2010 Murphy Society Faculty Funded Projects:

Design for America: Interdisciplinary Design Education Initiative

Elizabeth Gerber, Assistant Professor, Segal Design Institute and Mechanical Engineering

Design for America (DFA) seeks to expand and further develop its model for civic engagement in undergraduate design education, combining service and project based learning in an extracurricular experience in alignment with McCormick’s commitment to providing innovative, interdisciplinary educational opportunities for students that enable them to supplement a grounding in the fundamentals with experiences that require adaptability, collaboration and analysis.

Discovery Labs in Biomaterials, Nanomaterials and Energy

Derk Joester, Assistant Professor

New materials drive innovation. McCormick is a global leader in materials research and strives to be at the forefront of integrating recent developments into undergraduate teaching. Three types of emerging materials have particular potential to be highly transformative to society: biomaterials, nanomaterials and materials related to energy. We request funds for the third year of a three-year plan to develop challenging and stimulating “Discovery Labs” centered on these topics for the MSE 301 course “Chemical Aspects of Engineering Materials,” an engineering elective open to all McCormick students and a required class for all Chemical Engineering and Materials Science & Engineering majors.

New Course Development: Introduction to Agent-Based Modeling

Uri Wilensky, Professor, EECS and SESP

This project is to develop a new interdisciplinary course targeted for adoption in the core undergraduate engineering curriculum across all disciplines, an objective that fits with McCormick’s strategic objectives. This course will teach students how to construct and analyze computer simulations of natural systems in which many independent entities interact to create complex phenomena. Prototypical examples of such complex phenomena include ecologies of interacting and predating organisms, the flow of traffic, economies of trade of not-perfectly rational humans, properties of materials that emerge from complex microstructural dynamics, coordination of robot “swarms, etc. Our approach will foster creativity in design, lower the threshold for studying and building complex systems, and complement the equation-centric paradigm embedded in current engineering curricula. We will employ the NetLogo software, developed at Northwestern’s Center for Connected Learning and Computer-Based Modeling. NetLogo has world-wide recognition and is the leading ABM platform used both in research and education. Improvements to NetLogo needed for the course will also serve many other NU courses that use NetLogo.
Integration and Expansion of Rapid Prototyping to the Design Curriculum

Michael Beltran, Rapid Prototyping Lab Manager, Department of Mechanical Engineering

Rapid prototyping is a new manufacturing technology capable of rapid production of functional and visual models. Within Northwestern, the recent new emphasis on design and innovation stands to benefit greatly from this technology, allowing for students to quickly and simply produce products to aid in their design process, as well as further understand the link between manufacturing and design. To complete the full circle of the design process, students must not only be able to conceptualize their ideas, but bring them to realization through prototyping and fabrication. It is thus critical to provide our students with the tools and technology to create excellent prototypes, and complete the design process by producing a final product. This proposal seeks to expand the capabilities of the Rapid Prototyping Lab at Northwestern through the purchase of a new 3D printer capable of quickly producing low cost color prototypes.

Hands-On Experience for Students Taking Basic Mechanics Courses

Karen C. Chou, Assistant Chair and Clinical Professor, Department of Civil & Environmental Engineering

This project transforms the current passive observation (demonstration) to active participatory experimentation through multiple miniature digital apparatuses. This project will accomplish the following: (1) more faithfully satisfies ABET requirements for engineering experimentation, team based experience, and enhancement of communication skills; (2) provides hands-on (4-member team) measurement of mechanical material response with analog to digital data manipulation for comparative graphical output; and (3) further leverages the advantages of the residential education model. These experiments and demonstrations will be employed in large enrollment courses offered by the Civ-Env Department: Gen Eng 205 (mechanics (EA 2) taken by all engineering students), and Civ-Env 216 (mechanics of materials taken by many engineering students), and Civ-Env 221 (theory of structures I) and Civ-Env 325 (reinforced concrete). Mechanical response of material is one of the fundamental engineering topics that all graduates must master. This is true, in particular, for students in civil engineering (CE), manufacturing and design engineering (DSGN), and mechanical engineering (ME) programs. The objective of this proposal is to develop a number of hands-on experiments and demonstrations for the four courses listed above. To demonstrate the Civ-Env Department’s commitment to this project, the Department will spend about $10,000 to purchase some of the equipment to initiate the project in the summer of 2010.
**Materials Synthesis and Processing Laboratory**

*Yip-Wah Chung and Katherine Faber, Materials Science and Engineering*

We propose to establish a Materials Synthesis and Processing Laboratory to provide hands-on experience to students in MSE 391 (Process Design), a required course for all MSE undergraduate majors. There is a severe shortage of materials synthesis and processing equipment in our teaching laboratory to provide adequate hands-on training to students enrolled in this class. Our stopgap solution is to either use the equipment in existing research facilities, or to design “kitchen chemistry” projects to simulate materials processing. Neither is satisfactory. The proposed Laboratory will address this shortcoming.

**Investigating and Improving Engineering Students’ Mathematical Modeling Abilities in Capstone Design**

*Jennifer Cole, Assistant Chair and Lecturer, Department of Chemical and Biological Engineering*

This project investigates students’ abilities to generate mathematical models that they can use in the development of innovative design solutions to open-ended problems. In particular, we will study the students’ approach, creation, solution, and interpretation of mathematical models, which our previous work has found to be a difficult part of design. In addition, we seek to understand how instruction can be changed to improve students’ modeling capabilities. We plan to answer these questions through analysis of student work in capstone design courses in two departments, and development, implementation, and analysis of an instructional tool designed to guide students through the modeling process. The results of this study will lead to recommendations on how to improve instruction in mathematical modeling, a practical skill that students need in engineering careers.

**Revitalizing the Laboratory Component of EECS203: Introduction to Computer Engineering**

*Russ Joseph, Associate Professor, Chi-Haur Wu, Associate Professor, Hai Zhou, Associate Professor*

We request support for innovative changes to EECS203 -- Introduction to Computer Engineering. This course serves as either a required or restricted elective for many McCormick undergraduate degree programs, but the antiquated laboratory hardware is both unreliable and painfully out of step with modern technology. This proposal describes a plan for revitalizing the laboratory curriculum through purchase of new equipment and development of new digital design projects that will challenge students, enhance learning, and build excitement about computer engineering.
Development of Regenerative Engineering Labs

Shu Q. Liu, Associate Professor, Biomedical Engineering Department

The objective of the proposed project is to develop a new undergraduate lab course, entitled BMD ENG 359 Regenerative Engineering Labs. Regenerative engineering is the engineering aspect of regenerative medicine, an emerging medical branch for developing cell-based regenerative therapies for human disease. The Biomedical Engineering Department has established a regenerative engineering course BMD ENG 349 Bioregenerative Engineering. This course covers fundamental concepts and current research topics in regenerative engineering and has become one of the best-received biomedical engineering courses. However, this course cannot cover labs essential to regenerative engineering because of time limitation. Here, we intend to establish a new regenerative engineering lab course with cutting-edge technologies, enabling students to understand the principles of designing and developing regenerative therapies.

Innovation in Embedded System Design

Kevin Lynch, Professor, Mechanical Engineering Department

Design is an emphasis of McCormick education. The goal of this proposal is to increase the opportunities for embedded design (mechatronics) education for McCormick students. Mechatronics is central to modern design, as it involves the interfacing of microprocessors to sensors (such as the accelerometer in the iPhone) and actuators (such as the vibration motor in your phone). The proposed grant will support mechatronics education and the development of innovative mechatronics prototyping hardware and tutorial exercises, culminating in web-based exercises, a book, and associated hardware kits that will increase our (currently oversubscribed) capacity to educate students in mechatronics. Funding of this proposal will positively impact students involved in projects and courses across McCormick, including Design Competition (DC), NUvention, Segal project courses, Design for America (DfA), and senior design projects. This proposal is supported by the department chairs and key design leaders in BME, EECS, ME, and Segal.

Development of a McCormick Course in Analytical Methods of Investment Science

W. E. Olmstead, Professor of Applied Mathematics Department of Engineering Sciences & Applied Mathematics

In response to the growing interest of McCormick students to take jobs with financial institutions, a new course is being developed to provide students with a basic background in the analytical methods of investment science. The course is designed to provide not only theoretical knowledge, but also the practical application of strategies for investment and risk management. This proposal requests funds to enhance the practical aspects of the course and thereby make it a more complete educational experience.
Humanitarian Logistics Beyond the Classroom

Karen Smilowitz, Associate Professor, Industrial Engineering and Management Science

Humanitarian Logistics is a vital and growing field of logistics that applies a systems approach to societal issues such as disaster relief, food distribution and health care access. Northwestern University is emerging as a leader in this critical area. The proposed initiative aims to engage IEMS undergraduates in Humanitarian Logistics and train them to be leaders in the field through (1) service learning opportunities for students and (2) a Humanitarian Logistics seminar series; both activities will be linked to the One Book One Northwestern selection for the coming year, Mountains beyond Mountains.