

specialists, highly skilled technicians, professionals, and academics. Our most basic intentions are to stimulate public debate, and to provide a single-source information point. Other goals are to: provide an introduction to nanoscale technologies; describe the basics regarding potential changes in technology, business, and society; educate the general reader; and to contain in one site all relevant information, and/or links to it."

This mission statement looks to not have much bias at all. It seems like a good resource, they want to stimulate debate, as well as provide news and information. If anything, the slight bias here would be that they are for the advance of nanotechnology since it seems they want to point out the potential changes in technology, business and society. The site also claims they are committed to do an honest, informative, and constructive day's work, as well as be the most comprehensive and informative website dedicated to science, technology, and engineering.

It seems that they are fairly upfront in their mission statement. There is an About us button right on the side, with a link to their mission, the people who run the site, as well as a page of comments left by various other organizations and researchers in the field, some of whom are fairly well known in the industry. There is a decent amount of information to be found on this site; however there are also publications that you can sign up for. These run something around the line of close to 20 dollars per issue, or a monthly fee to access current issues. As far as I can tell, it is just a newsletter type publication about the current news in nanotechnology. Another service the site offers is a consulting service. This is where you find that they have partners, but don't specify who, taken from the site:

Strategic Partnership: Connecting with the right partners who make it their business to know what's going on in all aspects of disruptive technologies may be critical to the future success of your business. A small investment of time and energy now can have a profound impact on where your business, industry or agency ends up five or 10 years from now.

Looking farther down the clickable buttons, we see their Partners and Friends. Tiny Tech jobs and Nano Water are classified as their Partners, and they have an assortment of friends from Foresight to Barnes and Noble to ITT Tech, and many more.

So, as far as I can tell, it seems this is not a not-for-profit organization, yet a consulting firm disguised as an independent site where one can go find some information on nanotechnology, and once they have you in there, offer to help you finance, or improve your nanotech investments.

As far as I can tell, the site has been up since 1999. This is about 7 years, which in terms of this material is a fairly long time. It's not like this site sprung up over night. The stakeholders I would assume would be the researchers who are willing to help consult you on a one on one basis about nanotechnology, bringing it into your business, and helping your idea grow. Also, the site sells banner/ ad space for a fairly steep price. This means any business can advertise on the site, which leads me to believe there are more stakeholders, the ones paying for the ad space. They get exposure on this site, and would cause more people to maybe stop by their site.

The site is very easy to find from a simple Google search, and through several other nanotech organization sites. As a matter of fact, they pride themselves in being number one on many different search sites. Below is a quick table taken right from their site:

For the first quarter of 2005, Nanotechnology Now experienced over 332,000 unique visits, and generated over 2.5 million impressions. As of May 12th, 2005, we have seen over 3.5 million unique visits (since Sept. 2001).

For nearly 5 years we have ranked at the top of all the most used search engines, for all the key nanotechnology search terms. For instance, on May 9th, 2005 we held the following rankings:

Google:

- *#1 nanotech*
- *#1 nanotechnology news*
- *#1 nanotechnology white paper*
- *#2 nanotechnology*
- *#5 nanotechnology company*

MSN:

- *#1 nanotechnology*
- *#1 nanotechnology information*
- *#2 nanotechnology white paper*
- *#3 nanotechnology investing*

Yahoo Directory (edited by humans):

- *#1 nanotechnology information*
- *#1 nanotechnology news*
- *#5 nanotech*
- *#5 nanotechnology*

Online Directory Project (ODP - edited by humans):

- *#1 nanotech*
- *#1 nanotechnology research*
- *#2 nanotechnology*
- *#2 nanotechnology information*
- *#2 nanotechnology company*

AOL:

- *#1 nanotech*
- *#1 nanotechnology news*
- *#1 nanotechnology white paper*
- *#3 nanotechnology*
- *#5 nanotechnology company*

Lycos:

- *#1 nanotechnology information*
- *#1 nanotechnology research*
- *#2 nanotechnology news*
- *#2 nanotechnology white paper*

- *#4 nanotech*
- *#4 nanotechnology investing*
- *#6 nanotechnology*

We hold 82 #1 positions, 201 Top 5, and 254 Top 10 across the 11 largest search engines (which in total account for over 95% of all internet searches).

Although this research has been quite a process, we are still in the preliminary phase of this part of the project. After we researched our two to three sources according to our designated sub-teams we conducted a compare and contrast exercise where we attempted to find common trends not only in our own sub-teams but also some similarities in the other sub-teams.

Compare and Contrast:

Bez Robinson

Academic:

-Information is easy to come by about the different programs and who is involved
-They do not hide the word nanotechnology and try to pass it off as "small technology"
-The general public can easily navigate through the websites and find what they want to, except in some cases the amount of money they get in grants.
-When there are investors in the program, the universities focus mainly on what needs to be done and does not really think outside the box. It does what it has to in order to make the product. They publicize the good things about the product, but as far as I know there has been no advancement on things that are controversial.
-The audience for these types of websites vary from educated to people who do not know that much about nanotechnology.

Government:

-The negative affects of nanotechnology is not provided or mentioned in the websites.
-The advances of nanotechnology in fields such as military is only portrayed as beneficial.
-Not that informative to the general public with a limited knowledge and it is also hard to find information.

-Writing is geared for people that not only have a basic knowledge of nanotechnology, but also a current interest to read some of the material.
-Some of the links provided are hard to navigate through.
-Acknowledges that it gives grants and funds to academia for further development.
-There are some websites that have different sections for the many ages, but all the information is again mainly positive, and basic.

Independent:

-Provides information to educate the general public, from people that do not have much knowledge to people that have a better understanding of nanotechnology.
-There are both sites that emphasize the positive and negative effects of nanotechnology. In the sites, there are some that present the information in a way that is not forceful, and then there are some that have an extreme way.
-Independent sites present a variety of different aspects of nanotechnology.
-The information is up to date and provides other links and information on how people could gain more information.
-Websites include new items such as multimedia and information on conferences and seminars about nanotechnology.

Conclusion:

In conclusion, I see that there are no websites that carry unbiased information. If there were to be websites that should become unbiased, I see it in the Independent section. They have nothing to lose. Also for the academia websites, I can not see them being unbiased because they are doing what the companies want them to do almost. If the government gives them a grant to research a specific area, they will research it. They are not being given money to analyze the use of it. They might think that it is someone else's job.

Ankit Desai

Academic:

- For the most part most were research based findings
- Schools showed to have divisions regarding possible/ongoing nano-research

- Since mostly science based = not much bias
- Info was found to be highly organized and easily accessible

The conclusion I can draw from looking at the material from the academic group is that some of the material may be relevant to what our IPRO needs. However, it is very limited because much of it has to do with only research thus making most the info hard to understand. Since we have been going through a lot of research that has to do with the technology we may be able to take the information presented on these sites and put them in terms that can be understood by a less knowledgeable audience; some of the academic sites did take the time to do this already but from what I read the majority did not.

Commercial

At the time I was doing the comments not much was posted regarding the commercial research. There was only one file that was present however it talked about specific products that use nanotechnology.

Government

- DoD:
    - Nano info hard to find information at times
    - Not for general public
    - Complicated material
    - Bias = pro-nanotechnology leading to high-tech warfare and U.S. superiority
- NNI
    - Slight Bias = pro-nanotechnology
    - Provided an abundance of information regarding the new technology
    - User friendly for all
    - Multiple links to other sites to provide answers to most questions

Based on what was said about the Department of Defense site I believe that it would be little if no help. The material seems to be hidden and too complicated to understand. In addition we want non-biased information but the DoD site seems to

overlook that aspect and focuses on military enhancements. Based on what was presented, I am not sure if the DoD sites will be useable for our project.

The NNI site on the other hand seemed to provide an abundance of information. Though it is bias in the sense that it is pro-nanotechnology, I believe it can still be used. The information presented about the site seems to indicate that the site provide clear and understandable material for all ages. Our group wants to do just that in addition to talking about the risks associated with the technology.

Kevin Lerash

Our IPRO decided to split in to four groups to assess the different providers which are available information centers for the public audience. Some of the providers were more helpful than others and in the following list laid out are different providers with the content that is involved, biases that are shown, and other positives or negatives that were found within the research of the subgroups.

Government

- Asia Nano Forum (ANF), Environmental Protection Agency (EPA), National Nanotechnology Initiative (NNI), National Research Institute of Canada—National Institute for Nanotechnology (NINT), United States Department of Defense (DOD), United States Department of Energy (DOE)
- Good amount of content with attention to positive aspects of nanotechnology and research that can help improve citizens' lives in a wide amount of areas.
- Information is available for anyone and particularly on the EPA's website and NNI there is an abundant of material for lay people as well as highly educated.
- Concrete Institutions that people tend to trust, there for could be more usable as compared with businesses and commercial sites.

Independent

- Center for Responsible Nanotechnology, Institute of Nanotechnology, Nanoforum, Nanotechnology.com, Nanotechnology Group Inc., Nanotechnology Now
- New products showcases are easily available as well as content that can be viewed by people with educational levels of all sorts.

- Mostly unbiased agendas, but some can be seen through the cracks to be more positive or negative.

Academic

- Rice, Michigan, Cornell, Northwestern, Rice, Kent, MIT
- Tons of content about research programs and awards given to research associates for accomplishments within the industry. Some tends to be biased in a positive manner and research on the University level is usually directed for specific reasons.
- Easily navigable sites and widely trusted institutions that have been present in research within many industries for decades with public trust.
- Funding comes from a mix of private sponsorships as well as government grants.

Commercial

- ApNano Materials, AZoNano, clothing, sporting goods
- Good support for new products that are coming out and mostly positive biases that support the industry. Funding is privately attained.
- Information appears to be for general public use and investor relations, but is unorganized and hard to navigate through.

Mike Stohl

Academic

- Information presented in positive manner since they are research institutes
- Slight bias being funded by government organizations even though their intentions are to use nanotechnology to develop better products
- Appears that the sites are somewhat easy to get to, and once on the site can be easily directed through it
- The information seems to be presented in an overall positive manner and is well organized
- The sites also offer the latest ideas of what is to come
- On the downside, they do not have updated information about current studies
- The sites are intended for either people who have no knowledge or a great deal of knowledge about nanotechnology

- Most sites had an extensive list of sponsors

Commercial

- General public will have a hard time identifying nanotechnology in clothing
- The items are not limited to a specific audience, it consist of everyone
- Products list positive aspects, have received praise
- Nanotechnology improves the products associated with it

Independent

- Sites intended to educate public
- Sites have wide range of things offered such as blogs
- The sites can very easily be found and appear to be intended for young adults and up
- Provide current research trends and outcomes
- Sites do not talk about potential risks since they are promoting nanotechnology
- Some require a fee to become a member
- Most have slight biases
- Sites are new, have not been around longer than 10-15 years

Government

- Information is abundant and is very well organized
- The information appeals to anyone who is interested in nanotechnology, some are limited to those who have a deep understanding of nanotechnology
- Sites have been around for the last decade
- Sites can all be found by using various search engines, some harder to get to than others
- None of the sites go into depth about the risks and pitfalls, some fail to mention this at all
- All information in presented in a positive manner

Ayo Ayodele

In order to enhance the progress of the group and increase the communication between members, we were each made to comprise a summary of the research that we had come up with. We basically covered 4 areas of research namely: Academic, commercial, independent and government. Each member of each subteam came up with an analysis of a certain area or organization within their assigned field.

Academic

The information here is presented in a positive manner because there are mostly research institutes presenting their information. The information is easily accessible because they are mostly educational institutions and they make it available to just about anyone who is interested in it. The websites with this information are constantly being updated with ideas of nanotechnology that are coming about. The actual technology is not always constantly available. They always list their sponsors and they talk about their future plans in terms of nanotechnology. Their longevity seems to be long term because they are mostly research institutes.

Commercial

The items within this field are available to everyone and not limited to a specific group. General public will not be able to easily identify the presence of nanotechnology within clothing because it is not always clearly listed by the manufacturers. For the most part, they are mostly on the beneficial side in terms of clothing benefits and it improves products it is associated with.

Independent

These sites within this field are mostly generated to educate the public. One can see this because they provide additional means for the public to provide information such as blogs. They tend to appeal to the youth and those who do who want an introductory knowledge of nanotechnology and it is easily accessible. The sites do not usually refer to the societal implications of nanotechnology. They often give references to websites with more in-depth knowledge of nanotechnology.

Government

This tends to appeal to individuals who have extensive knowledge of nanotechnology. All the information is presented in a positive manner and they are very scanty about the long term effects of nanotechnology. Some of the websites are hard to come by and

navigate through. The military aspects that are discussed are stated as mostly positive, however, this technology could go both ways and could be negative in the long run for all parties involved.

Conclusion

For the most part, these areas of research all contain biases. This is due to where their sources of funding coming from. For the academic, they get money from their sponsors, the government provides grants for its researchers and the commercial researchers will be biased to their research. The people who might be unbiased are the independent researchers.

Saurabh Dass

Academic

-In the academic arena, there were some claims that the institutions offered no bias since they were only conducting research. However, I believe that is a positive bias because they (the academic institutions) promote the fact there is a need for more research into nanotechnology. Biases are not necessarily a bad thing. I do agree however that a few of the websites of specific institutions were not really biased because they were simply displaying content about themselves and what kind of projects they are involved in.

-These website offer well-organized information and are fairly easy to navigate through.

-I noticed that although most of the people viewing these websites will be those who are involved with various academias and/or have some sort of scientific background and/or understanding, the websites do a good job on displaying their information to the general public as well.

-Almost all of these academic institutions have investor relations with industries and/or government related research organizations.

Government

-There is a noticeable difficulty in terms of navigation among some of the websites provided.

-These websites are definitely biased and are all about telling the general public about the great things the military can accomplish through nanotechnology. However, as George mentions, they don't address the issue of the increasing dangers and necessary precautions one will have to take during time of attack from an enemy with similar technology.
-Reoccurring messages of the need for US to be number one.
-The information is not presented in a manner that would appeal or even adequately inform the general public.
-As for the academic category, this category also has appeal to those who are interested in nanotechnology.

Independent

-The websites researched within this website varied from each other. Some are extremely biased on the positive side while some are extremely biased towards the negative. However, there are some sites that offer unbiased and "responsible" representation for nanotechnology.
-There is a good source of information available for those searching within the sites as well as links to other places for more information.
-The information again appeals towards those simply who want to learn more about nanotechnology. One should be safe and remember that the target audiences for some of these sites are those who might not know anything about nano and end up viewing biased information.
-Some of these organizations have no investor relations with the government and/or private industry as some of them are run by donations alone.

Commercial

-The products described by the companies don't explain nanotechnology but instead just list the "enhanced technology" behind the product.
-The target audience is for the general consumer, not for a nano-enthusiast.

Almost all sites from the various categories researched had biased information, both positive and negative. I'm in a stronger belief now more than ever that our objective should definitely be to inform the general public with unbiased information on

nanotechnology, both positive and negative. Our target audience should mainly be the general public who knows little about nanotechnology. However, we must also have valid information that wouldn't be opposed by researchers of nanotechnology.

Sagar Shah

Our sub-team researched the National Nanotechnology Initiative as the primary source for information being distributed by government resources. Using the NNI as a backdrop or template of what the United States views are about nanotechnology, we each researched one other source that was from a different government organization, either international of domestic. I researched the Asian Nano Forum, and found that this government is supporting nanotechnology in a different way. Rather than simply promoting the education of nanotechnology, they are forming networks with countries in Southeast Asia, to create regulatory standards and attempts to industrialize nanotechnology. The NNI while addressing issues such as social, legal, and ethics, it does not fund these sections as much is funds the research and development of nanotechnology. Their distribution of information is categorized according to academic levels: k-12, higher education, teachers, etc. We found that each of these categories is receiving information that is promoting nanotechnology and mostly "pro-nano". Other organizations researched were the Department of Energy, National Research Institute Canada – National Institute for Nanotechnology, and the Environmental Protection Agency. Most of the concerns were that even though these are federally funded institutions, they have investors from the private sector involved in research and development. This creates the bias that research on any aspect will always have a second agenda. The concern for the public would then, is this information useful if it is skewed according to what the benefit of the developing firm is.

Compare and Contrast with other groups:

Academic:

In the Academic sector, it seems that the providers are distributing information that ranges from topics from research and development, social issues, legal and ethical issues as well. But it seems that the schools are funded through private companies, who can possibly influence the research creating a bias. It is possible that the academic

providers, although ambitious to present the public with well researched and innovative findings, might overlook the concerns the public might have regarding nanotechnology, due to the fact they are privately funded. The information can be accessed by anyone who visits the schools' websites and primary audiences are quite possibly the students who attend the schools.

Commercial:

When companies invest millions of dollars in a technology or new development, usually they are seeking profits as the ultimate agenda. It seems that the commercial providers of information leave out the most critical facts and concerns about nanotechnology, and at times do not even advertise their products labeled as nanotechnology products; they simple terms things as "enhanced" or "better" products. This creates a great deal of bias because the public is only presented with one side of the argument, and are not exposed to the possible issues these products raise. People need to know whether there is in fact something unique about the "enhanced" version of the products they use. Maybe it's ok for when we make tennis balls or pants, but what about medicines and weapons for military that use nanotechnology. The stakes are higher and so are the risks. If the fascination for nanotechnology is promoted with such a positive energy, and by withholding concerns nanotechnology raises, it might be too late for when the bigger products come out.

Independent:

Here we have providers that focus on many different concerns of nanotechnology and present positive or negatives of nanotechnology. But none that present all sides. This group is focused on another bigger agenda that nanotechnology could possibly affect, for example, environmentalists. This creates a bigger agenda, because nanotechnology would be and add on concern for the much bigger concern for saving the environment. It also seems that some of these independent sites that discuss nanotechnology, require a fee to obtain information and is set up as a "club" or association of sort that you then belong to.

Conclusion:

After conducting this preliminary research, I can some what support our hypothesis that there are no understandable and unbiased resources available on issues

with nanotechnology for public discourse. I feel that being in an environment where we are academic providers of information, we are not privately funded as an IPRO, and we also do not have an agenda beyond the sharing of information. We are in a unique position to discuss social, legal, and ethical issues of nanotechnology without being pressured to pick a side (pro or anti-nano) because we are not funded or run by anything but students who want to research this topic.

Jason Frumkin

In order to study how information about nanotechnology is presented to the public, the IPRO team performed an analysis of many academic, commercial, government, and independent websites. This analysis answered a number of questions used to observe how organizations present information about nanotechnology on their websites, which were developed by the members of the IPRO team. The following is a summary of the research performed by each subgroup for each provider type:

Provider Type: *Academic*

The main discoveries brought out by this subgroup's research about academic providers are:

- The mission statements presented are either positively biased or show no bias at all
- These organizations have been involved in nanotechnology research for a very long time
- Information is presented in a well-organized manner
- Stakeholders in these organizations include many companies involved in the industry and government-related research organizations
- The staff of these organizations are easy to get in contact with
- The content of these sites are almost always positive, attempting to further research and development in nanotechnology to provide benefits to the public
- The information about nanotechnology is available in many different forms including news articles, informative videos, laboratory reports, etc.

- Most of the academic sites are geared mainly for those who wish to perform research in their facilities, while others are aimed to those who have a general understanding of the technology

Provider Type: *Commercial*

The main discoveries brought out by this subgroup's research about commercial providers are:

- Most of the information about nanotechnology is presented to the general public and is targeted to consumers, but some are intended to recruit investors for the organization
- Some companies that use nanotechnology in their products do not advertise the use of the technology, but instead highlight the benefits (such as stain-resistant clothing and high performance tennis balls)
- Information is not as well-organized as it should be
- The content of these sites are all positive and show how nanotechnology will improve consumer goods

Provider Type: *Government*

The main discoveries brought out by this subgroup's research about government providers are:

- There is a great deal of information presented on these sites in a well-organized manner
- These sites are intended for anyone that is interested in learning about the technology, though some of the sites are aimed towards those who have an extensive knowledge of nanotechnology
- The content of these sites are positive, rarely touching on any potential risks of nanotechnology
- These are established organizations that have been around for a while
- The stakeholders involved in these providers range from federally funded institutions to private research groups
- Some of the websites are hard to navigate through, which may frustrate the user

Provider Type: *Independent*

The main discoveries brought out by this subgroup's research about independent providers are:

- The companies involved in this provider group are relatively new and haven't been around as long as the government or academic providers
- An abundance of information is provided and is geared towards the general public
- The content ranges from positive to negative, but mostly positive as to highlight current research in the field
- Some of the sites have different features, including blogs and site memberships (that require a fee)
- Most of these sites have no investor relations

Andrew Wilk

Academic

In this field, it seems a major trend is that the information provided through these sites is usually for nanotechnology. Since these sites are connected with research facilities because they are affiliated with schools, the information almost has to be pro nanotechnology. Since the whole point of experimenting is for the advancement of this technology, if the academic institutions focused on the negatives, they wouldn't be able to advance in their research as fast. Most of these sites you would normally get to from the school's webpage under their research tab. Also, a lot of the schools have either partners or sponsors which we have to keep in mind. The companies most likely have a certain reason they chose to invest in the research of nanotechnology. One more point to bring up is the fact that most of these sites are geared toward those people that are already in the field, and have the know how, and the education to understand the articles on the sites. Most of these research centers are attached to schools that have been rooted in academia for a while, and the centers have been up for a fairly a long time considering how long nanotechnology has been really researched.

Government

In this field of nanotechnology research, it is a large trend to show almost only the positives of the technology. Since, similar to the way the academic sites are, this site tries to stay away from information that can show possible risks of nanotechnology, however it sounds like the NNI site offers some links about the societal impacts the technology may have. The sites sound like they were created to draw the reader in by fascinating them with ideas of the possibilities of nanotechnology. The Department of Defense website has a patriotic angle as George mentioned, and wants to draw Americans in by telling them of what could be capable. The National Nanotechnology Initiative website is user friendly, offering a plethora of information, and links to read. The creation of cartoon characters shows the NNI wants to get children involved, and make the technology look good. (Though I'm not too sure what to think about that, it reminds me of one of those old "A is for Atom", or something along that line of movies, where a cartoon atom explains the benefits of nuclear energy). Finally, funding is from the government, so there is plenty of money that can be used, and just recently the government plans to spend a lot more money investing on this.

Commercial

As of this writing, Bez was the only one that posted something, so there were no real trends between a number of articles, but I'll write a little on this subject. The products offered have already been through the R&D stage and are currently offered to the public. This means the companies probably won't be too worried about risks, especially InMat.Inc, the company which makes Air-D-Fense unless something goes wrong with the product, and causes health issues to people. The companies in this field would most definitely not advertise the risks, as it would be a hit in the company's pocketbook, and if serious enough, could cause the business to go under. A site like this would not be a good site to visit for the technical aspect of learning about the technology, as the company is going to try to appeal to the general public, and I'm going to go out on a limb here, but I am willing to bet a majority of the general public could care less about the technology that went into the design of the product. These companies will rely on

sales to the public, so this is why they must promote the technology, and not comment on possible risks.

This concludes the Research and Analysis section of our report. Our preliminary findings show that there seems to be a communication bias when industry, academic, government, and other organizations communicate to the public. It is then our objective to speculate further how we as a team can create a better tool or resource for public discourse that can present information in a clear and unbiased manner.

Discussion:

We all started this IPRO with a pretty limited knowledge of nanotechnology. There were some of us who knew more about certain areas (e.g. Sungwoo and his academic experience) of nanotechnology but none of us knew the big picture. That is what our purpose in this IPRO was going to be: gain a better understanding of nanotechnology and then formulate a way to share our knowledge with the rest of the public. Along the way we hit a few speed bumps but nothing to slow us down. In the very beginning we all shared our thoughts on what nanotechnology is and how will it affect our lives and everything around us. Twice a week for 1.5 hours we would meet up and discuss topics such as:

- What is nanotechnology?
- How is nanotechnology affecting us?
- Who do we want to educate?
- What do we want to present to the groups we want to educate?
- How do we want to present our material?
- How much do we know about nanotechnology ourselves?

These and many more were discussed at our meeting. Early on in the IPRO we started to lean on developing a tool of some sort, whether it was a website, TV show, or any other

type of media, that we could use to educate our target audience. We kept fumbling around on not only who we wanted to educate, but also how are we going to educate them. There some disagreement on who to educate. Some students suggested we educate K-12 students, while others suggested we try to educate some of the public here at IIT. Another speed bump was how we were going to find out what the target audience knew about nanotechnology already. We found it important that in order to develop a good tool we had to know what people already knew. Some suggestions on how we were going to go about this were:

- Asking around
- Professional surveys
- Articles

We also considered asking the psychology department on helping us conduct some surveys for us but that turned out to be too expensive for our budget. Plus, we still weren't sure on what exactly we were going to do. We still had not put our fingers on it. However the one thing we all agreed on was that in order for us to develop a good well documented tool, we first had to educate ourselves on nanotechnology. After some discussion on how to structure the team, we decided to split up into four different areas of research:

- Electronics
- Military
- Consumer Goods
- Medical

Each sub-group would research their specific topic about the applications of nanotechnology in their category. They also researched the pros and cons of nanotechnology that arose in their topics. We all decided to meet in the Galvin Library

Learning Center to do our research because we all had computers and also had a librarian to help us with the research. After we all conducted our research, each team presented their finding to the whole team. After presentations were given the team continued to talk about nanotechnology but still we had not picked the goal of the IPRO. Through the IPRO we decided to create a tool that could be flexible enough to be molded to any target audience we saw fit. We chose this idea because it left many possibilities open and did not limit us to just on target audience. Our meetings were very productive but had no real direction to a goal. We kept discussing and discussing but we still could not find the true goal of our IPRO. As Prof Woerner said, "You guys are very close to *IT* [the goal] but still have not defined what *IT* is." Seeing that it was about half way through the semester and we had no clear goal she told us that this was time to get serious. Discussion was great but it was time to stop talking and doing.

It was decided that we have a Saturday meeting to finally decide on a goal. We HAD to leave the meeting with a goal. No ifs and or buts; it had to be decided. At the meeting we discussed of ways to approach the goal and all decided that the goal of the IPRO was going to be:

- We want to present an unfiltered, unbiased understanding of nanotechnology and it impacts on our world. This approach will touch on the pros and cons of nanotechnology and also the legal and ethical issues that are evident and others that can be of consequence in the future.

We chose this goal because our hypothesis was that there are no **major** websites, articles, journals, media, etc. that present unbiased information. Throughout the meeting

we discussed on ways to go about researching this assumption. We decided to use a vast range of sources including but not limited to:

- Peer reviewed articles
- Websites
- Publications
- Forms of media such as TV, radio, etc.

There was also a concern on the type of tool we should develop. Should we develop a tool? If so what kind of tool should it be? Some of the team members also suggested that we don't need a tool this semester. We don't want to bite off more that we can chew. Some of the arguments against the tool idea was that we should first do research before even considering a tool. In order to have a well documented tool you first need a strong foundation of research to support it. It was believed that everyone should be doing research so that we can come up with quality research to support the tool. To the anti-tool group it seemed that by also researching a tool it would take away from the quality of the final product, that being the tool.

On the other end of the argument, the pro-tool members argued that it would be a waste of resources if everyone just did research. We have 14 team members in this IPRO and we should all use them to the maximum potential. One idea that floated around was that we should have a small "tool" group that looked into possible tool ideas as well as did research. Thus once the research was done we would have an idea of a tool that could be used. After much debate the team members decided to present their ideas to the rest of the groups and get some input from them. After discussing it with the rest of the team, the majority of the team members voted on not having a tool group and just focusing on

research for this semester. Going this route allows us to perform quality research and have it ready for next semester to build a tool off our research.

Now that we picked out the goal of the IPRO the next issue was how we are going to structure the team. We first thought of splitting the team members into groups investigating the different range of sources. One team would be researching journals, the other websites, and so on. However after discussing this we viewed this as sort of complex and ambiguous such that there are so many possibilities for each source. Instead we decided to break the team up into four different sub groups researching four categories:

- Academia
- Government
- Commercial
- Independent

Each sub-group would analyze different sources from their specific topic. The sources would include the ones previously discussed. We chose this method of research because now each sub-group has a specific area to look into. Instead of researching different sources, we researched different categories using the sources as are methods. Our research criteria for each topic included:

- Articles within each group?
- Is there any biases?
- What is the longevity?
- How is the information presented/organized?
- Who does this information appeal to, i.e. who are the stakeholders?
- Investor Relations?
- How does the general public get to the website?
- What can we not get off the website?
- Is the information positive or negative?
- Who is the intended audience?

Each team member was asked to analyze two sources in his/her topic and write a 2-3 page paper on his analysis. Each group member was also asked to read the analyses of everyone else in his group and write a summary describing the position that his/her category embodies. After all the individual research was completed the whole team was asked to read all of the rest of the research papers submitted by the rest of team and to summarize each of the four subgroups material. We found this important to do because it helped us all become more well rounded in the other subcategories but more importantly it helped us analyze common trends connecting all four sub groups. For our midterm presentations we decided to create an abridged PowerPoint slide that summarizes this report.

Below is a chart that shows our team's values that were filled out in the beginning of the IPRO before we all got to work.

Spring 2006 Team Values Statements Summary — IPRO 341

Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	MEAN
I personally want to get an A for my work in this IPRO.																					
VALUE 1	3	2	2	5	5	1	1	1	1	1	2										2.1818
Every member of the team should contribute equally																					
VALUE 2	1	1	3	1	1	1	2	3	1	2	2										1.6667
Decisions should be reached by consensus.																					
VALUE 3	1	2	2	2	1	1	2	2	3	3	2										2.0833
Our team should be recognized at IPRO Day for excellence.																					
VALUE 4	2	1	3	4	1	3	4	2	3	1	3										2.4545
Every team member should be able to do as much or as little as they wish.																					
VALUE 5	1	5	4	5	4	3	4	3	5	5	4										3.9091
We should learn about the ethical implications of our decisions.																					
VALUE 6	3	2	2	1	1	3	3	1	1	2	3										2
Team members should not criticize each other.																					
VALUE 7	1	4	3	3	3	3	3	3	3	5	3										3.0909
Work for this team should have priority over social activities.																					
VALUE 8	4	3	4	4	3	3	4	4	4	3	4										3.6364
Every member of the team should receive the same grade, good or bad.																					
VALUE 9	3	3	4	5	4	4	5	5	5	5	4										4.2727
I want to learn as much as possible about the problem we are addressing.																					
VALUE 10	2	1	2	1	1	2	3	1	2	1	3										1.7273
Students who are not doing their share should be asked to drop the team.																					
VALUE 11	2	3	4	3	3	2	3	4	2	4	3										3
It is more important to select students as team leaders who need to develop leadership skills than to pick those with the most experience already.																					
VALUE 12	4	3	4	3	5	2	5	1	4	4	3										3.4545
Faculty leaders should keep close tabs on who is doing what, and make sure that all students are doing their share of the work.																					
VALUE 13	2	3	4	1	1	3	3	3	1	4	2										2.4545
Student leaders should be responsible for making sure the work is evenly distributed, and that students who are slacking off change their behaviors.																					
VALUE 14	2	2	3	3	1	3	3	3	2	3	3										2.5455
Team leaders should be selected by students rather than faculty.																					
VALUE 15	1	2	4	1	1	1	5	1	2	5	3										2.3636
Performance of team members should be evaluated on a regular basis.																					
VALUE 16	1	2	3	4	2	4	3	4	2	4	2										2.8182
I want to be able to use this IPRO on my resume.																					
VALUE 17	1	2	3	2	2	2	3	1	2	2	2										2
I need references from my work in this IPRO to help me find a job.																					
VALUE 18	1	2	4	3	3	4	3	3	3	4	3										3
I want an IPRO assignment where I don't have to depend on other students who don't want to do any work.																					
VALUE 19	3	2	4	4	2	3	5	2	2	4	4										3.1818
All team members should arrive at all meetings on time.																					
VALUE 20	1	1	4	1	1	3	3	3	2	3	3										2.2727

KEY:
1 Extremely Important
2 Very Important
3 Quite Important
4 Somewhat Important
5 Not at all important

In the beginning of the semester as shown by the charts we all pretty much wanted to get an A for this course but all agreed that everyone had to contribute equally to the IPRO. This meant that in order for an individual to get an A he/she had to put in as much work as everyone else in the team. Hence, no slacking. So far we are quite please with everyone's involvement in the IPRO. Everyone is contributing to this IPRO while even under pressure with midterm exams. This also helps to prove the fact that we all stated in the values that each team member is not allowed to do as much work as he/she wants. The fact that we are have good discussion in the IPRO and that everyone agrees to what direction we need to move as a group clearly exemplifies the teams position on group discussion as shown in the chart. A few more points on the chart that we have stood by include:

- We want to learn about the ethical and social impacts of our IPRO
- We want to learn as much as possible about the topic at hand
- We all want to be able to use this IPRO for our resumes

Learning all the ethical issues at hand is a topic that is driving this IPRO. After our preliminary research it is hard to find many sources that talk about this topic. There always seems to be an overwhelming response that nanotechnology is the next big thing and it is the greatest thing to happen since sliced bread. Also the fact that we want to know as much as possible about this topic can be supported by the research done by the whole team. We were required to only write a 2-3 page summary of our preliminary finding but everyone went above and beyond that requirement and wrote excellent research. The fact that we all want to use this IPRO as part of a resumes is also a driving force behind our work.

Some of the problems we have encountered over the IPRO are mostly time management issues. On a couple of occasions we have fallen behind schedule and Prof. Woerner had to get us back in line and on topic. A good example of this would be the Saturday meeting we had to finally figure out a goal and direction for our IPRO. Also in the beginning we would reach the end of our IPRO class time without fully completing the goal set forth in the agenda. Originally we all used to meeting the LLC in the Galvin Library and this might have been a cause of our time management skills. The fact that we were all hidden behind computers and not in a big round discussion circle limited our discussions. Also the fact that we had computers in front of us was a distraction and it was only time before some team member would start surfing the net and fall out of conversation. This can be proved because the person who is currently writing this sentence was guilty of the same thing. After seeing how well the Saturday meeting due to

being around a big table facing each other, we decided to move all consecutive meetings to the classroom we were originally in. In this way, we are all able to sit in a big group circle and face each other. This has improved discussions tremendously. In summary the team has not strayed from the original team values. As shown in the above chart every value that has been highlighted has been followed to the best of our abilities.

Below is a timeline/calendar of the team's progress up to this point:

January

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17 First Day Introductions	18	19 IPRO First Class	20	21
22	23	24 Discuss Plans for this Semester	25	26 Discuss Plans for this Semester	27	28
29	30	31 Define Team Structure				

February

SUN	MON	TUE	WED	THU	FRI	SAT

			1	2 Define Objectives	3 Project Plan Due	4
5	6	7 -Assess Project Plan -Research Groups Meet	8 Leadership Meeting	9 Research Groups Meet	10	11
12	13	14 Research Group Presentations	15	16 Research Group Presentations	17	18
19	20	21 Discuss Target Audience	22	23 Compile a Knowledge Assessment Survey	24	25
26	27	28 Finalize Knowledge Assessment Survey				

March

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2 Begin Surveying Audience	3	4
5	6	7 Reflect on what has been accomplished	8	9 Present Midterm Report Draft	10 Midterm Progress Report Due	11

SPRING BREAK12	13	SPRING BREAK 14	15	16 SPRING BREAK	17	18
19	20	21 Compile Survey Data	22	23 Discuss what to include in the tool	24	25
26	27	28 Begin Work on Final Deliverables	29	30 Activity Groups Meet	31	

April

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4 Activity Groups Meet	5	6 Activity Groups Meet	7	8
9	10	11 Activity Groups Meet	12	13 Activity Groups Meet	14	15
16	17	18 All Activity Groups Finalize and Report Progress	19	20 Present First Presentation Draft	21	22

23	24	25 Practice Presentation	26	27 Practice Presentation	28 -Poster Due -Website Due	29
30						

May

SUN	MON	TUE	WED	THU	FRI	SAT
	1 Abstract Due	2 -Practice Presentation -Practice Exhibit Questions	3 Presentation Due	4 -Practice Presentation -Practice Exhibit Questions	5 -IPRO Day Conference -Final Report Due -Deliverables CD Needed	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Conclusion:

After having an excellent discussion we concluded that each sub group had some common links such as:

- Each category had its own agenda to promote
- Very little non biased information was presented
- Everything could be traced back to government funding (e.g. NNI) either directly or indirectly

Following this research we hope to dive deeper into the meaning of nanotechnology and answer questions that pertain to why these providers (the four categories) are presenting their websites in such a fashion. We plan to look more into the commercial sector to see:

- Why is information being withheld from the public
- How do they withhold information from the public?
- Do they avoid stating that products are made from nanotechnology so the public does not get weary of the product
- Are they only looking out for their own interests
- Do they have something to lose if they present information that doesn't agree with their agenda
    - Losing funds, acclaim, etc.
- Do they not want the public to know in fear of getting shut down or hindered in anyway

Another interesting fact is that – can the commercial sector be helping the researchers and scientists in numbing the public's perspective of nanotechnology. What we mean by this is – are the commercial sectors exposing the public to nanotechnology on a smaller scale and thus gently easing the public into this new technology so they will not be scared or critical about it when the bigger inventions come out such as military applications and medical applications. Its seems it is easier to get somebody to play tennis with a racket made out of nanotechnology than to have him get a operation with nanobots and nanomaterials floating in his blood. With the tennis racket there is no grave danger to your heath in using it but with nanodrugs your skin might fall off. So thus maybe the

public needs to be better assured to trust nanotechnology and so far – as we have seen with cosmetics and stain resistant textiles – it might be working.