Appendix 11: Stanford University/Center for Probing the Nanoscale Profile

I. Description

Institution: Stanford University
PI: Kathryn Moler
Co-PIs: David Goldhaber-Gordon
Title: Center for Probing the Nanoscale (CPN)
Proposal: 0425897
Program Officer: Denise Caldwell
Education Outreach Director: Kyle Cole, kylecole@stanford.edu

II. Research Agenda

Research Focus: The Center for Probing the Nanoscale is developing novel probes that can dramatically improve our capability to observe, manipulate, and control nanoscale objects and phenomena. Our nanoprobe development encompasses three themes: nanomagnetics; nanoelectronics; and nanomechanics.

NSEC Description
Stanford and IBM founded the Center for Probing the Nanoscale (CPN) to achieve five principal goals:

- To develop novel probes that dramatically improve our capability to observe, manipulate, and control nanoscale objects and phenomena.
- To apply these novel probes to answer fundamental questions in science and to shed light on materials issues which have economic importance for industry.
- To educate the next generation of scientists and engineers regarding the theory and practice of these probes.
- To transfer our technology to industry so that other R&D efforts can benefit from our nano-metrology groundwork.
- To inspire middle school students by training their teachers at a Summer Institute for Middle School Teachers.

III. Education Activities within the University

In this section we describe only Year 1 Activities that have already been carried out.
Description of activities
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Postdoctoral, graduate, and undergraduate education through research.
Education and research permeate every activity at Stanford University. The development of nanoprobes to address fundamental physical questions is exciting, challenging, and multidisciplinary. Nanoprobe development attracts postdoctoral, graduate, and undergraduate researchers whose home departments are physics, applied physics, chemistry, mechanical engineering, computational sciences, electrical engineering, and materials science and engineering. These student researchers gain expertise in modern nanofabrication, materials characterization, sensitive measurement techniques, state-of-the-art experimental design, and multi-scale modeling, as well as the design, operation, and data interpretation of nanoprobes.

"Advanced Topics in Nanoprobes"
The CPN faculty, led by Mac Beasley, teach a 3-unit course to familiarize graduate students with the advanced nanoprobe technology under development. Every week, a different participating investigator teaches two lecture classes and a discussion class. They describe the interesting science that motivates them to develop their tools, the tools they are developing, the technical issues involved, and the factors limiting progress. This course familiarizes all of the Center Fellows with a variety of techniques and motivations. Enrolled students additionally present on ideas for advanced nanoprobes: in the first year of the course, these presentations frankly outclassed the faculty presentations for creativity and far-sightedness.

Visitors
The Center for Probing the Nanoscale hosted 1 professor from the National Hispanic University and 2 teachers from its associated high school, the Latino College Preparatory Academy, to do research and develop lesson plans for 8-10 weeks during the summer.

Program staff and expertise

- 3 IBM Research Staff Members and 17 Stanford faculty, including seed grant recipients, are CPN members and participate actively in CPN programs
- Associate Director Kyle Cole, Ph.D. Yale Biology, has 5 years of industry experience as a Research Manager at Affymetrix. His education background includes teaching at Lake Tahoe Community College and the Continuing Studies Program at Stanford, as well as being a College Director of the Freshman-Sophomore College.
- Program Manager Laraine Lietz-Lucas has twenty years of experience in administering educational and industrial programs at major research universities.

Goals and objectives
Our year 1 goal was to build a strong base among the CPN faculty and students. Our goal for the next few years is to build on this base to broaden our nanoprobe outreach efforts, including a webcast class offered through the Stanford Center for Professional Development and including service/outreach in learning for CPN-affiliated students.

Target audience (educational levels, number of students at each level, etc.)
The target audience for year 1 consisted of 2 postdocs, 26 graduate students, 2 undergraduate students, 1 high school student, 2 teachers, and 1 professor from the National Hispanic University.

Current activities: Anticipated outcomes and/or deliverables (student awareness, curriculum materials, classroom demonstrations, etc.)
Student awareness: Our students will complete their work here with an impressive combination of technical engineering skills, basic scientific understanding, and communication skills. They will be poised to contribute to nanoscience and nanotechnology. They will also understand the interaction between science and society and will have experience in communicating and engaging both their fellow scientists and the public.

Curriculum materials: We post all class materials on a web site. In 04-05, access to this website was restricted to CPN members (broadly defined), but in future years we plan to post the materials publicly and we anticipate that the website will eventually develop into a seminal resource.

Nano S&E content focus
Nanoprobes to observe, manipulate, and control nanoscale objects and phenomena.

IV. Education Activities Outside the University

Description of activities

Workshop

The CPN hosted the first annual workshop on Probing the Nanoscale. It had 8 speakers, mostly from industry: 21 students presented posters, and the workshop was attended by over 100 people from a broad range of backgrounds.

Summer Institute for Middle School Teachers

CPN plans to offer a Summer Institute for Middle School Teachers twice each summer to twenty teachers from California (forty teachers total per summer) for 3 units of Continuing Studies Credit. The Institute will cover nanoscience, nanotechnology, and their societal implications, as well as delving into details of advanced nanoprobes. The Institute will provide ample opportunity for teacher-teacher interaction and curriculum development. In designing this institute, we were inspired by the successful institutes for *high school* science teachers run by the NSECs at Cornell and Rice. The ability of the teachers to connect the California State Science Standards to exciting CPN research on the imaging of single atoms and nanostructures will inspire middle-school students, who are at a critical age for developing interest in science. Although we worked with four diverse nearby middle schools to identify teachers to partner in the development of the curriculum for the Summer Institute, we were unable to offer the Summer Institute this year due to lack of personnel.

Program staff and expertise

Workshop

The program for the 2005 workshop was designed by Kathryn Moler and David Goldhaber-Gordon. The logistics and advertising for the workshop were beautifully executed by Laraine Lietz-Lucas.

Summer Institute for Middle School Teachers

The leader of the Summer Institute in Year 2 will be Dr. Kyle Cole, our new Associate Director. CPN faculty and graduate fellows are excited about participating in the workshop with Kyle's guidance. In addition, several local middle school teachers and our expert partners (discussed in the evaluation section) will play key roles in the development of the curriculum.

Goals and objectives

Workshop

Our first annual workshop was a celebration of the Center for Probing the Nanoscale as well as a chance for industry and members of the public to mix with each other and university researchers.

Summer Institute for Middle School Teachers

The Summer Institute is designed to give teachers the tools that they need to teach effectively and to inspire and inform their students.

Target audience (grade levels, number of students at each level, school districts, etc.)

Workshop

Companies represented at the workshop included NanoSig, Applied Materials, KLA-Tencor, Intel, Agilent, IBM, SRI International, VLSI Standards Inc, UMech Technologies, and Cascade Microtech Inc. Schools and museums included National Hispanic University, Foothill College, Tech Museum of Innovation, UC Berkeley, Delta College, Santa Clara University, and UC Santa Cruz.

Summer Institute for Middle School Teachers
Our Summer Institute targets middle school teachers, primarily in California, from a broad range of middle schools. By reaching 40 teachers per year, we can ultimately reach tens of thousands of students in grades 6-8.

Current activities
The teachers will return to their schools with curriculum; practical, explicit lesson plans; and low-cost kits to illustrate the action of nanoprobes at a humanly-accessible length-scale. The teachers will also receive Stanford Continuing Studies Credit: we will work with each teacher's district to ensure that the institute meets their requirements for the teachers' professional development.

Nano S&E content focus
Visualizing and manipulating the nanoscale.

Nano S & E content consultants
CPN researchers, both faculty and students; Dr. Marni Goldman, the Education Director for CPIMA (a MRSEC); Prof. Maureen Scharberg, Professor of Chemistry and Director of Science Education at San Jose State University.

V. Education Outreach Materials

Describe and provide examples of materials, outlines, demonstrations, etc. developed for outreach activities for the K-12 and/or informal audiences
We do not yet have K-12/informal outreach materials that are ready for publication.

Describe a recent successful education outreach activity
Ms. Dixie Sinkovitz, a physics and math teacher at the Latino College Preparatory Academy, completed a 10-week internship at the Stanford University Center for Probing the Nanoscale. On returning to LCPA, she delivered an 8-day lesson on the nanoscale to about 60 LCPA high school students.

VI. Education Outreach Evaluation

Summarize outreach evaluation plan
We plan to construct our outreach evaluation plan in partnership with three experts. Dr. Marni Goldman is the Education Director for CPIMA (a MRSEC). Prof. Maureen Scharberg is a Professor of Chemistry and Director of Science Education at San Jose State University. Dr. Nora Sabelli is the co-Director of the Center for Teaching and Learning at SRI International. These three education experts have been extremely helpful in advising our Center since its conception.

Summarize outreach evaluation results
Course and workshop evaluations were quite favorable, but the real impact of our outreach will be determined after the efforts have ramped up in the 05-06 year.

VII. Lessons Learned

List 2-3 lessons learned to share with others embarking on a nano education outreach effort.

- Graduate students are an awesome resource.
- It's not good to be located in Silicon Valley during one of the world's most severe housing bubbles when recruiting an education director candidate.
- Describe what you might do differently in the future
- Focus early on the infrastructure needed to create a successful program.