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Organization: Princeton University

Workshops on Enhancing the Impact of University Research on Critical Technologies

Project Participants

Senior Personnel

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Worked for more than 160 Hours: Yes
Contribution to Project:

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Worked for more than 160 Hours: Yes
Contribution to Project:

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8/3/00
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Organizational Partners

ETH Zurich

ETH Zurich, the home institution of Dr. U.W. Suter who was one of the conference coordinators, provided some participant support.

University of California-Santa Barbara

The Materials Research Laboratory at UCSB contributed funds to provide participant support as well as non scientific staff assistance.

Other Collaborators or Contacts

Other coordinators of the ITP conference were: A.K. Cheetham (UCSB, Materials Research Lab); Dr. A. Evans (UCSB); Dr. U.W. Suter (ETH Zurich); S. Yip (MIT)

Activities and Findings

Project Activities and Findings:

This proposal was designed to initiate a series of workshops in which participants from universities, government and industry would look strategically at selected areas of technological and societal importance. One of these workshops, dedicated to the discussion of how materials modeling can solve critical problems in industry, held at the Institute for Theoretical Physics, University of California Santa Barbara, January 7 through 11, 1996. 'Modeling of Industrial Materials: Connecting Atomistic and Continuum Scales' was the first of a coordinated series of workshops, spanning over two years, being organized by a group of academic scientists at UCSB, MIT, and the Swiss Federal Institute of Technology Zurich (ETH). On the premise that materials research focused on technology also presents fundamental scientific challenges, the Workshop sought to identify specific areas of industrial needs and opportunities for materials modeling, interpreted as theory and simulation across all the relevant length scales, and to stimulate meaningful university-industry partnerships.

Funded primarily by a grant from the Mathematical and Physical Sciences Directorate of the National Science Foundation, the Workshop was jointly sponsored by the Institute for Theoretical Physics and the Materials Research Laboratory at UCSB, ETH Zurich, and the Center for Materials Science and Engineering at MIT, with organizational support from the Industrial Liaison Program and the Materials Processing

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Center. Technical areas chosen for discussion were topics pertaining to the processing and thermomechanical performance of composites, multilayers, polymeric and catalytic materials.

The Workshop was attended by 119 participants, the number limited by the facilities, with a distribution of 57% university, 30% industry, and 13% government labs. There were 31 participants representing foreign institutions.

In structuring the Program, conscious effort was made to follow through on the Workshop theme of developing an industrial perspective on materials modeling. After an overview by M. Ashby at the opening session, the issue of how industry can use materials modeling was addressed directly in a plenary talk by J. Williams, with specific examples drawn from current technological requirements in developing aircraft engines. This was followed by a panel discussion of a wide range of needs and opportunities in industry by scientists from the automotive and structural materials sectors, as well as the technology and software vendors.

To stimulate discussions on the issue of university-industry collaboration, a list of questions was sent to the participants just prior to the Workshop. These questions were the following:

For industrial participants:

What are specific examples of materials problems that your company -- or your industry as a whole -- needs to solve?

In what way might numerical modeling be useful in the solution of these problems?

Are these problems so special that only in-house research is feasible, or do they have general features for which solutions -- perhaps in the form of computer codes -- might have broader applicability?

What fundamental scientific issues might be involved?

What length scales -- atomic, mesoscopic, macroscopic -- seem relevant?

What kinds of skills and interactions will be needed in order to bring fundamental scientific advances to bear on the technological problems that arise in your industry?

Might your company be interested in participating in university-government-industry collaborations aimed at solving these problems? Does it do so now?

What obstacles must be overcome in order for such collaborations to be formed and to function successfully?

For university and government participants:

What are specific examples of advances in materials modeling that you think might be useful in industry?

What are present limitations? Future prospects?

What fundamental scientific issues remain unresolved in the modeling problems with which you are familiar? What are the relevant length scales?

What obstacles do you perceive in establishing effective university-government-industry collaborations?

What kinds of industrial materials problems seem suitable for academic research? Which are unsuitable?

What gaps need to be bridged?

What is the role of government laboratories in these collaborations?

Project Training and Development:

At least partial answers to most of these questions, especially the more technical ones, emerged during the Workshop and are reported in the Proceedings. There was also considerable discussion of the policy-oriented questions. The paragraphs that follow are intended to convey some sense of the nature of those discussions.

Through these and subsequent deliberations among all the participants, a general sense of the intellectual basis and the practical constraints of university-industry cooperation is beginning to emerge. Concentrating mostly on 'what to' rather than 'how to', the participants identified a number of key areas where current advances in materials simulation and modeling can have significant impact on industrial research and development (see Part II for specifics). Since the basic scientific expertise resides to a large extent in the universities and government labs, collaboration with industry is clearly the next critical step in the technology transfer. However, establishing effective partnerships will require that each side be genuinely willing and able to accommodate the particular constraints and objectives of the other.

Defining shared values and formulating compatible objectives is generally not a straightforward process given the traditionally different measures of success (or relevance) adopted in each community. Consider the scenario where one is asked to articulate the needs for modeling research. The industrial scientist is likely to cite the benefits of cost reduction, such as reducing the number of iterations in a product cycle or the cost of technology development. In contrast, the academic counterpart would be more inclined to emphasize fundamental advances or innovation as the motivation. These two points of view need not necessarily conflict, and indeed a greater window of opportunity would result if they can be realistically reconciled. Put in another way, what the Workshop intended to bridge was the gap between the knowledge-oriented approach traditionally favored in academia and the problem-oriented approach that is necessary in industry. As seen by one member of the panel discussion on industrial needs and opportunities, the intention of university-industry dialogue is not to dilute the scientific content of a research project, but to focus and integrate it for industrial impact.

Another panel discussion focused on existing programs and on-going initiatives promoting industrial applications of materials modeling. There appear to be only a few established programs and little operating experience that can provide guidance for the type of cooperative activities envisioned at the Workshop. A number of the industrial participants in both this panel and the one described previously reported successful involvement in CRADA's and other consortia such as those sponsored by NIST and the DOE Laboratories. They felt that their companies had more to gain from such involvement than they would lose by sharing technical information. In short, if important technical developments were occurring, they could not afford to be left out. Not all companies represented at the Workshop shared this opinion, however; several participants stated or otherwise implied that they had been sent to listen but not to share information. Moreover, there was a general sense of pessimism that the federal government would continue support for such activities.

Despite the lack of significant institutional support for research at the interface of academia and industry, there was much enthusiasm among the participants for initiating some form of organized effort toward multi-institutional cooperation. As one can sense from the various recommendations being put forward in the Workshop Report, there is a spirit of 'let's just do it ourselves' which points to the timeliness of the issues. Using the level of interest stimulated among the participants as an indication of success, the Workshop can claim that the first step toward bringing about cooperation among university, industry, and government labs has been taken.

If the objective of assessing the scientific frontier in materials modeling across the length scales (in the specific topical areas addressed) has been achieved at this Workshop, it is quite apparent that the task of transferring the state-of-the-art technology to industry still lies ahead. Meaningful progress is likely to result from a number of small-group efforts focusing on specific problems, and general programmatic support at the federal level, to be sure, can be amply justified on the basis of technological development and manpower training to meet national needs.

Further considerations of specific areas of opportunities along with implementation of some of the recommendations resulting from this Workshop was taken up in the two following events in the coordinated series. Event Two was an extended program entitled Quantitative Methods in Materials Research, held at the Institute for Theoretical Physics, UCSB, January - June 1997. A core of about 15 scientists were in residence for up to six months to engage in joint studies on industrially relevant problems, including those identified at the Workshop, and to interact with industrial scientists invited for shorter visits. Coordinators of this event were A. K. Cheetham, E. Kaxiras, J. S. Langer, and S. Yip. Event Three, a workshop linked to the two preceding programs, was scheduled for MIT, September 14-18, 1997. Organizers of this third event included R. A. Brown, J. Joannopoulos, S. Suresh, and S. Yip. At each stage the intent was to build on the experience from the preceding event, to engage industrial and academic scientists in constructive dialogues leading to specific collaborations, and to demonstrate the true benefits of multiscale modeling to the entire materials community.

Research Training: Outreach Activities:

The Institute for Theoretical Physics keeps online records of its activities. While they are limited for this activity, what we have is available at <http://www.itp.ucsb.edu/past/mat97.html>.

Journal Publications

Cheetham, Suter, Wimmer, and Yip (Editors), "Modeling Industrial Materials", *Journal of Computer-Aided Materials Design*, p. 1, vol. 3, (1996).) Published

V. Bulatov, F. Abraham, L. Kubin, B. Devincere, and S. Yip, "Connecting Atomistic and Mesoscale Simulations of Crystal Plasticity", *Nature*, p. 669, vol. 391, (1998).) Published

Books or Other One-time Publications

Web/Internet Sites

URL(s):

<http://www.itp.ucsb.edu/past/mat97.html>

<http://www.itp.ucsb.edu/solidification.html>

<http://www.itp.ucsb.edu/fracture.html>

Description:

Other Specific Products

Contributions

Contributions within Discipline:

Only as detailed above.

Contributions to Other Disciplines:

Only as detailed above.

Contributions to Human Resource Development:

Contributions to Science and Technology Infrastructure:

This was one of the first projects that we detailed on the ITP website. The Proceedings will be extensively consulted by people in academia, industry, and government laboratories.

Beyond Science and Engineering:

Categories for which nothing is reported:

Activities and Findings: Any Research Training

Any Book

Any Product

Contributions: To Any Contributions to Human Resource Development

Contributions: Beyond Science or Engineering