

**MESM 2010 Group Project Proposal:**  
**ENVIRONMENTAL RISK AND EMERGING REGULATION IN THE**  
**NANOMATERIALS SECTOR: A 2009 INVENTORY AND SURVEY OF INDUSTRY**  
**PERCEPTIONS AND PRACTICES**

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**FACULTY SPONSOR**

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***STATEMENT***

Nanotechnology is the understanding and control of engineered materials at dimensions of 1 to 100 nanometers, i.e. at the “nanoscale.” Engineered nanomaterials (ENMs) are designed to exhibit novel or enhanced properties that affect their physical, chemical, and optical behaviors, in effect presenting opportunities to create new and better products. Consequently, nanotechnology has the potential to make significant contributions to many fields, ranging from semiconductors to biotechnology to energy, transportation, agriculture and consumer products. Nanotechnology also presents new opportunities to improve how we measure, monitor, manage, and minimize emerging contaminants in the environment. Already, nanotechnology is making its way into our daily lives. ENMs are being used in the manufacture of cosmetics, clothing, sports equipment, coatings, and electronics. It is estimated that global sales of ENMs could exceed \$1 trillion by 2015. At the same time, however, the novel properties that confer the industrial potential to ENMs may in fact generate new risks to workers, consumers, the public, and the environment. Questions have been raised regarding the potential environmental and health effects of ENMs whose properties are undoubtedly different from their constituent elements. Early efforts to inform and adopt appropriate practices have the capacity to preempt negative environmental consequences.

Ironically, particulate ENMs are easily synthesized, but their development and synthesis is outpacing efforts to characterize their chemical, physical and biological interactions. Consequently, decisions regarding safe practices in manufacturing and disposal have to be made conservatively, and without the full knowledge of nanoparticle behaviors. Additionally, at this early stage of nanotechnology’s development, guidance from governments on how ENMs should be handled to minimize their potential risks is just evolving. Companies are seeking guidance on how to handle ENMs safely and avoid liability, while still producing new products swiftly and at competitive prices.

This research project aims to understand what steps that nanomaterials firms, i.e. industrial producers and users of ENMs, and research labs are taking to ensure the safety of workers, customers, the public, and the environment from potential risks associated with ENMs. The project will focus on: 1) *risk management* practices, that is, the steps producers and users are taking (e.g., protective equipment, use restrictions, etc.) to reduce the potential hazards or exposure associated with ENMs, and 2) *risk perception* systems, that is the ideas that industry leaders hold regarding the hazards associated with nanomaterials and which are expected to profoundly influence the degree to which companies voluntarily and proactively take actions designed to protect workers, consumers and the environment.

***OBJECTIVES***

We propose a two stage project beginning with a bibliographic survey of existing knowledge and opinion. We recognize that, worldwide, the safety of nanotechnologies is garnering significant attention and that various agencies of governments, industries, and nonprofit groups are in the process of discovering what practices are taking place in industry today. However, we expect that these efforts to delineate current practices are not systematic, global or transnational, are limited to a few types of industries or are not comprehensive in other ways. Therefore, the second stage of this project is to collect new primary data by directly interviewing industry leaders and EHS personnel in the US, Europe, Asia, and Australia to learn their current reported practices to manage potential health and environmental risks from ENM production to disposal in the workplace, and their perceptions of nanotechnology’s *risks and benefits* that may drive their decisions. To accomplish these two sequential objectives, we will:

- Contact NIOSH (in the US), appropriate EU representatives, and governmental and nonprofit watchdogs worldwide to assess ongoing and upcoming efforts towards discovering and summarizing industrial safety and environmental practices in the nanotechnology industry.
- Survey current practices for ENM risk management in industry. Surveys will be constructed and piloted with the assistance of survey researchers at UCSB and telephone interviews will be conducted with a broad sample of US, European, and Australian firms; past research indicates that web-based surveys will be the best method for collecting data from E., SE, and S. Asian industries. In all cases, interview instruments and surveys will be designed and implemented using rigorous social science standards.
- Analyze the results in order to contribute to the knowledge-base of ENM safety, closing knowledge gaps and developing recommendations for current practices in the nanotechnology field.
- Assess best practices for safe handling of novel materials.
- Produce and disseminate a report of our findings that will assist with the development of worldwide ENM safety standards.

### ***SIGNIFICANCE***

For perhaps the first time in modern society, governments and citizens are trying to anticipate the environmental and health consequences of a new industrial revolution.<sup>1</sup> This did not happen with the advent of modern agrochemicals and it did not happen in the agricultural biotechnology revolution. Yet it can happen with nanotechnology. Not only will this project serve to inform governments, citizens and industries of best practices in the industry for protecting health and the environment, but approaching and conducting this work will reveal the possible modes of acting preemptively in the face of new potential environmental and health threats. Students and faculty engaged in this project are expected to learn to what degree anticipatory research activities can preempt environmental and social harm in the face of new industrial movements.

An up-to-date, international assessment of ENM current safety practices would:

- Establish current recommendations for “best practices” in the nanotechnology industry.
- Identify knowledge gaps important in developing standardized ENM safety practices in the workplace.
- Bring recognition to the students involved. This is a highly publicized issue, and the two national centers involved in supporting the research can disseminate widely to national and international sites and organizations.
- Provide two full-time equivalent paid summer internships for group members. Opportunities for interaction in the interdisciplinary centers will provide professional training for Bren students; mentoring by an advanced social science grad student will enhance methodological training.

### ***BACKGROUND***

The U.S. Environmental Protection Agency’s Nanotechnology White Paper (External Review Draft) (1) was released to the public in December 2005. This paper indicates that a general disconnect between industry and government exists in the U.S. with regards to ENM safety. Current regulations in occupational safety and environmental protection do not apply to nanotechnologies, but the full extent of regulatory exclusion is not well understood. There is limited information regarding the human health effects of ENMs, and thus even a limited basis upon which to evaluate current occupational and environmental safety standards. NIOSH published a research agenda (2) in 2005, and has provided guidance for safe use of nanomaterials (3).

In 2006, a MESM group project was performed to provide the first world-wide survey of nanomaterials industries’ practices. The project, funded by the International Council on Nanotechnology (Rice University), was the first of its kind in scope and culminated in a peer-reviewed publication (4) and substantial attention. Due to the upstream nature of that study, the rapid pace of change in the ENMs industry and in the associated risk research, the findings of 2006 urgently need updating. Further, the 2006 project suggested that industry leaders’ perceived risk regarding ENMs may be a strong driver of their choices

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<sup>1</sup> In the US this anticipatory process is organized under the National Nanotechnology Initiative (NNI), which will provide funding for this project via the Nanoscale Science and Engineering Center: Center for Nanotechnology in Society at University of California at Santa Barbara (CNS-UCSB) and UC Center for Environmental Implications of Nanotechnology (UC CEIN) (NNI).

in health, safety and environmental stewardship, but this warrants more detailed follow up as risk messages about the materials have evolved over the past 3 years. . A “gap analysis” that examines the disparity between safety protocol development efforts, knowledge and existing practices can help determine what knowledge is needed. This will help determine the interests, barriers and needs of companies in developing and implementing safety frameworks with regards to nanotechnology.

### ***STAKEHOLDERS***

NSF-funded UC CEIN and CNS projects; U.S. Environmental Protection Agency; The National Institute for Occupational Safety and Health; Worldwide OSH agencies; Nanotechnology companies; Workers in the nanotechnology industry; Communities in which such industries are located; End-users of nanotechnology products (consumers, general public, environment)

### ***APPROACH AND AVAILABLE DATA***

**Approach:** This project will be implemented in two stages. The first stage of the project (Spring 09) will be a multi-country secondary delineation of the survey and “best practice” development efforts for ENM risk management based on existing data, reports, publications, and web materials. Upon completion of the initial stage, data will be summarized and reviewed, and an initial report of the findings generated. Human Subjects approval will be sought for the phone and web-based survey research, under the UCSB CNS and UC CEIN IRG 7 blanket protocol. The second stage of this project will refine a prior survey instrument developed in 2006 (4) to address both risk and benefit perceptions by the participants. Both health and environmental risk perception will be addressed in instrument revisions. Materials categories will be updated as needed, and challenges from using the prior instrument will be addressed. Contact databases from the prior project will be updated and enlarged. The new instrument will be pre-tested. In Phase Two, the project will use the instrument to survey prior and new participants. The ultimate goal of Stage Two (Summer and Fall 09, and Winter 10) is to delineate practices within industrial nanotechnology sectors, to organize the information into an understanding of how fully-evolved safety practices are, to compare new results to those obtained in the prior project (4), to newly evaluate benefit versus risk perception as explanatory variables, to learn where companies are innovating differently in the last 3 years, and to identify critical needs for the standardization and implementation of safety practices in the nanotechnology industry in different parts of the globe.

**Data:** An existing confidential database from the inaugural project in 2006 is available including: grey literature that is otherwise unavailable via library search engines, and a contact database of interviewees. New data, acquired with this project, will consist of: results of telephone interviews and web-based surveys with nanotechnology companies in North America, Europe, Australia and Asia (confidential), and results of the literature review via reports, publications and web materials.

### ***DELIVERABLES***

Stage One will be concluded with a report of the findings, including a description of research sources. This report will also identify current regulations pertaining to ENM safety which will be a context for any delineation efforts already underway. Stage Two will be concluded with a report of findings from the literature review and interviews, and a searchable database. The report will contain an analysis of limitations of current safety practices, research needs to address these limitations, and current “best practices” for ensuring environmental and occupational safety when producing or using engineered nanoparticles. The report will also examine current initiatives seeking to develop more appropriate recommendations on the safe production and use of ENMs. Materials will be disseminated via the website clearinghouses of the 2 NSF national centers, CNS-UCSB and UC CEIN.

### ***RESOURCES***

Resources are available through the Proposer’s (Professor Herr Harthorn) NSF funds to support 2 full time equivalent interns for 3 summer months and to provide necessary supplies. Also, either Ph.D. student or postdoctoral scholar affiliated with the UC CEIN or the CNS at UCSB will be supported by the Proposer to co-advise this project (an effective model for the 2006 project). Professor Magali Delmas (UCLA), a co-advisor of the 2006 project, has offered to be a resource to this project. Professor Rich Appelbaum, also a co-advisor in the 2006 project, has also expressed an interest in assisting as needed.

## **REFERENCES**

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