NSF-NUE NanoTRA- Texas Regional Alliance to Foster Nanotechnology Environment, Health, and Safety Awareness in Tomorrow's Engineering and Technology Leaders

Abstract: Texas State University - San Marcos and the University of Texas at Tyler, have recently awarded NSF-NUE (Nanotechnology Undergraduate Education) grant to develop introductory and advanced curricula that address the 'nanotechnology safety issues' that include social, ethical, environmental, health, and safety issues of nanotechnology. The curricula will be modular in nature, suitable for use either as two full-semester courses that will be taught online at UT at Tyler or for insertion as separate modules into undergraduate engineering, engineering technology, and industrial technology courses in face-to-face manner at Texas State.

PROJECT

In the next ten years, nanotechnology will emerge as the next industrial revolution. Therefore, the next generation of engineers and technologists must be prepared to address social, ethical, and environmental issues related to nanotechnology, particularly health and safety issues. The proposed effort will address this need by developing courses that consist of new teaching modules addressing critical issues related to nanotechnology. Students will learn nanotechnology safety issues, developing skill sets to assess and determine appropriate actions to maintain a safe working environment. To provide a holistic and engaging learning experience, students will take part in hands-on experimentation, tour and nanotechnology companies, lab training at the host institution, watch videos, write a group-based term paper based on case studies, engage in guided small-group learning, and listen to expert guest speakers. A Nanotechnology Advisory Council consisting of leading scientists and industry professionals in nanotechnology will assist in ensuring the quality and relevance of course content. The research team is highly interdisciplinary with extensive experience in nanotechnology, ethics, and nanotechnology safety, representing mechanical/manufacturing engineering, civil engineering, electrical engineering, industrial education and technology, physics, environmental biology, and philosophy.

GOAL

To educate engineering and technology undergraduate students in 'nanotechnology safety' that includes societal, ethical, environment, health, and safety issues.

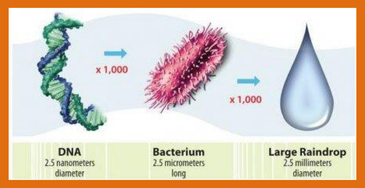


OBJECTIVES

- Develop two modular undergraduate-level courses dealing with nanotechnology environment, health, and safety awareness. These courses will better prepare undergraduate students to advance to graduate nanotechnology programs and to work with nanomaterials in their future careers;
- Build on pedagogical research by employing a variety of teaching methods to engage students, particularly women and Hispanic students, including hands-on training, socially-relevant case studies, plant tours, videos and guest lectures;
- Elucidate emerging needs in nanotechnology environment, health, and safety, and incorporate them into basic education that can be immediately employed in industry;
- Promote interdisciplinary interactions among engineering, engineering technology, science, and industrial management/technology majors;
- Assess the effectiveness of the newly developed curriculum using a rigorous formative and summative assessment plan;
- Disseminate the results of course development, including measured student learning outcomes, industrial relevance, and lessons learned, to stakeholders including academic scientists, administrators, and nanotechnology industry professionals; and
- Establish a Nanotechnology Advisory Council that will assist in providing current information related to research and tools in nanotechnology environment health and safety, and ensuring that our educational efforts serve the needs of industry.

What is Nanotechnology?

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers (1 nm = 10^{-9} m)



What is so special about the Nanoscale?

Materials can have different properties at the nanoscale. Some are better at conducting electricity or heat, some have different magnetic properties, some are stronger, some reflect light better, or change color as their size is changed. Nano molecules have far larger surface areas than similar volumes of large-scale materials. This means that nano molecules have a large interaction area for superior performance optimization in the materials around them.

Course 1: Introduction to Nanotechnology Safety

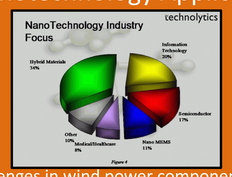
Course 2: *Principles of Risk Management for Nanoscale Materials*

Module	Theme of the Module		Theme of the Module
1A	What is nanotechnology and nanoethics?	1B	Overview of Occupational Health & Safety
2A	Ethics of Science and Technology	2B	Applications of Nanotechnology
3A	Social Impacts	3B	Assessing Nanotechnology Health Risks
4A	Ethical Methods and Processes	4B	Stustainable Nanotechnology Development
5A	Nanomaterials and Manufacturing	5B	Environmental Risks Assessment
6A	Environmental Sustainability	6B	Ethical and Legal Aspects of Nanotechnology
7A	Nanotechnology in Health and Medicine	7B	Developing a Risk Management Program
8A	Military and National Security Implications	8B	Presentations of Papers or Case Studies
9A	Nanotechnology Issues in the distant Future	9B	Hands-on Training on Using Safety Gear in Nonmanufacturing
10A	Presentation of Papers or Case Studies	10B	Plant Tour
	Guest Lecture		Guest Lecture
	Video Sessions		Video Sessions

Incorporation of Nanotechnology Safety Courses in Curriculum or Modules into Existing Courses

Location	Program	Course # and Title	Course/ Module
UT-Tyler	BS (Industrial Technology): Focus: Nano Management	TECH 2303: Introduction to Nanotechnology Safety	FULL COURSE
Texas State	BS (Industrial Technology): Focus: Nano Management	TECH 3303-Principles of Risk Management for Nanoscale Materials	FULL COURSE
Texas State	BS(MFGE), BS(IE),BS(EE),BS(ET), BS (IT)	US 1100: Seminar	2A
Texas State	BS(MFGE), BS(IE),BS(EE),BS(ET), BS (IT), BS (CIM), BS (CSM)	PHIL 1320: Society and Ethics	1A, 2A, 3A, 4A
Texas State	BS(MFGE), BS(IE), BS (IT), BS(ET)	IE 4380/TECH 4380: Industrial Safety	3B, 4B, 6B, 7B
Texas State	BS(MFGE), BS(IE),BS(EE),BS(ET)	ENGR 2300: Materials Engineering	1A, 3A
Texas State	BS(MFGE), BS(IE)	ENGR 2332: Materials Selection and Manufacturing Processes	6A, 8A

Nanotechnology Applications

- Nanotechnology resolving challenges in wind power component supply by saving weight, lubricants, and de-icing coatings.
- Nanotechnology in medicine involves applications of nanoparticles currently under development, as well as longer range research that involves the use of manufactured Nano-robots to make repairs at the cellular level
- Carbon Nanotube Composite materials used to decrease automotive body weight and improve performance by enhancing structural and sensing properties.
- Improving display screens on electronics devices by Nano molecules. This involves reducing power consumption while decreasing the weight and thickness of the screens.
- A wide range of nanostructures have been proposed as delivery mechanisms for cosmetic ingredients in moisturizers, anti-ageing creams, and other skincare products

Multidisciplinary and Ethnically Diverse NSF-NUE Team of Investigators

- Dr. Jitendra S. Tate, Principal Investigator, Ingram School of Engineering, Texas State
- Dr. Dominick E. Fazarro, Department of Human Resource Development and Technology, University of Texas at Tyler
- Mr. Satyajit Dutta, Ingram School of Engineering, Texas State
- Dr. Craig Hanks, Department of Philosophy, Texas State
- Dr. Walt Trybula, Ingram School of Engineering, Texas State
- Dr. Robert McLean, Department of Biology, Texas State
- Dr. Fritz Allhoff, Department of Philosophy, Western Michigan University
- Graduate Researcher: Mr. Lucio Andres Alvarez Andrade, Texas State
- Graduate Researcher: Mr. Adam Mokhtari, University of Texas at Tyler
- Undergraduate Researcher: Mr. Sergio Espinoza, Texas State

Nanotechnology Advisory Council (NAC)

This project is being advised by a forward-thinking team of experts from academia and industry. The NAC will assist in improving the quality of the contents in each course

- Ms. Deb Newberry, Director, NFS-Nanolink Center
- Dr. Mark Wiesner, Director, CEINT (Center for Environmental Implications of Nanotechnology) at Duke University
- Dr. Chuck Geraci, NIOSH
- Dr. Greg Marshall, Chair, Department of Respirator Care, Texas State
- Ms. Wanda Gress, SWeNT (SouthWest NanoTechnologies)
- Ms. Barbara Foster, MIP (Microscopy and Imaging)

Government Agencies Involved in Nanotechnology

Expected Impact on Undergraduate Minorities


- As of fall 2011, total enrollment in Engineering and Engineering Technology programs at Texas Satate was over 1,100 students, more than 35% are minorities (10% women, 23% Hispanic, and 5% African-American). As of fall 2011, UT at Tyler served 6,696 students, of which 60% were women, 9.6% African American, and 10.4% Hispanic.
- The majority of students in these programs will be impacted, either by taking required courses that include new modules developed on this project or by taking the semester-long courses.

Nanotechnology Safety

- The physicochemical properties that make nanomaterial's, industrial or engineered, attractive technologically also raise questions and concerns from industry, consumers and regulators regarding their toxicity and potential for exposure. Engineered particles such as carbon nanotubes require certain safety parameters while working with. Medicine nanoparticles in the industry can pose threats to human heart and lung functions. Therefore it is required for engineers to develop and implement safe handling practices that are included in modules such as, nanoparticle transport, administrative controls, theories of accident causation, and develop ASTM and OSHA guidelines for working with nanomaterial's. Underlying the potential hazards and risks presented by nanomaterial's is a fundamental responsibility.