Project Summary

Motivation and Goals: Only about 42% of incoming students who wish to pursue an engineering or computer science degree at Wright State University (WSU) ever complete the required freshman calculus sequence. The remaining 58% either switch majors or leave the University. These numbers are not unique to WSU; indeed, the inability of incoming students to successfully advance through the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. As a result, the WSU model seeks to re-define the way engineering mathematics is taught, with the goal of increasing student retention, motivation and success in engineering. *This work follows the successful completion of NSF Planning Grant #EEC-0343214.*

***Approach*:** The WSU model involves the implementation of a novel freshman-level engineering mathematics course EGR 101, as well as a large-scale restructuring of the engineering curriculum. Taught by engineering faculty, the EGR 101 course includes lecture, laboratory and recitation components. Using an application-oriented, hands-on approach, EGR 101 addresses only the salient math topics *actually used* in the core entry-level engineering courses. These include the traditional physics, engineering mechanics, electric circuits and computer programming sequences. Most importantly, the EGR 101 course replaces traditional math prerequisite requirements for the above core courses, so that students can advance in the engineering curriculum without having completed a traditional freshman calculus sequence. This has enabled a significant restructuring of the engineering curriculum, including the placement of formerly sophomore-level engineering courses within the freshman year. The WSU model concludes with the development of a revised engineering mathematics sequence, to be taught by the math department later in the curriculum. The result will shift the traditional emphasis on math prerequisite requirements to an emphasis on *engineering motivation* for math, with a just-in-time structuring of the new math sequence.

CCLI Cyclic Model Project Components: While the proposed research will incorporate multiple components of the cyclic model, it will primarily focus on *Implementing Educational Innovations* and *Assessing Learning and Evaluating Innovations*. The proposed research tasks include a multiyear implementation and assessment at WSU, an adoption and assessment at two other Ohio universities, and a widespread dissemination of results. The proposed research will rigorously assess how the WSU model impacts student learning in both math and engineering, and will provide both the pedagogical basis and dissemination strategy required for a subsequent Phase 3 implementation.

Expected Measurable Outcomes: Based on results of the initial NSF planning grant, expected measurable outcomes include the following: increased retention, motivation and success of incoming students; enhanced student learning in math and engineering courses; increased graduation rates in engineering; significant contributions to the STEM knowledge base; substantial STEM education community building across the State of Ohio and beyond.

Intellectual Merit: The proposed research team includes award-winning teachers and innovators in curriculum development representing each of the four College of Engineering & Computer Science (CECS) departments, as well as the Department of Mathematics and Statistics. A team of learning experts from both the WSU Center for Teaching and Learning and the WSU Statistical Consulting Center will support the PIs' commitment to a rigorous assessment of the program. This will be effected through a combination of quantitative and qualitative measures of student retention, motivation and success in engineering, with particular emphasis on student learning in subsequent math and engineering courses. The WSU model is overwhelmingly supported by faculty and administration at WSU and other mid-size state universities, by industrial members of the CECS External Advisory Board, and by leading textbook publishers who envision an “enormous” impact and nationwide marketability of the program.

Broader Impacts: The WSU model represents a revolutionary change in the way in which engineering mathematics is taught, yet is designed to be readily adopted by any university employing a traditional engineering curriculum. *Expected long-term impacts include significant increases in engineering retention and graduation rates not only at WSU, but at universities across the country.*

Integration of Research and Education: 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 restructured engineering curriculum will enable student exposure to engineering research activities prior to the completion of a 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 a traditional freshman calculus sequence.

Integration of Diversity: Low engineering retention is of particular concern for members of traditionally underrepresented groups. By making engineering substantially more accessible, the WSU model is expected to have a profound effect on both recruitment and retention of women, minorities, and other traditionally high risk students.