PROPOSAL
for
<u>**Innovative Instructional Technology Faculty Grant**</u>

Development of Academic Course to be Offered On- and Off-Campus
Via the New Technology

Applications must be received by 1 November 2004

I.   **Faculty Member's Name:**   Mohamad Hassoun
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II.   **Course title and number to be developed (or converted):**

A Robotics Approach for Integrating Design and Programming into the
Engineering Curriculum

Brief course description: This is a proposed phase I (of a three-phase/three-year effort)
of an attempt to integrate design and computers into the engineering curriculum. This
effort is intended to enhance student learning of engineering design and programming in
several existing courses in Electrical & Computer Engineering and potentially other
courses in engineering. This proposal builds on the successful implementation of a new
engineering core course (BE1200: Introduction to Engineering) which utilizes the Lego
Robotics Invention System Kit for teaching design and programming to engineering
freshmen students. The idea here is to allow students to utilize similar (but more capable)
robot kits in course projects in the sophomore, junior and senior years. This will enhance
student learning of abstract engineering concepts by allowing timely, uninterrupted
hands-on approach to engineering design. This effort is intended to bridge a gap in the
classical engineering curriculum where the teaching of design is jammed into the senior
year in the form of a capstone design project.

III.   **Technologies and explanation of how each technology is to be employed:**

A number of researchers have shown that robotics can be motivating and could
significantly impact student learning when teaching engineering and science (for
example, see: R. Beer et al. "Using Autonomous Robots to Teach Science and
Engineering," *Communications of the ACM*, 42(6), pp. 85-99, 1999.) Robots are a
powerful way to motivate learning. The construction and programming of robots uses a

wide range of scientific and engineering principles necessitating team work, planning, critical thinking, and problem solving.

The objective of the work proposed here is to build on a newly implemented freshman engineering design course (currently has 70 registered students) that teaches programming and design in the context of robotics. The approach is a fun, hands-on project-based approach that involves groups of students working in small teams to generate physical realization of their own inventions. The students gain an appreciation of practical engineering product design issues as they interact with their own robot creations. The college of engineering has invested over $20,000 in robotics kits, laptops and materials earlier this year in support of this course. This effort has also been supported (last year) by a WSU Innovative Instructional Technology Grant.

Over the past two years, the college's Academic Oversight Committee (AOC) has been working with faculty to redesign four engineering core courses (BE courses). The idea is to integrate project-based design, programming, and problem solving into those courses. The new course BE1200 (which I have developed and is currently teaching one of its two sections) is the result of this redesign effort.

I am proposing to investigate adapting this approach throughout the engineering curriculum in order to reinforce student design and programming skills. This innovative teaching approach employs current accessible robotics technology as the medium for effective learning of otherwise abstract engineering concepts. Here, more capable robot kits (which include programmable microprocessors) will be evaluated in the first phase of this three-phase (three-year) project. The requested funds are to be used to cover the cost of hardware, software, supplies and student assistant time needed for the first phase of this project. A web page will be constructed which will maintain notes, documentation, software tools, robot movie demonstrations, and external links to related online resources. This web page will be made available to students and faculty. Later phases of this project will address the implementation of those ideas (and training of instructors and student assistants) in a couple of sophomore/junior ECE courses and later expanding to include several engineering courses. For those later phases, college/department resources and support will become necessary.

IV. Expected contribution of the project (<u>including number of students per year who will benefit from the proposed innovation</u>):

Two or three commercially available micro-controllers (serving as the brain of a robot) will be evaluated for our purpose. Also, over 20 different sensors and actuators will be evaluated and tested in order to put together a robotics kit that would fit the proposed needs for our students and instructors. Specifications and sample programs describing the configuration and utilization of such sensors, and actuators will be developed and posted online. A website will be developed to post introductory modules that will serve as a resource for instructors and students. Those modules will include: tutorials, movies, pictures, documents and related links.

It is my belief that this technology-enhanced, robotics design experience will help excite our students and improve their learning of abstract engineering concepts and their design and problem solving skills. When implemented as a team project in an engineering course, the proposed robotics based hands-on approach will help achieve the following objectives:

1. Students will gain an understanding of the iterative, feedback nature of the design process which involves the following steps: Defining a design problem and its objectives, identifying constrains, identifying the materials and design aids available for them, generating a plan for tackling the problem, assigning tasks among team members (hardware tasks, software tasks, recording and data gathering tasks, communications tasks, etc.), building a prototype and generating program code for its operation, testing the prototype, refining the prototype and debugging its software, assessing the success of the various design modifications, and last arriving at a final implementation (a machine that meets all design requirements) along with complete operation and software documentation.

2. Students will learn a version of the C programming language. They will demonstrate an understanding of this language by successfully writing programs for controlling their autonomous robots. Students will gain an appreciation for the hidden difficulties of sensing physical quantities (such as obstacles, color, light, temperature, etc.) and the intricate issue involved in using such measured values to automatically (under microprocessor control) navigate a robot or control an autonomous machine. This gained appreciation is expected to "open their eyes" and lead them to ask probing questions about the nature of physical signals and the internal working of sensory devices, motors, and microprocessors; just the type of questions whose answers await in later engineering courses.

3. This integration of the design experience has the objective of smoothing the transition to senior-level capstone design courses and help integrate the design experience throughout the undergraduate curriculum.

4. Once the instructional resources and preliminary foundations have been established, engineering faculty will be encouraged to adopt the proposed approach in their respective courses

After this exploration and laying-the-foundations phase is completed additional work would still be needed. Future funding will be needed to address issues relating to pilot implementations of the ideas proposed here in a couple of engineering courses at the sophomore and junior levels. College funds will be required to obtain several kits to make available for student teams in those targeted courses. A third phase would address the training of student assistants and instructors in the use of those kits and online resources.

The results of this project will be presented at the Instruction Technology Forum on campus. Also, and because of its web-based nature, the contents and various tools utilized will be readily available for wide dissemination online.

V. **Two- or three-sentence synopsis of the overall project (course, plus application of technology); synopsis to be used, publicly, in announcing and publicizing the awards**

This is a proposal to integrate design, computers and project-based learning into the engineering curriculum. The idea here is to allow students to utilize a robotics kit in course projects in the freshman, sophomore, junior and senior years. This project-based robotics approach will enhance student learning of abstract engineering concepts by allowing timely and uninterrupted hands-on approach to engineering design throughout the curriculum. This effort should bridge a gap in the classical engineering curriculum where currently the teaching of design and programming is jammed into the senior year in the form of a capstone design project.

VI. **Budget:**

Faculty release time	$0
Other personnel (part-time student assistant)	$2500
Travel	$0
Hardware/software	$2,800
Other supplies/equipment (sensors, electronic components, etc.)	$1,700
TOTAL Project Expense	$7,000
Department funding	$2,000
Requested Funding	**$5,000**

Explanation of budget items: Funds from the Innovative Instructional Technology Faculty Grant will be used to cover the cost of microprocessors, sensors, and materials and supplies. Those devices will be tested and assembled into a kit that would serve as a self-contained robotics kit for utilization by engineering student teams throughout the engineering curriculum. The Department of Electrical & Computer Engineering will be providing partial funding for this project in the amount of $2,000.

VII. **Timetable:**

Beginning/ending date	**January 05/September 05**
Start-up date for new course	**AY 06/07**
Progress report due	**May 05**

VIII. **Approvals:**

Faculty member _____ Date_____

Department chair _____ Date_____

Dean _____

**Date_____

SUBMIT TO: **Jerry Herron**
Chair, Innovative Technology Grant Committee
2100 Undergraduate Library
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For more information on these topics, consult the Office of Teaching and Learning's Resources Page
http://www.otl.wayne.edu/tlwww.html or the Wayne State General Counsel.