FY07 Innovations in Teaching with Technology Awards: Online, Self-Paced, Practice-Focused Engineering Programming

Proposal Title: Online, Self-Paced, Practice-Focused Engineering Programming

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Org Unit: College of Engineering

Department(s):
- Biomedical Engineering
- Electrical and Computer Engineering

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Engineering Problem Solving II (59:006) is a large-lecture format, mandatory course in the College of Engineering typically taken by approximately 300 2nd-semester engineering students. The course introduces the C Programming language and Matlab programming skills. It is taught by a team of 3 professors, each presenting the same PowerPoint slides to one of the three lecture sections and supervising approximately 12 TAs, who meet with weekly discussion sections of 24-30 students and staff office hours held in the computer labs approximately 30 hours per week. Historically the course has been problematic, because the students perceive the weekly programming assignments to be very difficult. In some years cheating has been a problem, as the students attempt to share solutions, probably because they were unable to solve the problem before the homework deadline. The Dean’s Office has identified this course as having a negative impact on engineering student retention.

We would like to make this course an interesting, stimulating and innovative educational experience by changing the manner in which it is taught. Fundamentally, we think that by making this an online course, students will be able to experiment with new programming techniques immediately after the ideas are presented, rather than waiting between the time the idea is introduced in lecture and the time they can try the idea out in the computer lab.
Because of the visibility and importance of this course to the College of Engineering, it is essential that we ensure a professional quality, bug-free product that is both stimulating and effective. Consequently, we are envisioning a multi-stage, incremental, 3-year development process. Resources for this project will be marshaled from the College of Engineering, careful husbanding of our current teaching resources, Instructional Technologies and NSF. This proposal is directed at Phase I of the project: developing the electronic framework for the course, developing three pilot educational modules, and the subjective (formative) and educational (summative) evaluation of these modules. In the second stage we will pursue funding from NSF, emphasizing the prototype and our educational assessment objectives. The final phase of the project will emphasize support and maintenance of the project with resources from the College of Engineering.

Our team is particularly qualified to conduct this project because the instructors have taught and assessed this material for nearly a decade, they are well-versed in programming technology and specialize in human computer interaction and training, the graduate student participants have extensive, hands-on experience with the low-level problems experienced by the students, and instructional technology specialists have developed course modules for large-scale distribution for other university courses and are familiar with the developmental and educational challenges faced in introducing this type of technology in a large scale educational environment.

Our vision for the on-line course consists of a self-paced, learning model assessed with on-line quizzes that assess each student's understanding of specific educational goals. Students will still complete the weekly homework, but will be better prepared for this challenge because they will have mastered and demonstrated their skill in the individual skills required to complete the integrated challenge of the assignments. TAs will be available in real-time to assist the students as they work by using on-line chat and bulletin board tools. The professors will also be available through these online tools and through small group meeting and individual consultations. The grading of quizzes will be completed automatically, while the larger assignments and exams will be graded by hand, as is currently the practice.

As part of Phase I, we will complete the following tasks:

- The professors and TAs, working with consultants from Academic Technologies will divide the current syllabus into learning modules and identify specific instructional goals for each module. This will inform decisions about the content scope and module sizing suitable for online delivery, structure, and sequence.

- Three modules will be selected for immediate development based on the diversity of media and approach that would useful in presenting the concepts. For example, the
modules may include structural control using a while loop, diving a program into function, and introduction to structures. Each module would consist of one to three lectures worth of material, depending on the natural grouping and scope of the educational objectives.

- The three modules will be developed using either flash animation or a podcast (including narration and visual content) technology, depending on the educational modules selected in the previous steps. This development will also include the development of practice exercises and quiz questions to reinforce and assess the educational objectives.

- These educational modules will be introduced to a focus group of students with similar educational background as the target group to understand the strengths and weaknesses of the approach.

- Based on the feedback from the focus group the models will be revised and presented as part of the course in Spring 2007. A formal summative evaluation will be conducted to compare similar exam questions on the material covered by the models, comparing the performance of the students on similar questions in 2005 and 2006 (before the intervention) with appropriate exam questions in 2007 (after the intervention). An NSF proposal will be submitted to the Division of Undergraduate Education based on the results of the formative and summative evaluation and the plans for future development.

- A behind-the-scenes monitoring system will be developed that will provide a weekly report of the statistics on all the quizzes, the number of exercises that students pursued, and the common paths that the students took through the system. This will be used to provide feedback on system use and performance for the instructors.

The new system will improve student learning by allowing advanced students to move quickly through the course, while students who need more practice with easier concepts will receive more support. Interacting through the bulletin boards will allow more advanced students to help less advanced students without introducing awkward social issues.

The students will be able to try out programming ideas quickly without having to wait until lecture is over and they have time to enter the computer lab.

Students will be encouraged to develop their skills gradually rather than wait until all the skills must be combined in the main programming assignments, but students who have previous programming experience will not be overly hampered.
The course grading and feedback mechanisms will allow the professors to identify specific concepts that are creating learning problems for the students. These can then be addressed in future revisions of the concept modules.

Because most of the questions that TAs receive are not new, the development of an extensive FAQ or programming wiki will provide more effective assistance to the students over time.

### What resources will you need?

One ¼-time TA will be devoted to this activity for both 2006 and 2007 from the current pool of TAs. The funding will be used to support the efforts of one additional undergraduate to help prepare the educational content (edit the podcast and develop the Flash animation. This will cost approximately $7,500 for the three modules.

The remaining funds will help to offset the costs of the Instructional Technology Department for consultation help with the content, instructional design and the technical implementation of the new system within the ICON framework. The Instructional Technology department will also provide advice and assistance in the media and application development, which is provided primarily by the contributed TA time and the funded undergraduate time.

### Rough estimate of costs

$22,500; $10,000 for Instructional Designer and $7,500 for an undergraduate research assistant.

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