

**Request for Funding from the Dwight Look College of Engineering
Inquiry/Research-Based Education of Undergraduates
Quality Enhancement Plan
Academic Year: 2007-2008**

Part I: Cover Page

College of Engineering

Proposal Title: *Integrating the Design Process into the Existing ENGR 11X Project Structure.*

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Abstract:

The Freshman Engineering course sequence (ENGR 111/112) of the Dwight Look College of Engineering currently uses an inquiry-based project approach where inquiry includes the engineering design, analysis and testing process. Students enrolled in ENGR 111/112 are assigned to one of three different tracks depending upon their major. The mechanics track (about 60% of the students) uses four, 6-week design projects to drive course content over two

semesters of ENGR 111/112. This approach has significantly increased retention for students in this Track. The other tracks are moving toward increased project coverage. Heretofore an informal design approach has been used to develop the project designs. We are proposing to formalize this approach by stressing the project development process: project objective, alternative approaches, feasibility studies, etc. to a varying degree in each of the projects. We are also proposing to assess the learning outcomes with a before and after questionnaire in addition to the normal exam process. We will also present the overall approach and the results to faculty using a seminar series. We also intend to increase the scope of Teaching Assistant and Peer Teacher training during the implementation process. Since we are integrating this concept into existing courses, future sustainability is not an issue.

Part II: Learning Outcomes:

Each of the existing ENGR 11X projects (see below) has an existing set of Learning Objectives; this effort seeks to strengthen student understanding of the general engineering project development and design process. In short students must be able to:

- Sketch and annotate the general project development process for selected engineering type projects.
- Students must be able to develop and evaluate a set of feasible alternative design objectives.

Part III: Process:

The College of Engineering has an existing NSF-STEPS (Science, Technology, Engineering, and Mathematics Talent Expansion Program) grant that seeks to increase the number of STEM graduates by increasing the retention of first-year students. The College of Engineering NSF STEPS Program is described further at: <http://steps.tamu.edu/nuke/> and <http://steps.tamu.edu/nuke/AboutSTEPS/tabid/70/Default.aspx>. The three strategies employed by that effort that relate to this project are: a) the implementation of engineering type projects into the active-collaborative presentation style employed in the ENGR 11X sequence, b) the extensive use of Peer Teachers to assist with the in-class learning activities, and c) the training of a cadre of TA’s to assist the instructors with the general conduct of the course.

During the 2005 fall semester (third year of the grant), an ENGR 11X student retention study revealed that students involved in the STEPS Project exhibited a different retention experience than other students: a much higher percentage passed Calculus I (Math 151) in spite of the almost identical entering credentials (for example, SAT, Math SAT, and class rank).

The following table shows that twice as many (percentage wise) STEPS student passed MATH 151 than the general ENGR 111 population.

Fall 2005 ENGR 11X Student Cohort			
Non-STEPS	407 Students	179 Passed Math 151	44% Passed
STEPS	468	387 Passed Math 151	82% Passed

The following chart reveals that passing Math 151 (the first time) is the key to engineering retention, particularly with respect to STEPS students.

Fall 2005 ENGR 11X Student Cohort Retention				
		1 Semester	2-Semesters	3-Semesters
Passed Math 151				
Non-STEPS	179	161 – 90%	137 – 76%	129 – 72%
STEPS	387	351 – 91%	314 – 81%	299 – 77%
Failed Math 151				
Non-STEPS	228	187 – 82%	166 – 72%	151 – 66%
STEPS	81	40 -49%	22 – 27%	14 – 17%
Overall				
Non-STEPS	407	348 – 86%	303 – 74%	280 – 69%
STEPS	468	391 – 85%	336 – 72%	313 – 67%

The success (or lack of success) of the students enrolled in ENGR 11X is based upon the following factors: the impact design projects themselves, the impact of the relationship of math and physics to the engineering design and analysis process and the impact of clustering ENGR 11X classes with Math and Physics. If any of these components are omitted, retention decreases.

The intent of the QEP Project is to further strengthen the impact of the existing projects by placing greater emphasis on the project development aspects of each project. This means greater emphasis upon the development of a statement of project objectives, greater emphasis upon the exploration and evaluation of alternative solutions, and finally the selection of the final design alternative. Currently, this is accomplished by each team on an informal basis; this effort will formalize that process.

Bridge Project: Students are required to design, fabricate, analyze, and test a small bridge to accomplish a specific set of specifications. The process of selecting the final design (the one that will be tested and graded) will be formalized.

Merry-Go-Round: Students are required to design, fabricate, analyze, and test a small mechanism to accomplish a specific set of objectives. The process of selecting the final design (the one that will be tested and graded) will be formalized.

Ross Street: This project (or some classroom building or engineering dormitory project) will be used to explore the project development process in some detail, This would include: the generation of alternatives and subsequent evaluation using a set of established criteria, etc.

Structural Vibration: The process for selecting a retrofit design intended to dampen structural motion will be formalized.

Other Projects: Over the past three years eight shorter (1 to 2 weeks as opposed to 6 weeks) projects have been developed. A number of these could be expanded to consider alternative designs in a more formal way.

And important part of this QEP effort is the assessment of student learning outcomes and the

affect of strengthening of the project concept. STEPS students have come to realize the importance of success in Math (and Physics) to engineering design. We are suggesting the following assessment activities:

- Determine the student's ability to meet the stated learning objectives during the first week of class in ENGR 111.
- Retest the ability of the student at the end of the ENGR 111 semester.
- Repeat this process at the beginning of ENGR 112

The introduction of project-centered, inquiry-based learning at the freshman level requires some faculty training in order to be successful. Heretofore, this has been accomplished through a single coordination meeting just before the start of each semester. We are proposing to expand the concept to faculty not necessarily assigned to ENGR 11X in order to expand the number of faculty interested in pursuing this style of instruction. The Center for Teaching Excellence support will be sought for this activity.

Part IV: Budget:

Matching: Modules will be revised under the existing project sequence in ENGR 11X using the existing STEPS Project funding.

\$10,000 Assessment, seminar and other outreach activities to be funded from the QEP grant.

This project will be under the co-direction of Dr. Donald A. Maxwell, Professor of Civil Engineering and ENGR 111/112 coordinator, and Dr. Arun R. Srinivasa, Professor of Mechanical Engineering. Both are also PIs in the NSF STEPS program. The assessment activities will be under the direction of Dr. Jeff Froyd, Director of Academic Development in the Dwight Look College of Engineering. The outreach activities will be coordinated by Profs. Maxwell and Srinivasa. The majority of the budget request from QEP will be directed towards the assessment requirements and activities of this proposed activity.

Part V: Future Needs:

The new class material will be integrated into the existing classes being taught under the STEPS project format. This will not require additional funding in the future.

The faculty, teaching assistant, and peer teaching, seminars and training will be continued under the auspices of the existing ENGR 11X course structure and will not require additional funding. Any outreach to other instructors will require future funding from other than normal sources.

Note:

The STEPS Project is a 5-year project funded by a grant from NSF. While assessment is an important part of that project, the assessment of retention issues is the primary focus. This will enlarge the effort to include assessment of inquiry-based learning.