ENGINEERING FOR US ALL (e4usa)

Curriculum Summary

The Engineering for US All (e4usa) curriculum 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 **variety** 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)

e4usa+ Design Course Description:

Empowerment

e4usa allows students to deeply explore engineering as a profession which solves problems 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 e4usa+Design course, students will identify and solve engineering problems through a systemic design process, applying engineering tools mastered in earlier courses that could include CAD or programming.

Engagement

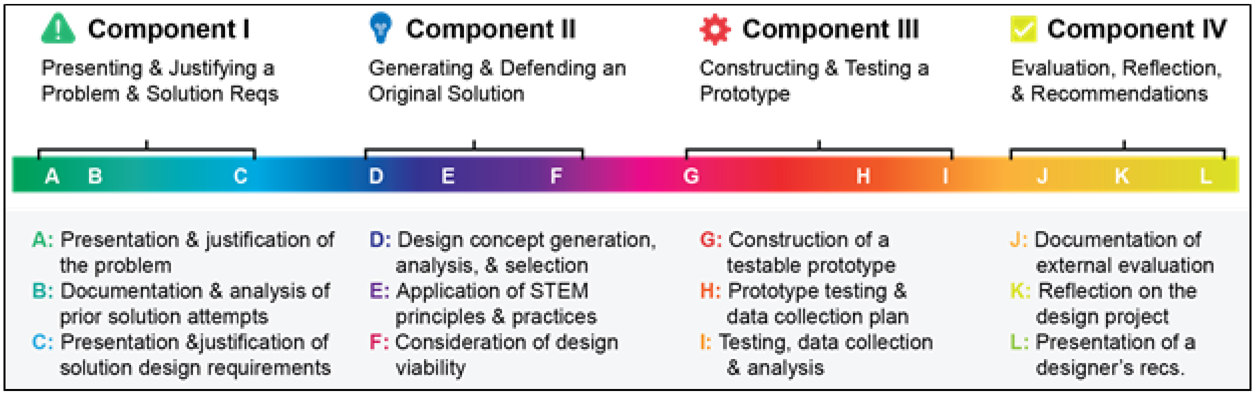
This course will explore the interplay among society's need for engineering, the intentions of engineers. Students, in multidisciplinary teams, will explore and embody various expert roles including both humanities and STEM-field experts as they grapple with humanity's grand challenges and solve problems identified in their local communities. Students will continue to 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. In this course, students will reach deeper levels of mastery in each step of the design process, and will document this in their portfolio. These comprehensive portfolios will document the entire engineering design process as well as summative reflections on the engineering design work and products.

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.



<u>Engineering Design Practices</u>

Students will continue to develop and refine their skill in navigating solutions using a systemic engineering design process. In this course, students will design in increasing ambiguity and complexity. Students will practice negotiating tradeoffs in design and valuing the input of multiple disciplinary expertise as their designs as they solve increasingly complex problems. Students will grapple with increasing amounts of iteration and improvement for each design solution created. Students will also consider the manufacturability and scalability of design solutions. Communication of results will occur in multiple communication scenarios and in documentation through a digital design portfolio shared with the entire *e4usa* community.

Benefits and Requirements for Teachers

<u>Curriculum and Support</u>

The *e4usa* curriculum is holistic. 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.

<u>Teacher Professional Development and Community of Practice</u>

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 either a synchronous virtual workshop or an in-person 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.C	Explain and apply ethical & societal considerations when solving an engineering problem.

Engineering in Society

ES.B	Identify and solve a problem related to 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 cross-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 to communicate solutions to engineering problems.
PS.B	Collaborate effectively in a team.
PS.C	Implement and adapt a project management plan.

Engineering Design

ED.A	Identify and describe personal and global problems that can be solved with a potentially new product or process.	
ED.B	Evaluate the input of appropriate stakeholders and content experts.	
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	Create a prototype.	
ED.G	Create and implement a testing plan to evaluate the performance of design solutions.	
ED.H	Apply iteration to improve engineering designs.	
ED.I	Articulate how an engineering design process could be applied to solving a problem.	

e4usa + Design Curriculum Overview

e4usa + Making is a prerequisite for this course.

The e4usa + Design 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.

1: Applying Engineering: Generating a solution to a global issue

Students will identify a global problem and design a solution to some aspect of that problem. Students will develop a prototype and testing plan as part of their design. Students will use test results to intentionally iterate to improve their solution.

Unit: 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: 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.

2: Generating an engineering solution to a problem relevant to *you*

Students will identify a problem of personal interest and use an engineering design process to design a solution to that problem. They will design a prototype and testing plan. The course concludes with a public showcase of the student work.

Unit: 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: 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.

Acknowledgements:

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