Project Year
2005

Project Team
Howard Katz, Professor, Materials Science & Engineering Department, Whiting School of Engineering; Kevin See, Graduate Student, Materials Science & Engineering Department, Whiting School of Engineering

Project Title
Enhancements to the *Electronic Characterization of Materials Undergraduate Laboratory* course through Networking

Audience
Students enrolled in the *Electronic Characterization of Materials Undergraduate Laboratory* course

Pedagogical Issue
The *Electronic Characterization of Materials Laboratory* course, (510.429, "Materials Science Lab II") is a discovery-oriented experience where students reinforce their understanding of key phenomena of electronic materials by performing experiments that dramatically display those phenomena. Professor Howard Katz has enhanced the student design and investigative aspects of the course by introducing novel materials and more complex devices based on his research program, such as organic semiconductors and capacitive elements. His group has synthesized materials and obtained new instrumentation for this purpose. With these innovations has come a need for better monitoring of these increasingly complex experiments. Furthermore, the communication and collaboration between members of the class also needs to be rethought. Students would benefit from being able to connect with members of their group outside of the classroom.

Solution
The creation of a networked resource tool would provide students with enhanced monitoring and controlling of laboratory experiments. In addition, an interactive class website could display real-time results for virtual team analysis and decision making, permitting the students to work more effectively in groups, both in and out of the classroom.

Technologies Used
Graphic Design, HTML/Web Design, Wireless Networking

Project Abstract
Professor Howard Katz is in the midst of enhancing the student design and investigative aspects of the *Electronic Characterization of Materials Laboratory* course by introducing novel materials and more complex devices based on his research program, such as organic semiconductors and capacitive elements. His group has synthesized materials and obtained new instrumentation for this purpose. Presently, most of the experiments are manual, and students can only collect data from one experiment

at a time. The proposed Fellow, Kevin See, as a teaching assistant, was responsible for providing a computer interface that demonstrated to the students the gains in experiment efficiency obtainable from automated data collection. However, this interface could be much more fully exploited if computerized experimental control and networked access were fully integrated into all of the course activities. The new materials and devices lend themselves to testing over extended periods, and to experiments whose parameters could be altered at arbitrary times, when the base laboratory is inaccessible. For example, device stability could be remotely monitored, and the effects of slow temperature changes could be observed. Planned changes of experiments in progress and interpretations of completed experiments could be discussed with real-time access to the data and instruments by the entire group, even if away from the lab. This would enhance the value of the course on multiple levels. More complex experiments could be performed, and laboratory period time limits would be made much less limiting. Most importantly, the students would experience the way engineering is performed in the real world, through virtual teams consisting of groups larger than a pair of lab partners. Thus, several requirements set by both ABET, the engineering accreditation body, and by industrial and government employers, would be addressed. This is a unique approach in terms of laboratory pedagogy, because laboratory courses have traditionally been time-bound and preprogrammed to give correct results straightforwardly, unlike in real research, where time is less limiting and practitioners react to unexpected results by altering the experiments. The Fellow candidate, Kevin See, is already an outstanding TA, familiar with the course, and a member of Professor Katz's research group. He has extensive web skills and has written computer code for the course already. He will be solely responsible for the software and network development. Professor Katz will integrate enhancements with new test protocols and broad goals of the course. Key success indicators will be the proportion of data being collected automatically, number of unique datasets generated, the degree of data sharing and related online discussion, and number of experiments controlled by online, remote intervention. The Fellow will devote one day per week to this project, plus a second additional day during the course. The output will be a stand-alone workstation integrated with the existing JHU network that could be utilized indefinitely. A technician overseeing the facilities will retain corporate memory, and will apply it to other departmental undergraduate laboratories. The principles are applicable to any course where a physical parameter is monitored over time, where parameters need to be re-evaluated outside of course time, and where data is to be widely shared.

Summary of Impact

A video of Howard and Kevin's presentation (time=4:03) is available here:
http://mfile.akamai.com/7111/mov/streams1.nts.jhu.edu/~jhumedia/cer/tfvideos/7_materials_full.mov