

**MESM 2007 Group Project Proposal:
AN INVENTORY AND EVALUATION OF ENVIRONMENTAL AND HEALTH SAFETY
PRACTICES IN THE NANOTECHNOLOGY INDUSTRY**

PROPOSERS

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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.” Nanomaterials are designed to exhibit novel or enhanced properties that affect their physical and chemical behavior, 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 challenges to improve how we measure, monitor, manage, and minimize contaminants in the environment. Already, nanotechnology is making its way into our daily lives. Nanomaterials are being used in the manufacture of cosmetics, clothing, sports equipment, coatings, and electronics. It is estimated that global sales of nanomaterials could exceed \$1 trillion by 2015¹. At the same time, however, the novel properties that confer the commercial, industrial potential to nanomaterials 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 nanomaterials whose properties are undoubtedly different from their constituent elements.

Ironically, nanoparticles 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 engineered nanomaterials should be handled to minimize their potential risks is just evolving. Companies are seeking guidance on how to handle nanomaterials safely and avoid liability, while still producing new products at competitive prices.

This research project aims to understand what steps producers and users of engineered nanomaterials are taking to ensure the safety of workers, customers, the public, and the environment from the potential risks of engineered nanomaterials. The project will focus on *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 engineered nanomaterials.

OBJECTIVES

In response to the International Council on Nanotechnology (ICON) RFP² entitled “Review of Best Practices for Nanotechnology Safety,” we propose a two stage project beginning with identifying current initiatives that are already underway to summarize the safe manufacture and use of engineered nanomaterials. We recognize that, worldwide, the safety of nanotechnologies is garnering significant attention and that various agencies of governments and nonprofit groups are likely to be 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 global, are limited to a few types of industries or are not comprehensive in other ways. Therefore, we will also directly interview industries in the US, Europe and Asia to learn directly what practices are currently being developed to manage potential health and environmental risks from nanomaterial production to disposal in the workplace. 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 nanomaterial risk management in industry. Surveys will be constructed with the assistance of sociologists at UCSB and telephone interviews will be conducted for US and European firms; web-based surveys will predominantly be used for collecting data from Asian industries. In all cases, interview instruments and surveys will be designed to rigorous standards in the social sciences fields, and corroborative efforts will be undertaken.
- Analyze the results in order to contribute to the knowledge-base of nanomaterial safety, closing knowledge gaps and developing recommendations for “best practices” in the nanotechnology field.-
- Produce a report of our findings that will assist with the development of worldwide nanomaterial 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. 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 international assessment of nanomaterial “best practice” development efforts and current safety practices would:

- Establish recommendations for “best practices” in the nanotechnology industry.
- Identify what knowledge is lacking that may account for the relative absence of standardized nanomaterial safety practices in the workplace.
- Place Bren on the map internationally. This is a highly publicized issue, sponsored by an international nanotechnology organization that aims to use our findings for the purpose of assisting government agencies with establishing international “best practice” guidelines for worker safety in the nanotechnology industry.
- Provide three paid summer internships for group members.

BACKGROUND

Research into nanotechnology is rapidly advancing worldwide without a full understanding of the safety implications. Roco and Bainbridge reported that the number of workers in the field that could be impacted totals one million in the U.S. and two million worldwide³. It is therefore critical that existing knowledge related to nanomaterial safety be compiled, analyzed and built upon, thus filling knowledge gaps, to ensure that development is accompanied by best efforts to protect people and the environment around the globe. Some organizations have begun to look into such issues. The U.S. Environmental Protection Agency’s Nanotechnology White Paper (External Review Draft)⁴ 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 nanomaterial safety. Current regulations in occupational safety and environmental protection may 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 nanomaterials, and thus even a limited basis upon which to evaluate current occupational and environmental safety standards. The EPA recommends further research into such issues, but does not indicate tangible suggestions for protecting humans and the environment.

It is possible that simultaneous efforts are underway worldwide that are aimed at evaluating the applicability of current regulations and delineating current practices in the nanotechnology industrial workplace. The latter is especially important to grasp before new efforts as such are undertaken. Available knowledge about safety practices in industry should be compiled and analyzed. Where safety practices are not established or are non-routine, it is important to determine what knowledge is lacking that may account for the relative absence of standardized safety practices in the workplace. 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

- The International Council on Nanotechnology (ICON)
- Environmental Defense
- U.S. Environmental Protection Agency
- The National Institute for Occupational Safety and Health
- Worldwide OSH agencies
- Nanotechnology companies
- Workers in the nanotechnology industry
- 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 06) will be a multi-country secondary survey of the “best practice” development efforts for nanomaterial 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 our findings will be generated. The second stage of this project will examine current industrial safety practices in targeted countries for nanomaterial risk management. The ultimate goal of Stage Two (Summer, Fall 06 and Winter 07) is to delineate practices within industrial nanotechnology sectors, to organize the information into an understanding of how fully evolved safety practices are, and to identify critical needs for the standardization and implementation of safety practices in the nanotechnology industry in different parts of the globe.

Data

- The ICON task group on best practices will assist by:
 - Providing grey literature that is otherwise unavailable via library search engines,
 - Developing target lists for interviews, and
 - Setting up initial contacts with some interview targets.
- Data will consist of:
 - Results of telephone interviews and web-based surveys with nanotechnology companies in North America, Europe and East Asia.
 - Results of our literature review via reports, publications and web materials.

DELIVERABLES

Stage One will be concluded with a report of the findings of our review, including a description of our research sources. This report will also identify current regulations pertaining to nanomaterial safety which we expect will be a context for any delineation efforts already underway. Stage Two will be concluded with a report of our 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 engineered nanomaterials.

BUDGET

An extramural grant proposal has been submitted (January 27th, 2006) to ICON in response to their RFP for this work. The grant, if funded, would precisely support all interns and all research costs. However, Environment Defense, a partner in the ICON RFP, has communicated that it can provide some support if the extramural proposal is not funded. The PI and Co-PIs on the ICON proposal are identified at the top of this proposal, and the full proposal submitted to ICON is available upon request to PI Holden.

REFERENCES

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