Engineering Design Process (EDP)

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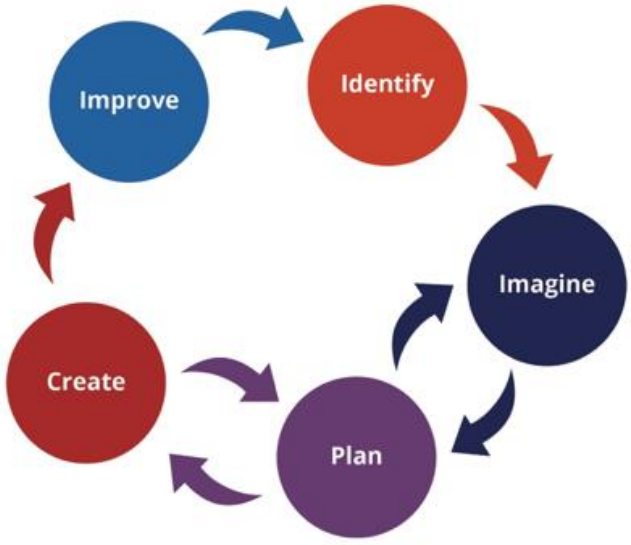
The engineering design process (EDP) is a thinking process used to teach and apply concepts and skills in an integrated manner. The EDP encourages open-ended problem solving and learning from failure. Learners engage with integrated concepts from multiple disciplines and use design thinking as a mechanism to design a solution for an authentic problem. There are numerous engineering design process models; however, they all share the foundational practices of identifying questions or defining problems, imagining, and brainstorming a solution, planning, creating, testing, and improving the design. During this process, scientists and engineers identify the advantages and limitations of their designs and models. A cost-benefit analysis is used to balance the scope, expectations of quality, and budget for the prototype, proof of concept, or process being designed.

Design Thinking

Design Thinking is a creative and user-centered design methodology that provides a solution-based approach to solving problems. It combines empathy for the context of the problem, creativity in the generation of insights and solutions, and rationality and feedback to analyze and fit their solutions to the appropriate context. The **engineering design process (EDP)** is complementary to the design thinking framework commonly used in STEM education. Both processes are used in engineering careers and are appropriate for a STEM project where learners need to design a solution and create a prototype or process.

Engineering Design Process



The design process is iterative, meaning its steps can be repeated to allow for improvements along the way. As designs are tested and improved, learners embrace the mindset of "learning from failure" and uncover new possibilities. This mindset and process nurture the learner's ability to create innovative solutions in various contexts.

Identify

- Identify the Problem
- Identify the Criteria and Constraints

Imagine

- Explore the Materials
- Brainstorm ideas

Plan

- Create a Plan Individually
- Gather Materials
- Select a Group Plan

Create

- Build the Product/Prototype
- Test the Product/Prototype or Execute the Process

Improve

- Analyze Results from Test
- Modify Process or Design to Make it Better
- Repeat as Many Times as Needed

Reflection and communication occur throughout the process but are an important culminating aspect of the process. Reflection on the process is crucial to learning from mistakes and promoting resilience and adaptability. It allows learners to reflect on their process and their end products. Reflection is where learners compare the different solutions created by their peers, determine the most effective or desirable solutions, provide feedback on designs, and discuss their processes. Instructors should offer teams the opportunity to communicate and share their solutions in various ways. Some examples include presentations, reports, exhibitions, special STEM events, display of designs or display boards, and pitches of the solutions to a panel of experts.

While there are multiple variations of the EDP, the processes all work from the same underlying principles.

- *Engineering design is a process.* The process involves steps that guide learners in solving problems. Each part of the process provides information about the problem and possible solutions.
- *The design process is iterative.* Some of the steps may need to be repeated before moving forward. The design may need to be modified and improved until the solution meets the needs of the design criteria. While there are predetermined steps, the steps in the process are not linear or sequential. It is common for engineers to identify the problem and brainstorm ideas before creating and testing a model.
- *Analyzing and evaluating solutions is an important part of the process.* Solutions will have different strengths and weaknesses and need to stay within the constraints of the design. Finding the most desirable solution with the fewest negatives is the goal of every challenge.
- *Failure is expected.* Having a design or prototype fail is a good thing. Failure helps engineers find the best solution before implementing the prototype in the real world. Establishing a "learn from failure" mindset is critical to engineering design success.

While participating in engineering design challenges and STEM problem/project-based learning experiences, students use the engineering design process to solve problems and gain experience with *STEM fluency skills (PDF)* which equip students for STEM careers.