ENGINEERING FOR US ALL (e4usa)

A partnership of University of Maryland, Arizona State University, Morgan State University, University of Indianapolis, and Vanderbilt University

2022/2023 Course Summary

The Engineering for US All (e4usa) course empowers, engages, and excites students to use what they know and find what they are passionate about to take control and boldly influence the world. Empowerment is built through an **awareness** of engineering in everyday life, the **diversity** of engineers, and by **interrogating** and **emphasizing** how engineering is embedded in **society**. Engagement occurs as students practice engineering design at multiple scales, considering local and global engineering design challenges. *e4usa* generates excitement as students are provided opportunities to design and create solutions in authentic, student-centered product development challenges. *e4usa* invites all schools, teachers, and students to participate fully regardless of their technical background or preparation.

Description of the Program

Course Objectives: Red, Yellow, Blue and Green Threads

Units (Curriculum)

Description:

Empowerment

e4usa is an onramp for students to learn about engineering as a profession and a personal practice, and increases student confidence to use engineering tools and thinking. Students will practice three systematic continuous improvement practices: consistent critical self-reflection, ethical action, and seeking feedback (e.g. performance data, mentoring, etc.). In the course, students will examine historical and current engineers and trace their professional origins to create their own understanding of the value of diversity in engineering, as well as build their own identity as a confident problem solver.

Engagement

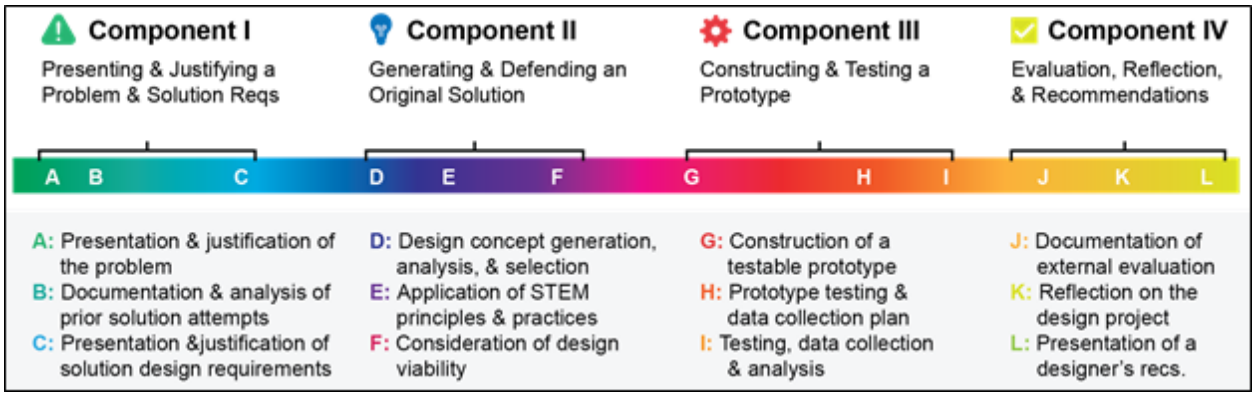
This course will explore the interplay among society's need for engineering, the intentions of engineers, and the positive and negative impacts of engineering. In multidisciplinary teams and individually, students will explore and embody various expert roles including both humanities and STEM-field experts as they grapple with humanity's grand challenges. Students will grow an appreciation for how shifting scales (e.g. local, regional, global) change the potential impact on society with attention paid to ethical implications.

Design Portfolio

Engineering design as a process, or design within constraint, is scaffolded in terms of a learning progression that can be practiced in *any* discipline. *e4usa* students will create engineering design process portfolios that document their work.

MyDesign® and the MyDesign rubric

Engineering design process portfolios are assessed formatively and summatively using the MyDesign Rubric. The rubric is comprised of four main components, each in turn comprised of three elements, as detailed in the figure below. Each element is broken down into a series of sub-elements that are scored on a scale of 0 (no evidence), 1 (novice), 2 (developing), 3 (proficient), 4 (advanced), and 5 (exemplary). With such a thorough focus on the details of the engineering design process, this rubric is useful in assessing student learning over the course of extended, complex projects. *e4usa* has moved MyDesign® into a classroom-ready tool. MyDesign® is an electronic engineering design process portfolio program, into which the MyDesign rubric described below is embedded, that integrates into local learning management systems and also functions as a stand-alone website.



Engineering Design Practices

Students will develop personal problem-solving agency by practicing a systematized method of engineering design that builds autonomy and mastery. Students will troubleshoot and optimize in contexts of increasing ambiguity and complexity. Students will practice negotiating tradeoffs in design and valuing the input of multiple disciplinary expertise. Communication of results will occur in a school-wide 'innovation showcase' and in documentation through a digital design portfolio shared with the entire *e4usa* community.

Benefits and Requirements for Teachers

Curriculum and Support

The *e4usa* curriculum is holistic. It is a free, online guide that includes opportunities for teacher personalization and autonomy focused on student decision-making. The curriculum is a scaffold to teach engineering awareness, engineering in society, and engineering design practices through iterative design challenges, yet it invites teachers to incorporate their students' interests, local needs, community partners, and personal expectations. The *e4usa* curriculum scaffolds and includes room to leverage each teacher's own curriculum, tools, knowledge, and skill. It is, at its core, a set of rubrics and activities designed to promote engineering learning progressions.

Teacher Professional Development and Community of Practice

Professional Learning (PL) is a critical piece of *e4usa*. Each spring a webinar aims to introduce new teachers to the *e4usa* mission and the Curriculum, as well as provide a foundation for the summer workshop. Over the summer, teachers participate in a synchronous virtual workshop with asynchronous assignments that provides teachers with meaningful opportunities to experience the course and also enhance both pedagogical and assessment skills. To ensure continued support, teachers will also receive a series of timely and responsive PLs throughout the academic year to further help with the implementation of the *e4usa* curriculum.

The PL workshops have established a Community of Practice, an actively managed network for both teachers and students. This network includes local faculty members and students from institutions of higher education, leaders in corporations and professional organizations, and *e4usa* team members. The Community of Practice allows teachers to ask questions of other engineers, collaboratively plan classroom activities, and provide high school students with mentorship and support.

Course Learning Outcomes

Connect With Engineering

CE.A	Iterate and evolve the definition of what it means to engineer and be an engineer.	
CE.B	Recognize the value of engineering for all regardless of one's potential career.	
CE.C	Explain and apply ethical & societal considerations when exploring an engineering problem.	

Engineering in Society

ES.A	Explore the impacts of past engineering successes and failures on society as a whole.	
ES.B	Recognize and investigate the world's greatest challenges and the role that engineering plays in solving these challenges (e.g., Engineering Grand Challenges, UN sustainability goals, etc.).	
ES.C	Integrate diverse disciplinary thinking and expertise to inform design solutions that add value to society.	
ES.D	Identify and analyze issues when bringing a solution to scale.	

Engineering Professional Skills

PS.A	Use various engineering communication methods.	
PS.B	Collaborate effectively in a team.	
PS.C	Develop, implement, and adapt a project management plan.	

Engineering Design

ED.A	Identify and describe a problem that can be solved with a potentially new product or process.	
ED.B	Identify appropriate stakeholders and content experts and evaluate their input.	
ED.C	Plan and conduct research by gathering relevant and credible data, facts, and information.	
ED.D	Articulate appropriate STEM practices and principles in the design..	
ED.E	Evaluate solution alternatives and select a final design by considering assumptions, tradeoffs, criteria, and constraints.	
ED.F	Use and recognize when to use computational tools.	
ED.G	Create a prototype.	
ED.H	Create and implement a testing plan to evaluate the performance of design solutions.	
ED.I	Apply iteration to improve engineering designs.	
ED.J	Articulate and reflect on how an engineering design process could be applied to solving a problem.	

e4usa Curriculum Overview

The curriculum is designed as a full-year course as detailed below. The expectation is for students to have approximately 200 minutes per week of instructional contact time. Schools working on block schedules should adjust the per week expectations accordingly.

Quarter 1: Introducing Engineering

Unit 1 - Engineering is… Everywhere

Students will explore engineering through the evolution of engineering products. They will define engineering by relating it to their future plans and engaging in two one-day challenges. Students will begin to build their engineering identity.

Unit 2 - Engineering is…Creative

Students move from "group work" to "teamwork". The students then engage in a guided engineering challenge(s) tethered to a global issue in which they are provided a related problem and design, and then construct and test and evaluate product(s) to address a need. This challenge is water filtration.

Quarter 2: Applying Engineering: Generating a solution to a local problem

Unit 3 - Engineering is… Human-Centered

Teams of 3-4 students will select a local problem to research, sketch, and then prototype a solution. This will be an in-depth investigation into "What is the real problem" as well as stakeholder analysis. The goal is to understand the real problem, creatively construct a low-cost functional prototype and compare to existing solutions not necessarily refine, iterate, or 'deliver.'

Unit 4 - Engineering is.., Responsive

Prototypes will be presented at an in-school design-a-thon and to community partners for critical feedback and user input. Design details will be documented in students' engineering design process portfolios.

From here, teachers can choose to proceed through Units 5-7, or choose to follow a path of either Unit 5 & 6 or Unit 7, depending on the comfort level of the teacher to allow more freedom in student-led teams and time available. ***All teachers will complete Unit 8.***

Quarter 3: Applying Engineering: Generating a solution to a global issue

Unit 5 - Engineering is… Intentional

Teams of 3-4 students will identify a global issue and a local problem that is associated with the global issue identified. The issues and problems selected will be co-constructed by students and teachers and framed with the task of trying to change the world for less than $1000. Student teams will present a design brief to external evaluators in which they will justify their conceptual design concepts and project management plan for the chosen problem.

Unit 6 - Engineering is... Iterative
Team of 3-6 students will engage in all aspects of the design process. Students will build, test, and optimize a prototype of the solution designed. As time permits, students will re-design a solution based on what they learned from the testing of their first prototype to refine what they learned through iteration. Student teams will generate a comprehensive engineering design report and will provide a design presentation.

Quarter 4: Generating an engineering solution to a problem relevant to *you*

Unit 7 - Engineering is… Personal

Students examine their day-to-day lives to find problems that can be tackled by teams of 3-4 students. Students may also solve a problem provided by a local community partner that is of personal interest to them. The process leading to a design solution is student-driven, teacher-guided, and highly informed by the prior experiences in the course. This is open-ended co-creation.

Unit 8 - Engineering is… Reflective

Students will reflect on both their engineering design process decisions and work as well as their teamwork in their final project. Students will also take part in a public showcase of their work.

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