SYMPOSIUM HH

Materials Science and Engineering Education in the New Millennium

April 24 – 26, 2000

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* Invited paper

SESSION HH1: EXAMINING MS&E PROGRAMS
Chair: Jacqueline A. Isaacs
Monday Morning, April 24, 2000
Salon 14 (Marriott)

8:30 AM *HH1.1
A PERSPECTIVE ON HOW THE NEW INDUSTRIAL R&D ENVIRONMENT MIGHT AFFECT MSE EDUCATION. Michael R. James, Materials and Computational Sciences Dept., Rockwell Science Center, Thousand Oaks, CA.

Corporate research centers have changed dramatically over the last decade. Many have faded into oblivion while others have been transformed into product development centers or advanced engineering centers-most all have been downsized. In general, the cycle time for R&D projects has decreased and the justification process for new projects has become more formalized. While many may bemoan the decrease in basic research and the loss of individual independence, these changes have brought about dramatic acceleration in interdisciplinary team approaches to R&D. A small group often can no longer independently carry out a complete project within a necessarily compressed time frame. This requires a change in culture within an organization that is reflected in the attributes of its new hires. These include increased use of computer simulation and interdisciplinary integration of software tools. It is evident that training at the bachelor's level provides a broad capability in use of computer tools, and industry has an expectation that new hires will use the tools at hand more efficiently. Another change is the need for broad flexibility of employees with the ability to focus on multiple projects and to interact and communicate with engineers in other fields more than in the past. In today's world, a generalist is often more in demand than a specialist, and this can have a significant influence on what's covered in an undergraduate MSE program. Examples for each of these will be given.

9:00 AM HH1.2
A GENERAL UNDERGRADUATE MATERIALS CURRICULUM - THE FIRST DECADE. Kevin Trumble, Keith Bowman, Gerald Liedl, Purdue University, School of Materials Engineering, W. Lafayette, IN.

A general undergraduate MSE curriculum was adopted in the School of Materials Engineering at Purdue University in 1989. After a decade of work, good progress has been made toward the goal of a balanced approach to the science and engineering of the different classes of engineering materials based on their Structure, Properties, Processing, and Performance. Elements of the curriculum (e.g., Processing) have been presented in detail previously, but not the curriculum as a whole. The overall curriculum, its underpinnings, implementation, and results will be the focus of this presentation. The challenges of faculty cooperation, competition for students with other disciplines, and dispersion of MSE across campus will be highlighted.

9:15 AM HH1.3
RESTRUCTURING UNDERGRADUATE EDUCATION AT ILLINOIS INSTITUTE OF TECHNOLOGY; CASE STUDY: METALLURGICAL AND MATERIALS ENGINEERING PROGRAM. Marek Dollar, Illinois Institute of Technology, Mechanical, Materials and Aerospace Engineering Department, Chicago, IL.

There is a broad recognition at IIT that we live in a time of revolutionary change in undergraduate education. In response, we are developing new ways to recruit and retain a diverse student body, seeking educational relationships with industry, experimenting with new approaches to teaching and learning, and positioning ourselves to meet ABET engineering criteria for the year 2000. The key elements of the undergraduate education restructuring will be presented. They include, but are not limited to, such initiatives as: Interprofessional Projects, project-oriented learning that teams students from different disciplines and professions and constitutes a new instructional tool through which students learn concepts of teamwork, communication and problem solving; Introduction to the Professions, a freshman-level course that in an innovative way bridges the gap between high school experience and the university's environment; and Writing Across Curriculum, an institutional structure for integrating writing into engineering courses. Our attempts to increase computer competence, introduce multimedia in the classroom and create undergraduate research opportunities will also be discussed.

9:30 AM *HH1.4
FEEDBACK LOOPS ALONG THE PRE-REQUISITE TREE. Thomas R. Bieler, Robert W. Soutas-Little and Melissa J. Crimp, Michigan State University, Department of Materials Science and Mechanics, East Lansing, MI; Marianne Huebner, Michigan State University, Department of Statistics, East Lansing, MI.

The ABET Engineering Criteria 2000 is stimulating development of quantitative feedback systems in the context of Engineering education. Efforts in developing feedback loops that carry quantitative information to facilitate the improvement of the ability for students to learn the material presented in large service courses taken by students in several engineering majors is summarized. The primary focus is on introductory courses in Statistics, Materials Science, and Mechanics. Methods used to identify desirable course learning objectives that satisfy needs in different engineering programs are described. The effects of establishing common course learning objectives for every section of these courses is examined. In some courses, common final exams are administered (at the same time in several rooms). In the mechanics courses, mechanics reform issues have been assessed and changes have been implemented to improve the ability of students to visualize solutions to problems with the aid of computational tools. Modular models for service courses are discussed, and possible implementation strategies and difficulties are described. Progress in developing a nearly common course evaluation form as an assessment tool that allows ease in transferring appropriate information across departmental boundaries is also discussed.

10:30 AM *HH1.5
A CURRICULAR BLUEPRINT FOR INTEGRATING STATISTICAL METHODS INTO MSE CURRICULA. Heather Smith, Statistics Department, Linda Vanasupa, Materials Engineering Department, California Polytechnic State University, San Luis Obispo, CA.

Materials Science and Engineering (MSE) curricula provide students with a solid foundation in understanding the underlying science of materials. Although most curricula also provide exposure to industrial practices, MSE students often find themselves without a clear understanding of how they can apply their materials science knowledge in an engineering setting. By having a firm grasp on statistical tools, engineering students can possess a means of using data to decide a course of action to improve an engineering process. In this talk we will present a curricular "blueprint" that describes how statistical tools can be built into the MSE curriculum. The blueprint consists of 4-levels of competency that correspond to integrating statistics at the freshman, sophomore, junior and senior levels. We will describe these levels and a systematic means of introducing the practices into an MSE curriculum.

11:00 AM HH1.6
AN INNOVATIVE APPROACH FOR TRAINING RESEARCH AND ENGINEERING PROFESSIONALS IN UNDERGRADUATE EDUCATION. P. Ruby Mawasha, Paul C. Lam, T.S. Srivatsan, The University of Akron, College of Engineering, Akron, OH.

The development and training of competitive engineers and researchers in the next century must essentially focus on an undergraduate curriculum that can provide a strong balance in both science and engineering. An undergraduate curriculum that is geared towards a balanced science and engineering education is becoming increasing difficult to establish. In this study, we postulate that the development of a successful and balanced engineering and science undergraduate education is dependent on the conjoint influence of several variables, to include: (a) Career orientation (e.g., commitment to engineering or research as a career, reasons for pursuing engineering or research as a career, opportunity to pursue a career). (b) Knowledge of mathematics (e.g., math courses completed, math achievement, math self-efficacy, hands-on math activities). (c) Knowledge in science and engineering (e.g., science courses completed, science achievement, hands-on science and engineering activities). (d) Research experience for undergraduates (e.g., science and engineering research with a faculty member, scientific and engineering presentations, and ability to write scientific manuscripts). (e) Cooperative education or engineering internship (e.g., industrial experience with an engineering company, supervision under experienced engineers, training in writing technical reports for company managers). The model is not intended to serve as an elaborate theory, but as a general guide in the re-establishment of a good balance between relevant aspects of science and engineering in undergraduate education. The proposed model is based on the primary premise that preparation of good researchers and engineers should be enthusiastically encouraged in undergraduate education.

11:15 AM HH1.7
A NEW MASTER COURSE PROGRAM IN MATERIALS SCIENCE AND ENGINEERING AT THE UNIVERSITY OF KIEL. Frank Paul, Helmut Foell and Wolfgang Jaeger, Faculty of Engineering, Christian-Albrechts-University, Kiel, GERMANY.

An international study course program in Materials Science and Engineering based on new concepts in engineering education has been developed by the Faculty of Engineering at the University of Kiel for students from Germany and abroad. The scope of this study program is to offer advanced materials science education leading to an internationally recognized Master (MSc) degree in order to be able to meet the demands of industry and research institutions in a modern industrial society and to provide students with the necessary skills to meet the challenges of a global job market. The main characteristics of the program for which tuition fees are not required consist in (i) theoretical teaching and lab training modules held in English language by members of highly qualified and renowned research groups (ii) excellent scientific equipment for lab courses (iii) internet teaching modules and group rooms with multi-media equipment (iv) a broad choice of courses including courses in non-technical skills, such as social sciences, business administration and languages (v) a Master thesis oriented at the German type of a Diploma thesis in areas of functional and structural materials (vi) collaboration with research institutions, such as the GKSS Research Center and the Fraunhofer Institute of Silicon Technology, and (vii) participation in the European credit point transfer system for international acceptance of course work. Important aspects are also the personal care assured by a mentor system, especially also for students from abroad, and a favourable ratio of students to professors. In order to keep the total study time reasonably short the Master program is designed to be part of a '3-5-8-model of engineering education', an acronym describing the total number of years required to obtain the academic degrees BSc, MSc and PhD, respectively. The paper will discuss the structure and contents of the study program and assess first experiences with the student course work.

11:30 AM HH1.8
MATERIALS SCIENCE EDUCATION IN INDIA IN THE NEXT MILLENIUM. D.N. Bose, Advanced Technology Centre, Indian Institute of Technology, Kharagpur, INDIA.

Courses in Materials Science commenced in India in the late sixties and early seventies and were pioneered by the Indian Institutes of Technology. As these Institutes emphasized Undergraduate Engineering courses in conventional disciplines, Materials Science was taught as a post-graduate course, open to Masters degree holders in Physics, Chemistry and also (fewer) engineering graduates. In the beginning general courses were given with electives in chosen areas, but at IIT Kharagpur specialization in three areas: Semiconductors, Polymers and Ceramics was introduced in 1981. This has proved attractive for both students and prospective employers. For engineering students at the undergraduate level Materials Science was taught as mainly as an elective subject, with varying degrees of success, since it had to compete with newer courses in the field of specialization. To make it more relevant and also compatible with semester load requirements, one solution was to teach Materials Science not as a general course but to aim it at either Mechanical Engineers or Electrical / Electronic Engineers. Competition with existing Courses in Metallurgy was another fact-of-life and the addition of a few lectures on non-metals was considered enough to call the subject by the newer name. In the nineties, the trend has been to convert Departments of Metallurgy into Metallurgy and Materials Engineering as is being done elsewhere. Industrial sponsorship of courses has not taken off although short-term courses in specific areas are being sought. Open-ended laboratory experiments have been introduced. Projects conducted in industry have been a successful innovation and give students much-needed exposure. The future should see more emphasis on computer-aided modeling although this should not detract from exposure to real-life processes. Universities and Regional Engineering Colleges are also introducing Materials Science courses but lack of infrastructure is the main hurdle to be overcome for meaningful training of students.

11:45 AM HH1.9
ENGINEERING ETHICS ACROSS THE CURRICULUM. Paul F. Johnson and Linda E. Jones, Alfred University, School of Ceramic Engineering and Materials Science, Alfred, NY.

More engineering programs are formally teaching professional ethics today than ever before. At least three distinct approaches are being used: large, specialized programs employ in-house professional ethicists; Philosophy Department ethicists teach service courses to engineers; and, engineering faculty coordinate ethics training by incorporating modules in technical courses. This paper focuses on the last approach. Some 70 young students enter our program each year knowing that they want to be ceramic, glass or materials scientists or engineers. We are able to start all students in a common freshman year experience that focuses on materials (they do not specialize until their junior year). A full year course, entitled Engineering Communications, is a part of that experience. Ethics is formally introduced in this course, and three Engineering Codes of Ethics are critically compared and contrasted. Students maintain an Ethics Journal that serves the dual purpose of providing a continuing emphasis on current topics in professional ethics and an informal writing sample that serves as an advising diagnostic for future coursework in written English. An opinion paper on the role engineering ethics played in selected, well-known, engineering failures is written by each student, and the paper is then published on the school's web site. The students are then grouped by the topic of their papers, and each group prepares an oral presentation performed before their classmates, selected faculty and the Dean of the School of Ceramic Engineering and Materials Science. We now have five years of experience with the freshman ethics module. Student involvement with professional ethics builds through ethics components in other courses, consideration of professional ethics in coop reports, and culminates in formal work done as a part of their capstone courses and their senior theses. Examples of student work, and details of our program design are presented.

SESSION HH2: EXAMINING OUR TEACHING/RESEARCH AS TEACHING

Chair: Katherine C. Chen
Monday Afternoon, April 24, 2000
Salon 14 (Marriott)

1:30 PM HH2.1
ENHANCING THE SUCCESS OF UNDERGRADUATES IN ENGINEERING: A TEACHING WORKSHOP FOR FACULTY AND TA'S. J.A. Isaacs, Northeastern University, Department of Mechanical, Industrial and Manufacturing Engineering, Boston, MA.

Among undergraduates with SAT scores above 650, the four most commonly cited concerns for switching majors from science, math, engineering and technology (SMET) include: (a) poor teaching, (b) lack of interest in science, (c) belief that non-SMET majors offers a better education, and (d) feeling overwhelmed by the curriculum load (Seymour and Hewitt, 1997). In order to retain students in engineering programs and produce a pool of technically skilled graduates, focused efforts are required to improve the quality of instruction. Because teaching is a primary concern, improvements in teaching skill will have the greatest impact on students. Since the vast majority of engineering faculty have no formal pedagogical training in instruction, and may be unaware of the variety of techniques for instruction, there is a great need for systematic programs for teaching engineering educators to improve their instructional effectiveness. The National Science Foundation funded an extremely successful faculty enhancement workshop entitled Teaching Teachers to Teach Engineering (T4E: 1996-1998), which evolved to the American Society of Civil Engineers' Excellence in Civil Engineering Education (ExCEEd). This learn by doing format ensures that participants will make substantive improvements in their teaching skills by the end of the week. To enhance the success of freshmen engineers in moving on to the sophomore year, the Colleges of Engineering and Arts and Sciences at Northeastern University are working collaboratively on a new learning excellence initiative. In this program sponsored by the General Electric Foundation, best teaching practices are identified, developed and delivered by a corps of exemplary faculty from engineering, physics, math and chemistry. One of the means for improving the teaching standards includes offering a teaching workshop, modeled after the T4E or ExCEEd workshops. Information on the existing ExCEEd workshop will be disseminated. Aspects of this workshop will be incorporated into a teaching workshop targeted for faculty and graduate teaching assistants at NU who teach freshman courses. Implementation of the teaching workshop at Northeastern University will be discussed along with expected outcomes.

1:45 PM HH2.2
SUBJECT CENTRE SUPPORT FOR INNOVATIVE TEACHING: A UK MODEL. Peter J. Goodhew and Caroline A. Baillie, Materials Science & Engineering, University of Liverpool, UNITED KINGDOM.

A Learning and Teaching Support Network (LTSN) has just been established to support undergraduate course delivery in the UK. There are 24 subject centres in the network and the Materials Subject Centre is based at the University of Liverpool. Its mission is to support teachers and learners who are providing courses in materials science, metallurgy, ceramics, and polymer, wood, paper and textile sciences. The Centre will have been in operation for several months by the time of the Spring Meeting and a summary of its methodology and its achievements at this stage will be reported. Major aspects of the Centre's work will involve the establishment of email networks, the mounting of a gateway Web site, the identification of good practice in the UK and elsewhere in the world, and the running of courses and workshops in innovative teaching methods. Interesting aspects of the work of the Centre are likely to include the extent to which there is a distinction between the practices and attitudes among Materials teachers compared to those in cognate disciplines such as Engineering and Physical Science, and the attitudes to change with respect not just to the increasing use of IT but to innovations unrelated to computer use such as peer mentoring or self assessment. It will be useful to compare our early experience in the UK with experiences of colleagues in the USA and elsewhere.

2:00 PM HH2.3
MATERIALS SCIENCE TEACHING RESOURCES CENTER.
Thomas Stoebe, University of Washington, Seattle, WA; Gerald Liedl, Purdue University, West Lafayette, IN; Rustum Roy, Pennsylvania State University, State College, PA.

The authors are developing a project to collect and catalog instructional materials in the area of Materials Science, Engineering and Technology. This collection process is ongoing and will result in a catalog of teaching materials on the new Materials Hub web site (www.ed4mse.org/) and in a print catalog. A draft version should be available on the web site in March, 2000. Included in this project are modules, laboratory exercises, demonstration units and other teacher resources with the exception of text books. The catalog does not attempt to reproduce these teaching resources, but rather gives the instructor a summary of the materials available by category and appropriate level from kindergarten to graduate school, along with a set of cross references for easy use. Each listing is being evaluated by experienced teachers and faculty prior to being listed, and reviews and specific evaluations are also included in the listing. The authors continue to receive nominations for units and modules to be included in this project. Information and requests should be directed to Gene Bazan at ejb2@psu.edu.
This program is sponsored by NSF grant DMR-9812144. The web site is supported by funds from AIME and TMS and is managed by Purdue University.

2:15 PM HH2.4
THE TRIALS AND ERRORS OF COLLABORATIVE LEARNING: A NEW FACULTY'S PERSPECTIVE.
Stacy Gleixner, San Jose State University, Dept. of Chemical and Materials Engineering, San Jose, CA.

For many of us, the lecture style engineering education we received as students is not the style we are trying to impart as educators. Many engineering faculty are adapting their curriculum to include the students as active participants in the classroom. For new faculty wishing to experiment with teaching styles, curriculum development is not simply dusting off your course notes and recreating the lectures you once sat through. New faculty are faced with the challenge of not only developing new material but also experimenting with ways of delivering that material. There are a number of teaching techniques that have proven very useful in involving the students and increasing their learning. As a new faculty member, I have chosen to improve my teaching by first implementing in-class, collaborative learning exercises into my lectures. In this paper, I will detail the studies and advice that led me to this decision. Some of these are that students learn from teaching the material to each other, there is a greater percentage of retention in doing rather than just hearing and writing, and the exercises give good in-class assessment on the lecture's effectiveness. The introduction of collaborative learning exercises into my lectures has also brought a number of problems and fears including time constraints, the practical issues of forming groups in large classes, and the barrier students have towards working together. From the perspective of a new faculty, I will discuss the problems I have had implementing collaborative work into my classes, the ways I have developed to evaluate how successful the projects were, and tips for avoiding and overcoming the problems I have encountered.

2:30 PM *HH2.5
A NEW ROLE FOR ENGINEERING EDUCATORS: MANAGING FOR TEAM SUCCESS.
Debra S. Larson, Department of Civil and Environmental Engineering, Northern Arizona University, Flagstaff, AZ.

For a variety of reasons, collaborative learning teams, project teams, or design teams are now a part of undergraduate engineering education. In response, the current education-related literature is blooming with team-type topics that include when to use teams, why teams, team dynamics, and how to structure the team. Almost non-existent, however, are discussions about the role and impact of the faculty member in and on student teams.
Through research and teaching within NAU's unique undergraduate curriculum - *the Design4Practice* program that emphasizes team-based, hands-on learning in a design environment - I have come to believe that faculty who use student teams need to assume a new, managerial, role in the classroom.
This idea developed as a by-product of monitoring the confidence component of student problem solving using a validated test called the Problem Solving Inventory (PSI). Low PSI scores mean students trust their problem solving ability, are willing to attempt difficult problems, and are in control of their feelings and behaviors during this process. While looking for changes in student PSI scores, as a consequence of their participation in *Design4Practice*, I found an unexpected score correlation between students and their instructors. Faculty with low PSI scores had teams and class PSI averages that were lower than the PSI scores of students in classes that were taught by faculty with high PSI scores. Digging deeper, the low PSI instructors always had successful student design teams, whereas team success for the high PSI instructors varied.
Instructor PSI scores appears to be an indicator of style and team management skill, as the faculty with low PSI scores (and successful student design teams) exhibit some common characteristics. These instructors understand the creative problem solving process and are confident about design, transferring that confidence to their students. They help their student teams organize themselves and plan for the work ahead. They facilitate the teams' progress throughout the course of the project and care about student and team successes. In other words, these engineering educators go beyond the normal teacher-student relationship and take on the role of project manager.

3:30 PM *HH2.6
ACHIEVING THE BALANCE - THE ROLE OF TEACHING AND RESEARCH IN TENURE DECISIONS.
John C. Bravman, Department of Materials Science and Engineering, Stanford University, Stanford, CA.

The task of balancing teaching and research responsibilities in the quest for tenure will be discussed. Although it is common knowledge that achieving this balance is quite difficult, there are strategies that can be adopted that can help the pre-tenure professor. The authors perspective is based on seven years experience in relevant administrative roles (Department Chair, Senior Associate Dean, Vice Provost), plus his own pre-tenure period. Direct questions from the audience will be an important part of this process; interested parties may send questions in advance to bravman@stanford.edu for possible use in this presentation.

4:00 PM *HH2.7
UNDERGRADUATE MATERIALS RESEARCH INITIATIVE: PROVIDING ACTIVE RESEARCH EXPERIENCES.
Bethanie J.H. Stadler, Ingrid L. St. Omer, University of Minnesota, Department of Electrical and Computer Engineering, Minneapolis, MN.

The Materials Research Society's Undergraduate Materials Research Initiative (UMRI) is a program designed to introduce undergraduates to research and the excitement of discovery in materials science and engineering. Through an open competition process modeled after federal funding agencies, participants gain an understanding of the research process from proposal to final report. Each awardee receives a grant for the cost of a moderate research project, maximum $750, plus an additional award of $250 payable to the researcher upon completion of the project. The MRS awarded 20 grants for research performed during the inaugural 1998/99 academic year, and it has awarded 40 grants this academic year. In addition to financial assistance, the MRS also provides positive exposure for both the undergraduate participants and their advisors in order to highlight the importance of an active research experience. Past and present UMRI awardees have been invited to present their work in a poster session during this meeting. The educational impact of the program will be explored in terms of applicant demographics and survey responses from awardees, advisors and reviewers. The review process, international aspects, and suggested research timeframes will also be discussed. The basic operating principles of this program have potential application to any academic, industrial or governmental program designed to increase faculty and student interest in undergraduate research. Such programs address the need to attract and retain talented individuals to technical careers.

4:30 PM HH2.8
USING WEB-BASED INSTRUMENTATION AND RESOURCES FOR UNDERGRADUATE RESEARCH AND EDUCATION.
B.L. Ramakrishna[1], Vincent Pizziconi[2], William S. Glaunsinger[3], Ansuman Razdan[4], Eddie W. Ong[5], Kirsten Hintz[5], Laurie Luckenbill[5]. [1]Department of Plant Biology, Arizona State University, Tempe, AZ, [2]Department of Chemical, Bio & Materials Engineering, Arizona State University, Tempe, AZ, [3]Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ, [4]Partnership for Research in Stereo Modeling, Arizona State University, Tempe, AZ, [5]Center for Solid State Science, Arizona State University, Tempe, AZ.

The Interactive Nano-Visualization for Science and Engineering Education (IN-VSEE) project is an effort, funded by the National Science Foundation, that brings sophisticated, yet user-friendly, state-of-the-art imaging technology and instrumentation that are traditionally available only at elite research centers into any classroom. The project combines elements from interdisciplinary research, integration of research into materials education, industrial liaison and outreach to provide innovations in formal and informal education at the high school and college levels. The project is exploiting the incredible potential of materials science for teaching students about fundamental concepts that cross traditionally separate disciplines. It is centered on the web-based remote operation of a Scanning Probe Microscope. It has also been developing web-accessible educational modules and a Visualization Gallery to aid in synchronous and asynchronous distance-learning activities. Aspects of our remotely operable microscope, educational modules, and Visualization gallery will be described. We will also describe how undergraduate students and their mentors can access and use these resources for independent research projects, honors theses, supplementary lecture and class materials.

4:45 PM HH2.9
AN INTERDISCIPLINARY APPROACH FOR INVOLVING UNDERGRADUATES IN THE MATERIALS SCIENCE AND ENGINEERING PROGRAM. R. Bruch, Dept of Physics, Univ of Nevada, Reno, NV; N. Afanasyeva, L. Welser, Dept of Physics, Univ of Nevada, Reno, NV; S. Gummuluri, Dept of Electrical Engineering, Univ of Nevada, Reno, NV.

The University of Nevada, Reno Physics Department has a successful history of involving undergraduate students in research, including the fields of material science and engineering. Our group has given a number of undergraduates the opportunity to work on professional-level research projects. This has proven to be beneficial not only to the students, but also to the entire group, whose diversity is enhanced by having a cross-section of teaching faculty, research faculty, post-doctoral students, graduate students, and undergraduates. In a small department like that of physics at the University of Nevada, it is common to have a high percentage of undergraduates involved in research projects. Therefore, the Materials Science and Engineering Program can tap the opportunity for spawning inter-disciplinary research programs. Specifically, our research involves fiberoptic evanescent wave Fourier-transform infrared (FEW-FTIR) spectroscopy of various materials. Two undergraduate students have assisted in analyzing spectra, which can identify deformations in polymers. This technology can also be applied to many growing sub-fields of material science, such as agricultural quality control, archaeology, geology, and forensics. The Materials Science and Engineering Program should facilitate growth of inter-departmental materials science research, since a lot of related work is being done in the basic sciences like physics, chemistry, and also civil engineering. Many students are not aware that their research falls under the umbrella of materials science. Therefore, under- graduate research activity and involvement in this field can be increased by focussing on departments that are not strictly materials science oriented.

SESSION HH3: EXAMINING STUDENT LEARNING
Chair: Stacy H. Gleixner
Tuesday Morning, April 25, 2000
Salon 14 (Marriott)

8:30 AM *HH3.1
BUILDING KNOWLEDGE IN MATERIALS SCIENCE. Caroline Baillie, Dept. Materials, Imperial College of Science Technology and Medicine, London, UNITED KINGDOM; Jonas Emanuelsson and Ference Marton, Dept. Education and Educational Research, Gothenburg University, Gothenburg, SWEDEN.

Many studies regarding Materials Education consider implementing known innovative approaches to the disciplinary context and explore the effects on student learning. Few practitioners or researchers start from the subject and are involved with the scientific or engineering concepts themselves and how these might be "learnt" or understood by students. The present paper discusses the outcomes of research exploring the formation of knowledge in the area of composite interfaces. There are at least two different outcomes for the "knowledge building" research. The first is in the area of the discipline itself. How the knowledge is construed helps us to understand the subject itself better, as researchers. The second outcome is that having a better understanding of the way in which knowledge is built up from basic principles will give us a much more effective way of helping students to learn. This paper discusses the possibilities that this outcome holds for Materials Science Education. A series of interviews have been conducted with researchers from eight different countries, all involved in investigating some aspect of composite interfaces. Questions were aimed at exploring their understanding of the "interface" in fibrous composites. The interviews were transcribed and data analysed using a phenomenographic approach (borrowed from qualitative education research). It is, of course, accepted that each researcher cannot undertake such an in-depth study of conceptions within their own field, however, it is hoped that by exploring their own learning process and discussing with education researchers and others involved in understanding the knowledge building process, they might be better able to construct learning environments which help students "build" their own knowledge.

9:00 AM HH3.2
EVERYTHING YOU'VE ALWAYS WANTED TO KNOW ABOUT WHAT YOUR STUDENTS KNOW BUT WERE AFRAID TO ASK. Eric Werwa, Otterbein College, Department of Physics and Astronomy, Westerville, OH.

As part of the development of Materials MicroWorld, a review of the educational literature on student and public conceptions about physics, chemistry, and materials was conducted. Much of these findings were reinforced by the results of two front-end audience surveys, commissioned by MRS and conducted among visitors to the Maryland Science Center in July, 1999. We learned that people of all ages have robust alternative notions about the nature of atoms, matter, and bonding that persist despite formal science education experiences. Some confusion arises from differences in the ways that scientists and the lay public use terms even as simple as materials. Two-thirds of all respondents first associated the term, materials, with natural resources, fabric, and construction materials. Many models that eloquently articulate arrangements of atoms and molecules to scientists may in fact promote naive notions among the public. While nearly all adults in the survey recognized three-dimensional models as representative of atoms, only one-third of children made the same conclusion, while another third confused atomic models with models of genes or cells. Shifts between models and changes in size-scales are particularly confusing to learners. People's abilities to describe and understand the properties of materials are largely based on tangible experiences. Much of what students learn in school does not inform their interpretations of encounters with materials and phenomena in everyday life. Most people focused on observable properties (as opposed to behavioral properties) and applications when asked to describe various samples, and very few people associated material properties with atomic structures or larger microstructures during initial interview phases. In this talk, I will present specific examples of misconceptions, examine how we plan to address these in MicroWorld, and hopefully inspire some thoughts on how we can use this knowledge to be more effective in our own classrooms.

9:15 AM HH3.3
WRITING EFFECTIVE COURSE LEARNING OBJECTIVES: A FEW GOOD TIPS. Emily Allen, Department of Chemical and Materials Engineering, San Jose State University, San Jose, CA; Blair London, Materials Engineering Department, California Polytechnic State University, San Luis Obispo, CA.

Creating a set of learning objectives (LO's) for an MSE course can be a difficult process. This is true for new faculty as well as for faculty who have taught a course many times. In this presentation, we will briefly introduce a few different strategies for writing effective LO's for a typical MSE course. Along the way we will highlight what has worked well and not so well in our experience in developing LO's and using them. Representative examples of LO's for introductory-level and advanced-level MSE courses will be presented. Methods of assessing the effectiveness of the learning objectives will be discussed along with ideas on how course learning objectives fit into program objectives and program assessment processes for ABET EC 2000.

9:30 AM HH3.4
TEACHING ENGINEERS MATERIALS SELECTION VIA INTERNET: ISSUES OF STUDENT DIVERSITY AND LEARNING STYLES. Y-Q. Sun, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, IL.

Advances in the Internet technology have provided new educational tools for reaching-out to more students and for the interaction among students and with the instructor. Materials Selection is needed by engineering students of many disciplines and is hence a suitable platform to implement the new Internet technologies for the purpose of making the course accessible to more engineering students and of forming an interactive learning community among remotely located students. This paper will report on the experimental use of these new educational tools in teaching Materials Selection at the University of Illinois. The course is taken via Internet video by off-campus students from all over the US and abroad. Internet Web Board is used to form an interactive learning community for the remote students with the on-campus students. This paper will assess the student reactions to the use of Information technologies in teaching and the interaction among the geographically distributed students via the Web Board. Issues of particular importance are the inevitable diversity in the student background and learning styles, and how the Internet technologies cater to the differences. The course structure of building the concepts around the materials properties will also be discussed.

10:15 AM HH3.5
INTRODUCTION OF ADVANCED MATERIALS CONCEPTS THROUGH PROBLEM BASED MATERIALS AND PROCESS DESIGN. D.L. Cocke, Gill Chair of Chemistry and Chemical

Engineering, Lamar University, Beaumont, TX; K. Li and D.H. Chen, Department of Chemical Engineering, Lamar University, Beaumont, TX.

Best practice in modern pedagogy has emphasized problem-oriented learning where students work together with professors on practical projects that integrate "need to know" or "just in time" book or literature knowledge to the demands of a realistic problem. In the Chemical Engineering and Chemistry Program at Lamar University we have begun to use integrated materials and process design problems to introduce advanced materials concepts. This is being done by focused introduction of fundamental materials concepts in the context of a problem targeted to challange the student to directly apply these to the design of a state-of-the-art materials and reaction system. Two problems will be used to illustrate this practice: a) the design of a multifunctional, sorption modified, material for water treatment and b) the design of a distributed light super-porous photocatalytic reactor. The former illustrates the fundamentals of zeolites, surface charges and surface sites, surface modification of materials with surfactants, selective adsorption, surface solubilization and surface adsorption processes. The second design problem requires knowledege of modern photocatalysts such as titania, surface adsorption, light distribution through fiber optics, photoreactions at solid surfaces and porosity design in materials such as catalysts. The results of the classroom utilization of these problems will illustrate the beneficial effects of the introduction of advanced materials concepts to student learning in chemical engineering and chemistry education.

10:30 AM HH3.6
FURTHER STUDY OF THE EFFECT OF GROUP SIZE ON STUDENT PERFORMANCE. Al Sutko, Midwestern State University, Manufacturing Engineering Technology, Wichita Falls, TX.

In a 1992 issue of the International Journal of Engineering Education, this author reported on the effects of laboratory group size on student performance. Most of the information was obtained from material science laboratories. The data indicated that individuals in groups of two or four students tended to receive better final course grades than those from groups of three. Discussion was given concerning the possible reasons for this finding along with information from the then current literature. This paper includes the key components of the 1992 paper and updates it with data obtained since then. It also includes information from other literature published in the recent past. The conclusions reached in the 1992 paper appear to remain valid.

10:45 AM HH3.7
Abstract Withdrawn.

11:00 AM HH3.8
INFLUENCE COMPUTER-AIDED TECHNOLOGY ON STYLES OF TEACHERS AND INSRUCTORS IN MATERIAL SCIENCE. B.N. Kodess[1,2], Anna Sidorenko[4], F.A. Sidorenko[3], G.B. Glazunov[3], P.B. Kodess[1]. [1]Dept of Materials Science, ICS&E, Denver, CO, [2]Dept of Crystal Metrology, Moscow, [3]Dept of Phys, Ekaterinburg, [4]Dept of Information Technologies, Ekaterinburg, RUSSIA.

An analysis of model of personality of a successful teacher/instructor in natural and technical disciplines has been carried out on the basis of the data on various personal techniques and tests. The model is based on various traits of personality interaction which is considered at various levels of complexity. The first level allocates three major spheres of activity - sphere of regulation, perception and emotions - and includes analysis of measured parameters. The second level -model of style of activity is basically connected with interaction of the first two spheres. The educators of Material Science and Engineering (MSE) recently undergo to essential influence of various factors. It is largely connected with both evolution of (MSE) paradigm and introduction of personal computers in practice of teaching. Various electronic manuals and testing complexes for students' personal work have been and are being created. It is more important, that software packages intended for work of a lecturer with the audience have appeared lately. They include interactive modules allowing to use them both in specialized high schools and colleges. The lecturer has got an opportunity to use various channels of perception more effective. In these packages balance of visual, audio and motor perception and parallel assimilation of principles and practical skills is being achieved with more simple methods. Our observations show, that use of such courses allows the teachers and instructors exploit the most strong sides of their teaching style, and also allows the students to rely on their most strong sides, to develop necessary types of perception for more complete and deep acquiring of study material. As a result, it is possible to speak about new type of more effective methods of education which include pedagogical dialogue. The computer-animated packages will be presented.

SESSION HH4: SYMPOSIUM X PRESENTATIONS

Chairs: Anna C. Balazs, Robert Q. Hwang, Kevin S. Jones and Frances M. Ross
Tuesday Afternoon, April 25, 2000
Salon 7 (Marriott)

12:15 PM *HH4.1/X2.1
MATERIALS MICROWORLD: A VEHICLE FOR TEACHING ELEMENTARY AND MIDDLE SCHOOL STUDENTS ABOUT MATERIALS. Eric Werwa, Otterbein College, Department of Physics and Astronomy, Westerville, OH.

Materials MicroWorld is a traveling museum exhibit about the world of materials science to be created through collaboration between the Materials Research Society, museum professionals, and designers. It will give science museum visitors an appreciation for the concepts, processes, and trends in materials science through a combination of hands on exhibits, climb through environments, and educational programming. The primary target audience of the science centers to which MicroWorld will travel is the elementary and middle school student, and as such these museums are very popular with elementary and middle school groups and with families having children in this age group. In trying to bring materials science to younger children (a group that has proven difficult to reach on a widespread basis in the past), this route appears to be a very promising one. By involving members of MRS in exhibit creation and educational outreach, this project will establish a strong link between the worlds of materials research and informal science education. An array of educational materials and training videos will accompany the exhibit which can be used by teachers to develop programs to use with students in the classroom and by parents to continue these experimental activities with their children at home. A Materials MicroWorld link on the MRS web site will provide teachers and parents with additional resources about materials.

12:30 PM *HH4.2/X2.2
PHYSICS FIRST: IMPROVING HIGH SCHOOL SCIENCE EDUCATION IN THE U.S. Leon M. Lederman, Resident Scholar, Illinois Mathematics and Science Academy, Aurora, IL.

Over 100 years ago, a prestigious Committee of Ten established a high school science curriculum, which mandated Biology (in ninth grade), followed by Chemistry (in 10^{th} grade) and finally, Physics (11^{th} or 12^{th} grade). In the year 2000, 99% of all the high schools in the US are following the same sequenceeven though it is manifestly in the exact wrong order! Why this is so and data on the benefits of a coherent and logical sequence, are the substance of the talk. The awesome resistance of school systems to change is keenly illustrated by this story.

SESSION HH5: K-12 AND INFORMAL EDUCATION

Chair: B. L. Ramakrishna
Tuesday Afternoon, April 25, 2000
Salon 14 (Marriott)

1:30 PM *HH5.1
MATERIALS MICROWORLD: THE MATERIALS RESEARCH SOCIETY'S FORMAL ENTRANCE INTO INFORMAL SCIENCE EDUCATION. Michael Driver, MRS; Betsy Fleischer, MRS; Alan Hurd, Sandia National Labs; Carol Inman; Alex King, Purdue University; Merrilea Mayo, Pennsylvania State University; Thomas Rockwell, Painted Universe Productions; Eric Werwa, Otterbein College.

Materials MicroWorld is a traveling museum exhibit about the world of materials science to be created through collaboration between MRS, museum professionals, and designers. It will give visitors an appreciation for the concepts, processes, and trends in materials science through a combination of hands on exhibits, climb through environments, and educational programming. By involving the scientists and student members of MRS in exhibit creation and educational outreach, this project aims to establish a strong link between the world of materials research and informal science education. Materials MicroWorld will be developed in two exhibit versions (5000 s.f. and 1500 s.f.) to serve large and small science centers nationwide. An accompanying array of educational materials and training videos will enable each museum to tailor exhibit-related programming to suit the needs of audiences and their staff. Basic program categories will be: (1) explorations of real-world testing, processing, and properties that can be conducted by museum staff with visitors in the exhibit's Exploration Stations; (2) formal presentations for larger audiences; (3) short and snappy demonstrations and materials that exhibit facilitators can pull out of their pockets to intrigue visitors and initiate discussions. A Materials MicroWorld link on the MRS website will: (1) allow families and educators to preview the exhibit and explore it in more depth; (2) summarize research about widespread preconceptions about materials; (3) provide hyperlinks to companies that supply demonstration materials; (4) feature a What's It Made Of? link that explores the structure and composition of everyday materials; (5) enable parents and teachers to download enrichment activities and experiments from an on-line catalog of Best Materials Science Activities and Demonstrations that can be conducted in homes and classrooms. This talk will review the project's history, present the current design and content plans, and discuss opportunities for volunteer involvement in the project.

2:00 PM HH5.2
THE EDIBLE MICROCHIP: A HANDS ON OVERVIEW OF THE SEMICONDUCTOR MANUFACTURING PROCESS.
Stacy Gleixner, San Jose State University, Dept. of Chemical and Materials Engineering, San Jose, CA.

In this presentation, we will fabricate on wafer (sugar wafers that is) transistors. The transistors may not have cutting edge gate lengths. They may not have the industry standard for oxide thickness. Technically, they won't even work. However, they will be the tastiest microchips ever made, guaranteed! The fabrication of the edible microchip will be used to step through the general semiconductor manufacturing process using the medium of decorating cookies to explain each processing step. The main steps that are covered in the demonstration are doping, deposition, photolithography, and etching. By actively replicating these steps on cookies, the students gain a good overview of the semiconductor process sequence regardless of their technical background. The scope of technical information in the Edible Microchip program can be tailored to make it appropriate for a range of ages and technical backgrounds. It is useful as a materials engineering recruitment tool for both grades 6-12 audiences and lower division college students. It can also be used to give an educational and entertaining introduction to semiconductor manufacturing for engineering students of varying disciplines. In this presentation, advice will be offered on how to adapt the demonstration to different age groups ranging from middle school on up. Information will be supplied on how to tailor the demonstration to varying backgrounds and interest levels and how to bring in more technical information such as how a MOSFET works or the adhesion issues of thin films. Equipment needed and practical tips for running the presentation will also be given.

2:15 PM HH5.3
MATERIALS SCIENCE AND ENGINEERING EDUCATION IN ESTONIA. Enn Mellikov, Tallinn Technical University, Center of Competence in Materials Science, Tallinn, ESTONIA; P. Kulu, Tallinn Technical University, Institute of Materials Technology, Tallinn, ESTONIA; A. Opik, Tallinn Technical University, Institute of Applied Chemistry, Tallinn, ESTONIA.

Estonian materials science higher education now has to function within the modern educational world, where competitiveness is mostly related to the relevance and quality of a country's own input. The Higher Education and Science Reform program was open in Estonia to overcome shortcomings in Estonian higher education, to make Estonia fully competitive in integrated world and to prepare for successful integration of Estonia into the European Union.
The former soviet time left for Estonia the higher education system, where specialists for extremely narrow fields of technology were prepared. The training of the large number of narrow specialized young engineers and scientists is very expensive and it is not applicable for the Republic of Estonia, a country of limited resources and generally small- scale industry. Small countries need a more flexible and universal system based on balanced engineering and science courses. In the process of development we used the valuable advise of more than 25 foreign experts that visited the Estonian universities during the last years. As a result the curricula for materials science and engineering education in Estonia was developed, what bases mainly on science and basic engineering courses at undergraduate teaching level. Specialization of students to the different fields of materials takes place at the postgraduate level. One of key actions was the formation of the Centers of Strategic Competence as the possible basic units for Graduate Schools based on the former academic institutions and the universities. It provides for the highly qualified research staff of these institutions who were not involved within the teaching process at the universities a"legal" possibility to take part in science-oriented education of students.
The paper has the aim to assure that the chosen way is optimal for small former soviet countries during the period of quick changes to the market economy.

2:30 PM HH5.4
FEEDING THE RECRUITMENT OF INNER CITY KIDS TO MSE BY KEEPING FIFTH GRADERS ON TRACK FOR ENGINEERING IN COLLEGE. William E. Brower, Jr., Marquette Univ, Dept of Mechanical and Industrial Engineering, Milwaukee, WI.

Engineering students traditionally have come from the white male population and more recently from females. Few minority, inner city students make it to college, and very few of these students choose engineering, much less MSE. When talented inner city students choose the low road in math and science (usually in middle school), they are almost certainly ruling out an engineering career. The fifth grade inner city volunteer teaching project at Marquette University's College of Engineering has attempted to inform and inspire Milwaukee's inner city fifth graders about engineering for the past ten years. Each year I have recruited our engineering students to volunteer to take self contained science lessons into the Milwaukee Public Schools' fifth grade classrooms for fifty minute lessons (labs really) on topics such as light, magnetism and phases of matter. Although the lessons are on science and the career goal touted is engineering in general, the lessons are flavored by my being in MSE. Being excited about a career is certainly a precursor to recruiting. High school students have generally already chosen a college career track, and are rather jaundiced. The practicing engineer visiting a science club is usually preaching to the conterted. Middle school students are generally too juiced to be excited by an outside speaker on careers in engineering. I have found fifth graders to be very excited about seeing and experiencing science in action. They usually do not have a clue about a career in engineering, certainly not about our small branch of engineering. Hopefully, our program here at Marquette will result in more inner city students choosing to enter college as engineers, and then MSE will garner its usual share.

3:15 PM HH5.5
7-14 EDUCATION OUTREACH PROGRAMS THAT MAKE A DIFFERENCE IN THE CLASSROOM AND BEYOND.
Donna Hammer, Materials Research Science and Engineering Center, Luz J. Martinez-Miranda, Dept. of Mats. and Nuc. Eng. and Materials Research Science and Engineering Center; Ellen D. Williams, Dept. of Physics and Materials Research Science and Engineering Center, University of Maryland, College Park, MD.

The Maryland MRSEC is committed to introducing, stimulating interest in, and teaching materials science to public school students and the community in an effort to inspire appreciation for science and engineering, and to help shape and guide the talent pool for the high tech workforce. The philosophy of the Maryland MRSEC outreach program is to use a service-based learning approach in which MRSEC research personnel all contribute service hours to one or more programs of interest to them. Over the last three years, the Center has developed a variety of programs aimed at students from middle school to college that emphasize hands-on learning, understanding of materials properties, and communication skills. Some of these programs include: Invention Convention, Hands-on, Minds-on Science and Writing, Student Science Conference, and Materials Science Demonstrations. This presentation will illustrate and discuss the successful implemention of these programs and how we generate interest in the field.

3:30 PM HH5.6
IMPACT ON TEACHERS AND STUDENTS OF MATERIALS SCIENCE INSTITUTE FOR TEACHERS. Thomas Stoebe, Materials Science and Engineering, University of Washington, Seattle, WA; Guy Whittaker, Science Dept., Coupeville High School, Coupeville, WA.

The University of Washington has conducted teacher institutes for high school and community college instructors over the past 3 years, based on previous programs at UW and at Battelle Pacific Northwest National Laboratories (PNNL). These programs teach materials science and technology as a hands-on applied science/technology course, with over 75% hands on laboratory and project work. The program uses the Materials Science and Technology curricular materials developed at PNNL under DOE sponsorship and the Materials World Modules developed at Northwestern University under NSF sponsorship. These units include collaborative learning activities related to all classes of materials and focus on materials as used in every day life. The influence of these units on student learning and interest in science has been evaluated in a study of attitudes of student after completing the materials course in 10 Washington State high schools. This evaluation involved 250 students who had taken material science courses from the teachers trained in the institute program. These students indicated that the course provided them with more understanding on careers in science or technology (64%), along with skills in working cooperatively in teams (66%), in laboratory work (66%), and in self expression (59%). When asked if they would recommend this class to other students, 76% said yes. When asked to complete the following sentence, I like materials science because, they finished the sentence with three general themes: The most frequently mentioned idea (14%) concerned learning about different materials and then using them to make a project. The second most common response was the theme of hands-on work (13%). Twelve percent of the students commented that the lab activities were fun. Three comments that seemed to stand out are: 1) I love working with materials. I learn so much easier by working with my hands. 2) It was a non stop action class. Almost everyday we are doing something new. I got to make a lot of cool stuff that I can keep forever. 3) My friends used this class as a stepping stone to get into the Boeing Manufacturing Internship in Auburn, WA.

3:45 PM HH5.7
INFUSING MSE TOPICS INTO NON-MSE CURRICULA: A MULTIDISCIPLINARY EFFORT. Devdas Pai, Jagannathan Sankar, NC A&T State Univ, Dept of Mechanical Engineering, Greensboro, NC; Clinton Lee, NC A&T State Univ, Dept of Electrical Engineering, Greensboro, NC.

Materials Science and Engineering related courses have traditionally played a muted role in conventional engineering curricula. As an example, many engineering curricula at the authors institution require at best a sophomore level materials science course. Any further exposure to materials is obtained only in technical elective courses. Mechanical Engineering students do also benefit from a required senior level course in materials engineering. However, when students enter industry or graduate programs upon graduation, they realize that most advances in product design and manufacturing are limited by the capabilities of conventional materials. Advanced materials are the enabling technology to take their intended application to the next level. They appreciate that to be successful in the new millennium, engineers of all disciplines need a working knowledge of the behavior and applications of advanced materials. Empowerment of materials education is a major thrust of the NSF Center for Advanced Materials and Smart Structures at NC A&T State University. The Center serves as a focal point for collaboration between materials researchers at this institution and in private industry and government. Basic research in four technical thrust areas (advanced ceramics, advanced composites, electronic ceramic devices, sensors and smart structures and III-V nitrides, ohmic contacts and devices) drives the Center's activities. The outcomes of the research are systematically being incorporated into both the undergraduate and graduate mechanical and electrical engineering curricula through a variety of means. Beyond classroom lectures and case studies, students receive an extramural exposure to the multidisciplinary aspects of MSE by engaging in team or individual projects that exploit fully the Centers facilities and resources. Benefits are being experienced in terms of a heightened interest in graduate study in MSE and increased placement of students in materials related positions in industry. The paper provides a detailed overview of the authors's experience with this approach.

4:00 PM HH5.8
INNOVATIVE UNIVERSITY-INDUSTRY PARTNERSHIPS TO RECRUIT QUALIFIED HIGH-SCHOOL STUDENTS INTO MATERIALS SCIENCE AND ENGINEERING PROGRAMS. C. Choi, Ray Umashankar, Al Ortega, University of Arizona, Tucson, AZ; Ranji Vaidyanathan, Greg Artz, Todd Anerson, Anthony Mulligan, Advanced Ceramics Research, Inc., Tucson, AZ.

During the summer of 1999, the College of Engineering at the University of Arizona (UA) offered a Summer Engineering Academy (SEA) to attract qualified high school students to consider engineering as a career option. The fundamental idea behind the SEA program was to show prospective engineers exactly how an idea becomes reality. On this program, UA and Advanced Ceramics Research, Inc. (ACR), a local business, teamed to provide student teams an opportunity to design and rapid prototype components for an electric car. Students were trained to use SolidWorks and Fused Deposition Modeling (FDM) for Computer Aided Design (CAD) and rapid prototyping (RP), respectively. In the current program, two groups consisting of 35 freshmen and sophomores and 47 juniors and seniors participated. Among the juniors and seniors, there were 14 female students and 17 male students from under-represented groups. The students were taught the general concepts of materials science, aerodynamics, CAD, and rapid prototyping by selected faculty from the University of Arizona College of Engineering. Five undergraduate guidance counselors trained the students to use Solidworks to design the models. The students visualized and modeled aerodynamic cars and prepared CAD files of the cars using Solidworks. The CAD files were emailed to ACR, who built the parts using an in-house rapid prototyping machine. The students toured the ACR rapid prototyping facilities while the models were being built. Subsequently, these cars were tested in a specially designed wind tunnel and a special prize was awarded for the most aerodynamic design. The design and model competition results were presented to the parents and faculty members of the College of Engineering. The students expressed an interest in choosing materials science and engineering as a career option. The design and model competition results from this innovative summer program for high school students will be presented in this paper.

SESSION HH6: POSTER SESSION: UNDERGRADUATE MATERIALS RESEARCH INITIATIVE (UMRI) WINNERS

Tuesday Evening, April 25, 2000
8:00 PM
Metropolitan Ballroom (Argent)

1999 UMRI Winners

UMRI-1
CHARACTERIZATION OF COMPOSITION EFFECTS ON IMPRINT BEHAVIOR OF PIEZOELECTRIC THUNDER ACTUATORS. Alison Jackson, Bob Schwartz, Clemson University.

UMRI-2
CHEMICAL BATH DEPOSITION OF THIN FILM PHOTOVOLTAIC SOLAR CELLS. William Junek, Jason Underwood, Ryne Raffaelle, Florida Institute of Technology.

UMRI-3
DEVELOPMENT OF CHEMICAL REACTION MECHANISMS FOR GAS PHASE WAFER CLEANING. Kasi Kiehlbaugh, Anthony Muscat, The University of Arizona.

UMRI-4
EPITAXIAL GROWTH OF OXIDES ON SILICON. Jens Schumacher, Johannes-Gutenberg Universitat Mainz.

UMRI-5
MODEL SURFACE STUDIES OF NICKEL METAL HYDRIDE BATTERY. Luis Cruz Rivera, Prairie View A&M University.

UMRI-6
SINGLE CRYSTALS OF PMN 35 MOL % PT FROM POLY-CRYSTAL PRECURSORS. Ed Gorzkowski, Lehigh University.

UMRI-7
SUB-GAP ABSORPTION SPECTRA AND PHYSICAL CHARACTERISATION OF SEMICONDUCTOR MATERIALS USING PHOTOACOUSTIC SPECTROSCOPY AND SYNCHROTRON X-RAY TOPOGRAPHY TECHNIQUES. Donnacha Lowney, Dublin City University.

UMRI-8
STRUCTURAL AND TIME RESOLVED SCANNING PROBE MICROSCOPY STUDY OF HETEROGENEOUS AMALGAMATED SYSTEMS ON A NANOMETER SCALE. Claudia Ritter, Klaus Rademann, Humboldt University Berlin.

2000 UMRI Winners

UMRI-9
A NOVEL APPROACH TOWARDS SIZE AND SHAPE MANIPULATION OF THIOLATE-ENCAPSULATED METALLIC NANOPARTICLES. Mathew Maye, State University of New York at Binghamton.

UMRI-10
ANALYSIS OF PROTEIN ADSORPTION OF PEG COVERED SILICA SURFACES BY FLUORESCENCE MICROSCOPY. Amy Stacy, University of California of Santa Barbara.

UMRI-11
ASYMPTOTIC MODEL OF AN INDUCTIVELY COUPLED PLASMA CVD SYSTEM. Ryan Evans, University of Akron.

UMRI-12
BIODEGRADATION OF POLYHYDROXYALKANOATES (PHAs) USING IN-SITU ATOMIC FORCE MICROSCOPY. Connie Rossini, James Madison University.

UMRI-13
BLEND-BASED PHOTOVOLTAIC DEVICES. Daniel Allen, Cornell University.

UMRI-14
CHARACTERIZATION OF A KONDO BOX IN A CHROMIUM-DOPED ALUMINUM NANOPARTICLE. Heather Lynch, Princeton University.

UMRI-15
CHARACTERIZATION OF HIGH TEMPERATURE SOLUTION GROWTH OF Cr^{2+}:CdSe. Oludurotimi Adetunji, Fisk University.

UMRI-16
CREATION OF QUANTUM DOT STRUCTURES IN SiO_2. Cody Friesen and Joel Hayes, Arizona State University.

UMRI-17
DEVELOPING AN ATOMIC SCALE UNDERSTANDING OF THE STRUCTURE-PROPERTY RELATIONSHIPS OF DISLOCATION CORES IN GaN. Ilke Arslan, University of Illinois at Chicago.

UMRI-18
DNA DETECTION USING COLLOIDAL GOLD NANOPARTICLES: TOWARDS NEAR PATIENT DNA DIAGNOSTICS. Kerianne Cullen, Virginia Commonwealth University.

UMRI-19
EFFECTS OF ADHESION AND STACKING FAULT ENERGY ON THE THERMOMECHANICAL BEHAVIOR OF THIN COPPER FILMS PASSIVATED WITH METAL NITRIDES. Krishanu Saha, Cornell University.

UMRI-20
ELASTIC AND MECHANICAL PROPERTIES CHARACTERIZATION OF FIBER COMPOSITES FABRICATED USING A NOVEL POLYMER INFILTRATION PROCESS. Lisa Friedman, Pennsylvania State University.

UMRI-21
FABRICATION PROCESS FOR A MICROREACTION DEVICE. Michelle Prevot, Louisiana Tech University.

UMRI-22
FUNDAMENTAL PROPERTIES OF GRAPHITE LAYER EDGE STATES. Peter Giunta, Seton Hall University.

UMRI-23
GROWTH STUDY OF $Fe_xZn_{x-1}F_2$ THIN FILMS. Jessica McChesney, West Virginia University.

UMRI-24
IN-SITU STUDY OF THE ADSORPTION AND PHOTO-POLYMERIZATION OF STYRENE ON A COPPER SURFACE FOR CORROSION RESISTANCE AND WIRE CONNECTION APPLICATIONS. Margaret Horton, Purdue University.

UMRI-25
INFLUENCE OF SUBSTRATE SURFACE CHEMISTRY ON THE BINDING OF DNA-RecA PROTEIN COMPLEXES. Blaine Butler, James Madison University.

UMRI-26
INVESTIGATION OF A NEW FOUR LAYER RUTHENIUM-BASED CUPRATE, $Ru_2LnSr_2Ln'Cu_2O_{11}$ (Ru-2312) (Ln = Lanthanide). Scott Bary, Beloit College.

UMRI-27
INVESTIGATION OF THE EFFECTS OF RELATIVE HUMIDITY LEVEL ON ADHESION FORCES BETWEEN PHARMACEUTICAL POWDERS AND STORAGE SURFACE MATERIALS USING ATOMIC FORCE MICROSCOPY. Elvin Beach, Michigan Technological University.

UMRI-28
MATERIALS ANALYSIS WITH RUTHERFORD BACKSCATTERING SPECTROMETRY. Melinda Allen, Colorado School of Mines.

UMRI-29
MEASUREMENT OF ELECTROMECHANICAL STRAIN IN PMN-PT THIN FILM STRUCTURES. Niall Donnelly, Queens University Belfast.

UMRI-30
MECHANICAL AND ELASTIC PROPERTIES OF CARBON INFILTRATED SILICON OXYCARBIDE CELLULAR CERAMICS. Obiefune Ezekoye, Pennsylvania State University.

UMRI-31
MECHANICALLY ENHANCED SINGLE LAYER DEPOSITION OF BRUSHITE UNDE SUPERSATURATED SOLUTION BY ATOMIC FORCE MICROSCOPY TIP. Rizal Fajar Hariadi, Washington State University.

UMRI-32
MICROPOROUS SOLIDS BASED ON TRIGONALLY SYMMETRIC ORGANIC LIGANDS. Natalia Melcer, University of Calgary.

UMRI-33
MICROSTRUCTURAL CHANGES IN HUMAN CORTICAL BONE UNDER THE EFFECTS OF GAMMA RADIATION STERILIZATION. Elizabeth Perepezko, Case Western Reserve University.

UMRI-34
MODELING DEFECT CONCENTRATIONS AND SILICON ACTIVATION IN GaAs FOR TCAD APPLICATIONS Anish Priyadarshi, India Institute of Technology.

UMRI-35
MODELING ELECTRON STATES IN SEMICONDUCTOR NANOSTRUCTURES. Jon Kennedy, Worcester Polytechnic Institute.

UMRI-36
MODELING THE ELECTRIC FIELD IN NEAR-FIELD SCANNING OPTICAL MICROSCOPE. Philip Flammer, Colorado School of Mines.

UMRI-37
PLD OF Ni_2Si ON SiC FOR HIGH TEMPERATURE SEMICONDUCTING DEVICES. Matthew Wisnioski, Johns Hopkins University.

UMRI-38
PULSE PLATING OF ULTRA THIN LAYERED MAGNETIC FILMS. Douglas Burnett, Washington Technological University.

UMRI-39
SCRATCH TESTING OF DUAL-LAYER CARBON OVERCOAT. Freddie Sng Lai Yong, National University of Singapore.

UMRI-40
SEARCH FOR THERMOELECTRIC MATERIALS IN PENTU-TELLURIDE SYSTEMS AT LOWER TEMPERATURES ($T<273K$). Bradley Kempton, University of Idaho.

UMRI-41
SPATIOTEMPORAL CONTROL OF NANOCRYSTAL SELF-ASSEMBLY. Rebecca Dylla, University of Texas.

UMRI-42
SYNTHESIS AND CHARACTERIZATION OF NEW VANADIUM DOUBLE PEROVSKITES. Joshua Goldberger, Ohio State University.

UMRI-43
SYNTHESIS AND STUDY OF NEW TRANSITION METAL NITRIDES FROM METAL CATION LOADED EMULSION POLYMERS. Virginia Miller, Rider University.

UMRI-44
SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF POTASSIUM MANGANESE OXIDES AS CATHODE MATERIALS IN LITHIUM AND ALKALINE CELLS. Melissa McCartney, Binghamton Univeristy.

UMRI-45
SYSTEMATICALLY DERIVED MULTIFUNCTIONAL NANOSTRUCTURES IN MULTICOMPONENT BLOCK COPOLYMER BLENDS. Kim Goodwin and Keith Hampton, North Carolina State University.

UMRI-46
THE FORMATION OF COPPER OXIDE THIN FILMS FROM COPPER ACETATE USING CHEMICAL VAPOR DEPOSITION (CVD). Andrew Skolnik, James Madison University.

UMRI-47
TOPOGRAPHICAL AND ELECTRICAL CHARACTERIZATION OF THE SiO2/SiC INTERFACE: APPLICATIONS TO POWER ELECTRONICS. Damon Farmer, Vanderbilt University.

UMRI-48
USE OF ATOMIC FORCE MICROSCOPY TO ANALYZE THE MICROSTRUCTURE OF NANOSCALE INTERMETALLIC MATRIX COMPOSITES. Rebekah Policoro, Michigan Technological University.

SESSION HH7: INTERNET/MULTIMEDIA
Chair: Darcy J.M. Clark
Wednesday Morning, April 26, 2000
Salon 14 (Marriott)

8:30 AM HH7.1
REDUCING THE COSTS OF LABORATORY INSTRUCTION THROUGH THE USE OF ON-LINE LABORATORY EXPERIENCES. David P. Pope, Department of Materials Science and Engineering, University of Pennsylvania, Philadelphia, PA.

This program is testing the assertion that laboratories can be taught more efficiently, less expensively, and better through the use of World Wide Web-based technology. This technology is being used to help students prepare themselves before coming to the laboratory by becoming acquainted with the equipment, going through pre-lab exercises and taking pre-lab quizzes, both on the content of the work and on the safety considerations of the laboratory, all through web-based exercises. The goal of the program is to develop the web-based materials for four laboratory courses, test these modules completely, evaluate them for cost savings and educational quality, and then make them available to our colleagues world-wide via the World Wide Web.

8:45 AM HH7.2
WHY DOES A LIGHT BULB BURN OUT? P. Mitan, M. McKelvy, K. Hintze, E. Patrick, K. Allagadda, B.L. Ramakrishna, A.V.G. Chizmeshya, Center for Solid State Science, Arizona State University, Tempe, AZ; V. Pizziconi, Department of Chemical, Bio and Materials Engineering, Arizona State University, Tempe, AZ.

Most incoming undergraduate students have little understanding of what materials are or the importance of materials in their daily lives. The online educational module, "Why Does a Light Bulb Burn Out?" is an inquiry-based introduction to the concept of materials and material properties through the interactive exploration of the life of the incandescent light bulb students use every day. The module offers an exploration of the history of the light bulb, its components, and important filament properties. Students discover the relationship between temperature and incandescence, along with electrical power and resistance through interactive Java applets. Then students "invent" their own filaments, after determining the material properties they need, through virtual temperature, performance and longevity tests of a variety of candidate materials. Next, students explore the filament failure process to discover why a light bulb burns out. They follow the filament aging process using both scanning electron and atomic force microscopy images, which illustrate the particle structure of matter and its ability to affect materials behavior at the macroscopic, microscopic and atomic levels. As the filament ages, grain boundaries are clearly identified by preferential etching, followed by exposure and growth of beautiful tungsten crystallites. Crystal structure at the atomic level (bcc tungsten), including crystallographic orientation, planes, and directions, as well as the relationship between the corrosion resistance of a material (tungsten) and its atomic structure (i.e., grain boundaries vs. single crystal regions) are all introduced in the process. The module culminates in students designing their own materials experiments using SPM Live! online at http://invsee.asu.edu. SPM Live! is a remotely operated scanning probe microscope developed by the NSF-funded Interactive Nano-Visualization for Science and Engineering Education (IN-VSEE) project, which is managed by an ASU-led consortium. Additional remote studies are accessible via the ASU Goldwater Materials Visualization Facility (http://gmsl.eas.asu.edu/gmvf).

9:00 AM HH7.3
LEARNING REINFORCED CONCRETE DESIGN PRINCIPLES IN A JAVA-VRML BASED STUDIO. Mohammed E. Haque and Amarneethi Vamadevan, Western Michigan University, Construction Engineering Department, Kalamazoo, MI.

Dynamics involving reinforced concrete design are the first real engineering course encountered by the undergraduate Civil engineering students. Quite often it's associated rigorous theories makes it uninteresting academic hurdle for many below mediocre students. However when the theory is exemplified with multimedia, interaction and visualization techniques, the conceptual understanding is enhanced. The teaching methodology presented in this paper is based on presenting students with an individualized, interactive and guided learning environment. The main elements of this approach are: a means of assimilating the students interactive learning knowledge and behavior (user model), representation of the instructors guidance and assessment knowledge (tutor model), utilization of motivational techniques such as multimedia, animation (visual model) and navigation of designed model (VRML model). Several principles are taken into consideration when designing such learning environment. These include the structuring of the courseware material with respect to the content, presentation, modularity and identifying, utilizing the teaching strategies involved in the learning process. The approach adopted in this research is that of intelligent interactive learning environment, which is developed, using VRML and Java programming languages. This contains basic interrelated definitions (concepts), various diagrams of structural behaviors such as stress and strain diagrams, procedures and VRML, Java applets for dynamic structural design. Although the presented approach is being applied to reinforced concrete design, it employs a generic architecture, which is discipline independent and may be adapted to any other similar domain which will certainly promote and enhance students' understanding.

9:15 AM HH7.4
MULTI-MEDIA VIRTUAL LABORATORIES FOR INTRODUCTORY MATERIALS SCIENCE COURSES. Rochelle Payne Ondracek, University of Nebraska-Lincoln, Center for Materials Research and Analysis, Lincoln, NE.

More real-world examples is a frequent comment from students on course evaluations for an introductory materials science course at the University of Nebraska-Lincoln (UNL). Understanding that students who are exposed to actual case histories remember concepts better and are more enthusiastic, virtual laboratory multi-media modules using Macromedia Authorware are currently being developed and tested at University of Nebraska-Lincoln. The goals of this project are to expose students to real-world problems and to give them an opportunity to use their knowledge to solve these problems. In each module, students are introduced to a materials-oriented case history and encouraged to run materials laboratory tests to understand an underlying problem. Each module includes a database of test results on several standard tests for several materials. After choosing which tests are appropriate for the case study, students will get instant results and will be encouraged to re-evaluate their options until they determine the cause of the problem. This discovery process allows the student to more thoroughly understand materials science concepts and materials laboratory tests and how they can be used. Students also have the option of reviewing important basic concepts and the laboratory tests within the modules if they wish. Six modules have been developed covering standard materials science topics such as tensile testing, hardness, hardenability, fatigue, impact testing and electron microscopy. These modules will be tested in an introductory materials science course offered to engineering majors at UNL during the Spring 2000 semester and the effectiveness of using these modules as a supplement to course materials will be discussed.

9:30 AM HH7.5
LEARNING MATERIALS SCIENCE VIA THE WEB USING MICROSPHERES AND SCANNING PROBE MICROSCOPES. Eddie W. Ong[1], Kenneth Mossman[2], B.L. Ramakrishna[3], Vincent B. Pizziconi[4], William S. Glaunsinger[2], Eric Patrick[5], Terrence Tan[6]. [1]Center for Solid State Science, Arizona State University, Tempe, AZ, [2]Dept. of Chemistry and Biochemistry, Arizona State University, Tempe, AZ, [3]Dept. of Plant Biology, Arizona State University, Tempe, AZ, [4]Dept. of Chemical, Bio- and Materials Engineering, Arizona State University, Tempe, AZ, [5]Dept. of Computer Science and Engineering, Arizona State University, Tempe, AZ, [6]Dept. of Electrical Engineering, Arizona State University, Tempe, AZ.

The Interactive Nano-Visualization for Science and Engineering Education (IN-VSEE) project at Arizona State University (ASU) has developed a remotely operable scanning probe microscope (SPM), a visualization gallery of images, and a number of modules with materials science themes. It is exploiting the incredible potential of materials science for teaching high school and college students about fundamental concepts that cross traditionally separate disciplines. The packing of spheres is a topic that is ideal for linking together the different science and engineering disciplines because of the ubiquity and relevance of spheres in the materials world and the universality of the rules that govern their packing over a large size scale. Students can perform a number of discovery-based learning activities, over the web, by simultaneously using IN-VSEE's web-accessible module (e.g., The Music of Spheres) and its remotely operable SPM and other instrumental techniques at ASU for experimenting with microsphere samples that they design. The beauty of using this approach is that students can pose materials questions and can easily make modifications to their experiments to test their understanding of real materials, using commercially available microspheres, and explore for themselves how their system behaves. The fundamental concepts (e.g., packing geometry and density, surface composition, long-range/short range ordering, intermolecular forces, etc.) they learn through these materials science experiments are applicable to many other research and academic areas. The speaker will show how a student's materials science educational experience can be enriched using web-accessible resources such as this module, IN-VSEE's remotely operable SPM, its visualization gallery and other instrumental techniques available at ASU.

10:15 AM HH7.6
THE INTERNET MICROSCOPE. James Marrow and Brian Derby, Manchester Materials Science Centre, UMIST and University of Manchester, UNITED KINGDOM.

At pre-university level, too few teachers and students grasp the idea that the steel that comes out of a steel mill is not just a different shape from the material that went in. It is an entirely new material whose strength, toughness, ductility and even corrosion resistance have been optimised by precise control of each and every stage in the production route. This is real engineering of a material. Changes in the microstructures eloquently illustrate such ideas, yet teachers cannot teach without the necessary resource materials.
The Manchester Materials Science Centre "Internet Microscope" (http://www.umist.ac.uk/-intmic/) attempts to address this problem. This is an extensive image library of microstructures with explanatory text. Its primary aim has been to supplement materials science training at University level. Features include on-line tutorials linking graphical data to microstructures and video of laboratory experiments. On-line pupil workbooks are now being developed for schools. We aim to help them find the answers to questions such as "Are sugar and salt crystals different?", "Just how small can an engineered component be?", "What does my Pentium chip look like?" and "What is inside of steel?".
Learning is best achieved by "Doing", not just "Seeing". The Manchester team is now going beyond the Internet Microscope. Information can be communicated with a greater sense of involvement if the learner has control of the microscope. The ability to collect original images gives a sense of "ownership" which reinforces the learning experience.
The project team is developing a scanning electron microscope that can be operated by untrained users via the Internet. It will contain a selection of samples encompassing general science, basic materials science and trends in science, technology and engineering, i.e. from crystals and fossils to semiconductors and nano-technology. Access will be free to schools, colleges and universities in the UK.

10:30 AM HH7.7
INTEGRATED MEDIA MATERIALS OF ELECTRONICS FOR EDUCATION IN INTERNET. George S. Turchaninov, Dept of Radioelectronics, Krasnoyarsk State Technical University, Krasnoyarsk, RUSSIA.

We work out the Integrated media for educational courcs Materials of electronics (MEIM). In the first place, MEIM is destined for distant education of undergraduates via Internet. MEIM includes the Handbook, a set of virtual laboratory works, expert system for the knowledge control, and the student-tutor interface modulus. The Handbook consists of five sections: Classification, Properties, Structures, Technology, and Corrosion and Destruction. Simultaneously, the Handbook can be used as a Reference Book on materials of electronics. The ready parts of MEIM are placed on the server of KSTU at http://ftp.kgtu.runnet.ru/do/rtf/tur/moe/index.htm, in Russian. Forms of MEIM are developed with the help of HTML, Dynamic HTML, JavaScript, and JAVA technologies. We consider used WEB-technologies in detail as well as the service works optimal distribution between server and client machine strategy. In particular, for the first time we have used the dynamical widening of Handbook contents in the same browser window on the client query, that essentially simplifies the reading of big documents in Internet. The crystal structures are represented in 3D rotational forms with the help of MIME formalism. The structure of the Handbook makes possible permanent accumulation of contents on the way to an Electronical Encyclopedia.

10:45 AM HH7.8
COLLECTIVE UNDERGRADUATE RESEARCH: A TEACHING/LEARNING TOOL FOR MSE STUDENTS. Wafeek Samuel Wahby, Eastern Illinois University, School of Technology, Charleston, IL.

A new experiment not quite explored before to implement and collectively publish undergraduate students' research was started at the School of Technology, Eastern Illinois University in the Fall of 1998. A summary of the procedures followed in this experiment, its assessment, and its progress are presented. Collective research publications authored by MSE undergraduate students and edited by their faculty benefits various individuals and groups involved, including students/authors, their peers, faculty/editors, local and other institutions, and industry at large, particularly when interactively posted on the Internet. Students learn better the subject matter, and early in their careers they become familiar with research methods and techniques, as well as polish their oral and written communication skills. The teaching/learning process in- and out of class is enhanced, and when graduates join graduate programs and/or industry, their performance is significantly upgraded. The experiment provided an opportunity for students to select and research a particular topic, helped them discover the research resources and reference materials available on the subject matter, offered a variety of learning environments to undergraduates, and helped promote student creativity and self-directed learning. The experiment also encouraged various methods of inquiry and organization of thought and sharpened oral and written communication skills of students. It also fostered teamwork, and peer collaboration and evaluation. It was confirmed that most undergraduate students hold unlimited potential for success as researchers, and that enthusiasm, sincerity, hard-work, self-motivation and dedication of students are likely to constitute better indicators of success than the conventional grades they earned in the past. For many students, this was one of the few creative opportunities offered in a class. Students taught themselves topics not covered in class through research papers and discussion questions during peer evaluations. Peer collaboration and evaluation are strong incentives for excellence. This experiment significantly enhanced students' teamwork capabilities as well as student/faculty interaction, both of which considerably increased the effectiveness of the teaching/learning environment.

11:00 AM HH7.9
EXPLORING MULTIMEDIA FOR EXPOSITION OF MATERIALS RESEARCH. S. Jagota, K. Krishnaswami, EOS - Eye On Science, Jigyasa, Inc., Wilmington, DE.

The focus of this work is to develop a series of software packages to introduce students to current topics in materials research using multimedia tools. Fundamental concepts in material science are explored and developed to provide insights into forefront research in the area. The intended audience is undergraduate students or beginning level graduate students. The software design provides an informal and interactive platform to expose the excitement of cutting edge innovation and discovery. Structure Property interactions in carbon have been chosen as the first example to demonstrate proof of concept in a package titled 'The Many Facets of Carbon'. Details of this piece will be presented in this paper along with a demonstration of the package. This is the first of a series "Eye on Materials: An Interactive Multi-media Exposition". Elements of the package include text, graphics, animations, sound, interactive elements and computer simulations.

SESSION HH8: LABORATORIES AND COURSES FOR NON-MSE MAJORS
Chair: Bethanie J.H. Stadler
Wednesday Afternoon, April 26, 2000
Salon 14 (Marriott)

1:30 PM HH8.1
SEMICONDUCTING POLYMERS FOR MULTIDISCIPLINARY EDUCATION. David Braun, Cal Poly State University, Electrical Engineering Dept, San Luis Obispo, CA; Kevin Kingsbury, Cal Poly State University, Dept of Chemistry and Biochemistry, San Luis Obispo, CA; Linda Vanasupa, Cal Poly State University, Materials Engineering Dept, San Luis Obispo, CA.

Cal Poly is in the process of revolutionizing how science and engineering students learn about semiconducting materials. Semiconducting polymers currently attract widespread attention as the subjects of numerous research and development projects. Semiconducting polymers are also excellent materials with which to teach structure-property relationships, polymer synthesis, polymer film preparation, optical and electronic properties, semiconductor device fabrication principles, and device testing. One key benefit of these materials is that they encourage student participation in educational activities that bridge several disciplines. Semiconducting polymers improve student learning by making normally obscure semiconductor concepts more tangible for students in several disciplines: Chemistry students create electronics applications for the compounds they synthesize, materials engineering students learn about opto-electronics techniques, and electrical engineering students gain hands-on experience with core concepts in semiconductor devices. This presentation describes the interdisciplinary projects that students and faculty have participated in thus far, particularly during the phase of lab design and construction.

1:45 PM HH8.2
A HOME-MADE INCH-SCALE SCANNING FORCE 'MICROSCOPE'. Claudio Guerra-Vela, Fredy R. Zypman, University of Puerto Rico, Department of Physics, Humacao, PR.

At the heart of the Scanning Force Microscope (SFM) is the cantilever, a tiny piece of about $100\mu m$ in length, which holds a micron size tip at its end. This tip is maintained above a sample under study, in order to measure tip-sample interaction forces. By moving the tip above the sample at constant force one wishes to extract sample topographical information. On the other hand, if the tip is held fixed at a point (x,y) on the surface but moved vertically, along z, one could retrieve an F-d (force vs separation) curve. At each separation d, the force is measured by looking at the deflection of the cantilever, which is usually detected by optical means. We have developed a 'microscope' with aluminum and steel cantilevers 10cm-long to use in our undergraduate laboratory. The detection mechanism is by means of vibrating piezoelectric. The tip-sample interaction is obtained by means of magnets attached at the end of the cantilever and on the sample. The main idea of this exercise is to provide students with a large cantilever from where they can build an intuitive feel of the instrument. Also, and perhaps more important, we teach the student how the extract forces from kinematics data. We let the cantilever move under the action of the interaction force, and record that motion as a voltage produced by the vibrating piezoelectric. That voltage is then processes (we present the algorithm) to reproduce the F-d curve. As opposed to what happens in the real microscope, in our case we have access to the sources of force and thus we can check the goodness of our reconstruction algorithm by comparing our reconstructed F-d curve, with the known one.

2:00 PM HH8.3
LABORATORY ACTIVITIES USED IN A SOPHOMORE MATERIALS SCIENCE COURSE AT TEXAS A&M UNIVERSITY.
R.B. Griffin, MEEN; A.L. Epps, CVEN; K.T. Hartwig, MEEN; Texas A&M University, College Station, TX.

A sophomore materials science course has been developed at Texas A&M University as part of a larger five course sequence through the support of the National Science Foundation. Texas A&M University is a member of the NSF sponsored Foundation Coalition. The courses were developed to include active and collaborative learning, application of technology, and integration as important components. Currently, a majority of departments within the College of Engineering (COE) at Texas A&M University have adopted the five-course sequence. During Fall 99, the COE is teaching the materials course to 260 students or four sections of 70 students each. As part of the development of the materials class, a series of experiments have been developed for use within the classroom. The experiments give the students an opportunity to experience hands-on activities. Several of the activities are done within the classroom, while others are performed in a separate laboratory building. The classes consist of two- 1 h 50 min. periods, and this time provides the opportunity to have the laboratory activities in class. The experiments encourage the development of teams and support various applications of materials science. The majority of students have very limited laboratory experience, and this course provides them an opportunity to develop some laboratory skills. Currently, we do seven experiments: 4-point bending, tensile test: metals and polymers, heat treatment, thermal conductivity, viscosity demonstration, and electrical components. In the paper and during the presentation, we will demonstrate several of the experiments and provide examples of student work. A detailed description of each experiment will be included in the paper.

2:15 PM HH8.4
IMPLEMENTATION OF A UNIFIED MATERIALS PROCESSING LABORATORY COURSE.
Kevin P. Trumble, Elliott B. Slamovich and Matthew J.M. Krane, School of Materials Engineering, Purdue University, West Lafayette, IN.

A junior-level materials processing laboratory has been developed and implemented taking a unified approach to processing ceramics, metals, and polymers spanning (1) deposition, (2) solidification, (3) powder, and (4) deformation processing. Three three-week core experiments stress interactions between shaping, microstructure, and properties in an open-ended make-it-from-scratch format. Lectures and prelab discussion groups are used to connect laboratory exercises with fundamental concepts. The course is capped off with student-proposed processing projects geared towards specialty materials. Each of the four main classes of processing can be studied at an advanced level in individual senior elective courses. Results from the lab and its role as the gateway into the senior electives will be discussed.
(Support for this work from the National Science Foundation under Grant Nos. DMR-9218126 and DUE-9950328 is gratefully acknowledged.)

2:30 PM HH8.5
INTEGRATION OF RECENT RESEARCH APPROACHES AND TECHNOLOGIES TO THE TEACHING OF UNDERGRADUATE MATERIALS LABORATORY.
L.J. Martinez-Miranda, I.K. Lloyd, L.G. Salamanca-Riba, M. Al-Sheikhly, J. Kidder and A. Christou, Dept. of Materials and Nuclear Engineering, University of Maryland, College Park, MD.

New areas in materials, such as nanomaterials, microarchitectural electronics and biomaterials, as well as new technological advances resulting from these require new or advanced analytical approaches in order to understand their properties and how these relate to both the structure of the materials and the ways they are processed. This in turn requires the integration of these analytical tools into undergraduate laboratory teaching. The challenge in organizaing such a course is to achieve a balance between the basic, traditional and still widely used analytical tools and to stress how new methods complement and improve on the information obtained using the former. At the University of Maryland, we have organized junior level laboratory course which addresses the needs mentioned above. The course consists of units which emphasize a specific analytical approach. Each unit includes an introductory exercise and an exercise based on current research, which relies on the research strengths and collaborations of the faculty in the department, and on current problems in the literature. The students are subdivided into groups to perform the exercise. The groups discuss and compare results among them. Each unit is evaluated individually following ABET EC 2000 guidelines. Improvements and modifications have been added accordingly. A number of former students have secured internships or research positions based on the knowledge acquired in this course. This presentation includes samples of such research based problems, evaluation questions and students' input.

2:45 PM HH8.6
FATIGUE AND FRACTURE MECHANICS LABORATORIES IN MECHANICAL ENGINEERING DESIGN AND MATERIAL SCIENCE COURSES.
Yulian Kin, Purdue University, Calumet, Engineering Department, Hammond, IN.

The proposed paper describes new Fatigue and Fracture Mechanics Laboratories implemented into undergraduate Mechanical Engineering Design and Material Science Courses at Purdue University Calumet. The Experiments are started at junior and completed at senior levels. The students work in teams (3-4 students per team) and required team formal reports are due to discussion sessions. Different teams get different assignments but all teams use the entire gained experimental data. Conventional fatigue experiments for different materials are conducted on rotating beam machines and all collected data are used to plot families of fatigue curves (5%; 50%; 95% probability S-N curves). From these plots the students are asked to determine necessary parameters to run accelerated fatigue tests which are usually completed for one or two laboratory sessions and require not more then 3-4 parts or specimens. The students have to estimate correlation between conventional and accelerated fatigue test results. Fracture mechanics experiments include determination of constant parameters and stress intensity factors in Paris formulation, and also laboratory measurement of J-integral. The flexure (four-point bending) fatigue tests are conducted on an MTS machine. The constantly observed crack images are captured and stored by an image grabber linked to the digital computer and video. The collected data are used to develop the expressions for the prediction of part life after a certain crack propagation.

3:30 PM *HH8.7
THE ROLE OF PHYSICS IN THE TEACHING OF MATERIALS SCIENCE AND ENGINEERING.
F.A. Ponce, Department of Physics and Astronomy, Arizona State University, Tempe, AZ.

Materials science and engineering is a multidisciplinary area that covers a large number of fields, techniques, and approaches. In principle, everyone working with matter belongs to it. Setting up an appropriate curriculum for the education of students in a materials science and engineering program is a challenging experience. An important question is the extent of the education in the basic sciences. In this talk it will be argued that the diversity of backgrounds and activities that are put together in the area of materials science and engineering requires a strong basis on the fundamental sciences. Physics is in particular quite important to the understanding of the electronic effects that are responsible for the growth mechanisms, materials properties, and device applications. While teaching physics to physicists is usually done in a very formal and systematic manner, for materials scientist a more conceptual approach is needed. This talk will be given by a former materials researcher in industry who suddenly turned into a physics professor. Aspects of his recent experience in teaching physics to materials scientists and engineers will be presented.

4:00 PM HH8.8
MATERIALS SCIENCE AT A LIBERAL ARTS COLLEGE.
James R. Doyle, James Heyman, Macalester College, Department of Physics and Astronomy, St. Paul, MN.

The importance of materials science as a scientific discipline has been recognized by comprehensive undergraduate programs and degrees in materials science and engineering at most major universities. However, at four-year liberal arts colleges, which typically lack engineering programs, materials science curricula must fall under physics and/or chemistry programs where it competes with the traditional curriculum in these disciplines. At Macalester College we have successfully incorporated substantial materials science content into our physics program using specialized and innovative advanced laboratory courses based on faculty research interests. These courses replace the more traditional station-rotation modern physics experiments that are usually found in undergraduate physics programs. We have developed a course Thin Film and Semiconductor Physics, where students gain familiarity with deposition methods, such as sputtering and plasma CVD, and standard semiconductor electrical and optical measurements on thin films and simple device structures. In another course Optical and Resonance Spectroscopy students study spectroscopic methods such as infrared absorption and photoluminescence with particular emphasis on solids, including quantum well structures. These courses utilize faculty expertise and research laboratory equipment and allow students to participate in state-of-the-art problems in materials physics. We will discuss other advantages of our approach as well as some potential disadvantages, including displacement of traditional advanced physics laboratory curriculum and depth versus breadth questions.

4:15 PM HH8.9
COURSE DEVELOPMENT FOR INCREASING THE AWARENESS OF MATERIALS SCIENCE TO NON-ENGINEERING MAJORS.
D.F. Bahr, M.G. Norton, Mechanical and Materials Engineering, Washington State University, Pullman, WA.

A common problem with engineering curricula is their inability to offer courses to students across the university, thus developing the concept that many of the engineering concerns are esoteric for the majority of the student population. To remedy this situation, a new course has been developed, and is targeted at third and fourth year undergraduates. This course will act as a Capstone elective course in scientific methods for the General Education Curriculum in which all undergraduates at Washington State University participate. The course will increase the awareness of the impacts of engineering and science on students from across the university, providing them with an appreciation for these fields which should continue in their future careers and endeavors. The end result will be an increase in the scientific literacy level of student across demographic groups that mirror the university and state rather than those solely in the engineering curriculum. By developing educational materials suitable for lecture and discussion-based courses, rather than laboratory courses, the materials become adaptable at a larger number of institutions given the effort and expensed needed to initiate laboratory courses. The topics and the methodology of implementing this course are described.

4:30 PM HH8.10
MATERIALS SCIENCE IN GENERAL CHEMISTRY FOR FRESHMAN ENGINEERING MAJORS. David E. Nikles, Department of Chemistry, The University of Alabama, Tuscaloosa, AL.

The College of Engineering at the University of Alabama is a member of the Foundation Coalition, sponsored by the NSF. We have developed an integrated freshman engineering curriculum that incorporates teaming and cooperative learning into chemistry, mathematics and physics courses. The two-semester general chemistry sequence was designed to provide all engineering majors an appreciation for chemistry as a science and its role in engineering. Materials science impacts all the engineering disciplines and was the theme for the second semester chemistry course. The mission was to teach chemistry in the context of materials science. We began with the structure of the atom, leading to an understanding of how atoms combine to form molecules. Next we considered the cohesive forces that hold atoms and molecules together in the solid state. The students were introduced to binary phase diagrams and determined the phase diagram for a simple mixture in the chemistry laboratory. The remainder of the course involved a survey of different classes of materials, polymer, ceramics, glasses, metals and semiconductors. For each class there was a description of the chemical bonding and how the bonding related its physical properties. The highlight was a joint design project between the chemistry course and the general engineering studies course. The students made nylon fibers in the chemistry laboratory. They chose the combination of monomers in their fibers and we given many chances to make fibers of different composition. The tensile strength and Young's modulus of their fibers was determined in an engineering laboratory. Based their experimental results the students were asked to identify applications for their fibers.

4:45 PM HH8.11
MATERIALS SCIENCE AND ENGINEERING LABORATORIES FOR NON-MATERIALS ENGINEERS. Dennis Maher, Ray Benson, Yusef Fahmy, Tom Hare, Lentrell Hill, Winston Parker, John Russ, Roger Russell, North Carolina State Univ, Dept of Matls Science & Engr, Raleigh, NC; Louis Raymond, LRA, Newport Beach, CA.

In this contribution, we will review laboratory models for non-materials undergraduate engineers. Presently, two models are being developed and implemented in the Department of Materials Science and Engineering at NC State. Laboratory model I is being designed to address a required laboratory/course for second-year civil, industrial, and mechanical engineers. The number of students that must be accommodated in the laboratory component is a critical issue that the model must be able to take into account. Laboratory model II is being designed to address the department's need to establish an upper-level laboratory intensive course for mechanical engineers who are taking a minor (or second major) in materials science and engineering. In both cases, processing, microstructure, and mechanical performance of materials are the focus of a hands-on laboratory experience. Cost-effective teaching stations that combine computer controlled testing routines, data acquisition sub-routines, real-time output, and metric extraction algorithms for assessing mechanical properties (i.e., tensile, bending, torque, etc.) are the foundation of both laboratory models. Microstructure-properties relationships are handled with light-microscope teaching stations that include digital image acquisition and analysis as well as archival data sets so as to address time constraints. Both laboratories are spread-sheet intensive and include: i) hardness-tension relationships; ii) an environmental effect on materials performance; iii) the existence and use of standards in materials selection and performance; iv) the science-of-variability; v) comparative analysis of metrics; and vi) CD-based tutorials.