ENGINEERING for ALL (EfA)

The *Engineering for All* (EfA) project, has been funded by the National Science Foundation (Grant # DRL 1316601) to create, test, and revise two-six week modules for middle school technology education classes on the important social contexts of *food* and *water.* The units are built on four "drivers" that underpin the Engineering for All approach. These include:

- Promoting the potential of engineering as a social good.
- Revisiting unifying engineering and technology themes (i.e., design, modeling, systems, resources, and human values) in authentic social contexts.
- Using design-based engineering activities as authentic contexts for teaching and learning Science, Technology, Engineering and Mathematics (STEM) ideas and practices
- Using *informed design* as the core pedagogical methodology.

Due to the essential roles engineering and technology play in addressing global and environmental challenges, support for PreK-12 engineering and technology education (ETE) programs has rapidly increased. In addition to the workforce and economic imperatives, engineering can and should be appreciated as a contributor to sustainable development and transformative improvement in quality of life. The UN *Millennium Development Goals* and the NAE *Grand Challenges for Engineering* inspire development of curricula that prompt learners to seek solutions to human needs: potable water, sanitation and waste disposal, energy, sustainable transport, and production of sufficient food to meet the needs of a growing world population.

School-based engineering meets the needs of millennial students who are civic-minded, team-oriented, and want to make a difference. There is growing recognition that ETE experiences can be pedagogically valuable for all students—not only in providing an effective way to contextualize and reinforce STEM skills, but also in mobilizing engineering thinking as a way for young people to approach problems of all kinds.

These units address science and engineering practices from the Next Generation Science Standards (NGSS) and Common Core State Standards (CCSS) in English Language Arts and Mathematics, as well as the Standards for Technological Literacy (STL). Lead developers of NGSS and STL, are serving as the project team curriculum leaders.

The primary target group for these units is technology education (TE) students and teachers, since the shift to STEM education substantiates the need for the nation's 30,000 TE teachers to play an expanded role in advancing the *T* and *E* in STEM for *all students.* The purpose of these units is to enable students to develop predispositions to forge a sustainable future and learn that engineering is a route to engage in socially significant work.

When completed, the EfA modules will become part of the International Technology and Engineering Educators Association's flagship *Engineering byDesign* (EbD) program.

CURRENT UNITS IN THE EfA Project (About EfA)

Engineering for All (EfA) is a series of curricular units for technology students and teachers. At present there are two units in the EfA series:

Water: The World in Crisis

To address the **Grand Challenge** of improving water availability and safety, students will explore issues of water scarcity, including the effects of unsafe water, water contaminants, and water filtration methods. The unit begins as students are told they have been accepted to be part of a team of engineering students that will be working with the local chapter of Engineers across Borders. Students learn about the world water crisis and water scarcity and become "experts" in "traditional" design and construction of contaminate removal/filtration systems.

Upon the completion of their water exploration tasks, students are presented with the Grand Design Challenge; student groups will design and construct a water filtration system for a single family in a specific developing country, using only locally available materials. Groups work to design the best possible system. Students then present their system to the staff of Engineers across Borders (Principal and others) and to classmates. Classmates critique each system and select the best features of each, then redesign into one optimum filtering system. The overarching goal of this unit is for students to develop engineering design and systems analysis skills while coming to understand that engineering has great potential to be a social good.

Vertical Farming: Feeding 9 Billion People

In order to address the **Grand Challenge** of producing food for a growing world population, students become "experts" in designing and constructing hydroponic systems. Once their hydroponic systems are up and running and plants are growing, the students receive a message that their firm has been asked to design a hydroponic system for the wall of an existing apartment building. Small teams compete to design the best possible system. Their work culminates in design drawing and a presentation to their classmates, who will consider each design on its merits, and then work together to plan the best possible design for their client. The overarching goal of this unit is for students to develop engineering design and systems analysis skills while coming to understand that engineering has great potential to be a social good by solving such critical problems as providing food and water for people around the world.