Project Summary

NSF-03-562 Planning Grant Proposal:
A National Model for Engineering Mathematics Education

Motivation and Goals: Only about 42% of incoming freshmen who wish to pursue an engineering or computer science degree at Wright State University ever complete the required calculus sequence. The remaining 58% either switch majors or leave the University. These numbers are typical of mid-size state universities in Ohio and across the country. It is proposed herein that retention rates in engineering and computer science could (and should) be much higher. *To this end, the proposed research seeks to re-define the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering.*

Solution Strategy: The proposed solution strategy starts with the development of a freshman-level engineering mathematics course (EGR 101). Taught by engineering faculty, the course will include lecture, laboratory and recitation components. Using an application-oriented, hands-on approach, the proposed course will address only the salient math topics *actually used* in a variety of core engineering courses. These include the traditional physics, engineering mechanics, electric circuits and computer programming sequences. *While the above core courses are traditionally reserved for the sophomore and junior years, this research proposes to move them earlier in the curriculum, with EGR 101 as the only math pre-requisite.* It is finally proposed to develop a new Engineering Calculus sequence to be taught by the math department later in the curriculum, in concert with college and ABET requirements.

Intellectual Merit: The intellectual merit of the proposed pedagogical research lies in its novel approach to engineering mathematics education, to be implemented by an interdisciplinary team of award-winning educators. In particular, a hands-on, application-oriented approach is generally lacking in engineering mathematics education. *Moreover, by removing traditional math pre-requisite requirements and moving core engineering courses earlier in the program, the approach will entail a significant restructuring of the engineering curriculum.* The result will shift the traditional emphasis on math pre-requisite requirements to an emphasis on *engineering motivation for math*, with a "just-in-time" structuring of the new math sequence. The proposed research team includes award-winning teachers and innovators in curriculum development representing each of the four College of Engineering & Computer Science departments, as well as the Department of Mathematics and Statistics.

Broader Impacts: The proposed research represents a revolutionary change in the way in which engineering mathematics is taught, and is intended to serve as a national model for engineering mathematics education. *Expected long-term impacts include significant increases in engineering retention and graduation rates not only at WSU, but at universities across the country.* This can only be realized through a commitment to assessment and dissemination of results, which will be significantly enhanced through NSF support. During the course of the proposed planning grant, the investigators will work with the WSU Center for Teaching and Learning to establish meaningful, quantitative assessment methodologies based on retention rates, student success in core courses and graduation rates. Dissemination of results will be accomplished through the development of a web-site outlining the WSU model for engineering mathematics education, the development of a prospectus for an engineering math textbook, the publication and presentation of results at ASEE conferences and other engineering education venues, the hosting of a workshop for engineering faculty from around the country, the continued interaction with regional high schools through established outreach programs (Wright-STEPP, Academic Advantage), and the consultation with industry members of the college's External Advisory Board, several of whom have written letters in support of this effort.

Integration of research and education: The engineering PIs all have active externally funded research programs, several of which are supported by NSF. The hands-on laboratory component of EGR 101 will provide an opportunity to infuse modern scientific tools and research methods into the undergraduate curriculum at the freshman level. *More importantly, the proposed restructuring of the engineering curriculum will allow student exposure to engineering research activities prior to the completion of the traditional math sequence.* This will provide students with an opportunity to get "hooked" on the excitement of research and discovery in engineering, regardless of whether they have successfully advanced through the traditional mathematics sequence.

Integration of Diversity: Low retention is of particular concern for members of traditionally underrepresented groups. As such, the introduction of EGR 101 and the restructuring of the engineering curriculum are expected to have the greatest effect on retention rates for women, minorities, and other traditionally high risk students.