

Summary
National Science Foundation
MATERIALS USE: SCIENCE, ENGINEERING AND SOCIETY (MUSES)
2004 WORKSHOP

The Materials Use: Science, Engineering and Society program is a part of Biocomplexity in the Environment (BE), a priority research area within the National Science Foundation. MUSES supports projects that study ways to reduce adverse human impact on the environment, and to maximize utility throughout the life cycle of individual materials. Such projects could investigate resource use, the design and synthesis of new materials with environmentally benign impacts, or the efficient use of individual materials at every stage of its entire life cycle.

The 2004 Workshop on Materials Use: Science, Engineering and Society was held October 6-7 at NSF headquarters in Arlington, VA. Seventy-four grantees from MUSES-funded projects attended, including PIs, Co-PIs, students, and post-doctoral researchers. The main objective for the workshop was to engage the community in examining the central themes that shape MUSES, as a means of better defining how research in this area serves the national needs. The workshop included plenary lectures by recent grantees, but placed particular emphasis on smaller breakout groups. The three interactive breakout sessions involved discussions around the following overarching questions.

1. How does BE: MUSES address issues of national importance?
2. What are the "best practices" to fully integrate MUSES across the disciplines, and to overcome any institutional barriers?
3. What is the role of international / global partnerships and learning experiences for BE: MUSES?

A summary of the salient observation and discussion points brought forward by participants follows.

Session 1

The MUSES program addresses many problems of critical national importance and recognizes that developing more comprehensive and proactive solutions for these problems requires an interdisciplinary approach. MUSES research topics can help make urban and rural environments more livable and to make it possible for humans to attain their aspirations. MUSES research also has relevance for national security — the outcomes inform policy makers on the long-term implications of their decisions, for example, on the use of mineral, energy and water resources. The new knowledge created from MUSES research can result from analysis of the measurement of national material flow over time, which can be used to link the wise use of materials with economic well-being. Some other major areas of national importance identified include:

- innovative materials development including bio-based materials;
- the design of manufacturing systems;
- employment opportunity creation and productivity increase;

- issues of urban sustainability, land use, and infrastructure; and
- understanding the role of global markets on the environment.

In the education area MUSES has helped to forge new interdisciplinary groups and novel methods of investigation that build collaborative expertise at universities. This has fostered and been supported by new approaches to education that stress cooperation and interaction among disciplines, including all areas of natural, physical, and social sciences and engineering that enable more integrative, as opposed to reductive, thinking. MUSES research addresses topics at multiple scales and perspectives of observation: geographic (regional, national, global), sector (public, private, non-profit), materials (nano to macro), social (individual, neighborhood, city, and region), and temporal (projecting into the future the implications of decisions).

Session 2

The implementation of MUSES-type research has many barriers across all sectors of society. These barriers take many forms, one of which is institutional — the management structures and attitudes of universities, governments, and private industries have been formed and reinforced over many generations and are slow in accepting change. Furthermore, there are institutional disincentives to cooperate across disciplines, as job descriptions tend to categorize according to disciplinary focus. Other difficulties lie in bridging across discipline-specific languages for communication, and understanding the need for and benefits of genuine interdisciplinary work. Moreover, these barriers lead to extra work aside from pursuing the intellectual merit for those who engage in interdisciplinary inquiry.

Overcoming such barriers is often difficult and time consuming. Factors that will have a positive impact on overcoming barriers and promoting interdisciplinary research and education include the availability of funding programs (such as MUSES, IGERT, GK-12, HSD) and the generation of successful examples of such research that will have a positive impact on promoting interdisciplinary research and education. It is equally important to demonstrate how such approaches can enrich and advance the knowledge frontier and to implement new incentives while eliminating the existing disincentives. Best practices as discussed at the workshop include:

- publishing in interdisciplinary journals;
- developing a more flexible graduate education or certificate programs that encourage matriculation of students from different disciplines;
- appointing joint advisors;
- incorporating “broadening” experiences into education (residencies in government or industry, interdisciplinary seminars and workshops, student rotations within the university);
- establishing cross-departmental communities of faculty who have common interests in developing new interdisciplinary research and education programs;
- better communication with the professional societies, and
- building common websites that share data, papers, presentations, and results.

At a more institutional level, best practices include the formation of cross-campus centers that work at the interface of various disciplines and the granting of seed funding to assist in establishing working groups of faculty.

Session 3

The rationale for international partnerships within MUSES stems from several factors. Many materials and resources comprise an important element of global commerce since they are shared and transported among countries. Additionally, environmental impacts of materials use and flow are increasingly regional and global in scope. Research also benefits from international collaboration, as the discussion of the multiple perspectives on issues of concern improves the understanding of different environmental problems and allows for the sharing of experience, data and resources. This contributes to the development of a global community of scholars that can lead to international collaborative ventures and the concomitant leveraging of resources to investigate topics similar to MUSES.

There are many barriers to international cooperation. These include governmental or institutional issues such as restricted funding practices of government agencies, and poor coordination among cross-border funding agencies, as well as broader cultural and language barriers. Steps for facilitating international cooperation include working with NSF's Office of International Science and Engineering to organize international workshops and to obtain funding for student and faculty exchange programs. It is also important to forge long lasting relationships with other countries by establishing partnerships with international institutions, and working among parallel funding agencies to develop new models for sustaining international collaboration.



This summary report was written by Dr. Thomas Theis, a PI on a MUSES grant, using the notes taken by the participants present at the meeting.