

Using the Engineering Design Process to Innovate school

Brief Overview of Lesson: This lesson is presented for 6th, 7th, & 8th grade classes who have had no engineering course work. The lesson is intended as a STEM kick-off where the engineering design process (EDP) is introduced in a way to personalize the six step, iterative, process. The challenge is for student teams (2 or 3 students) to identify ways a school can change in order to address needs and desires students identify. The teaching objective is engage students in active learning through using the EDP to innovate the school. The result will be posters reflecting the EDP and student identified change points for the school.

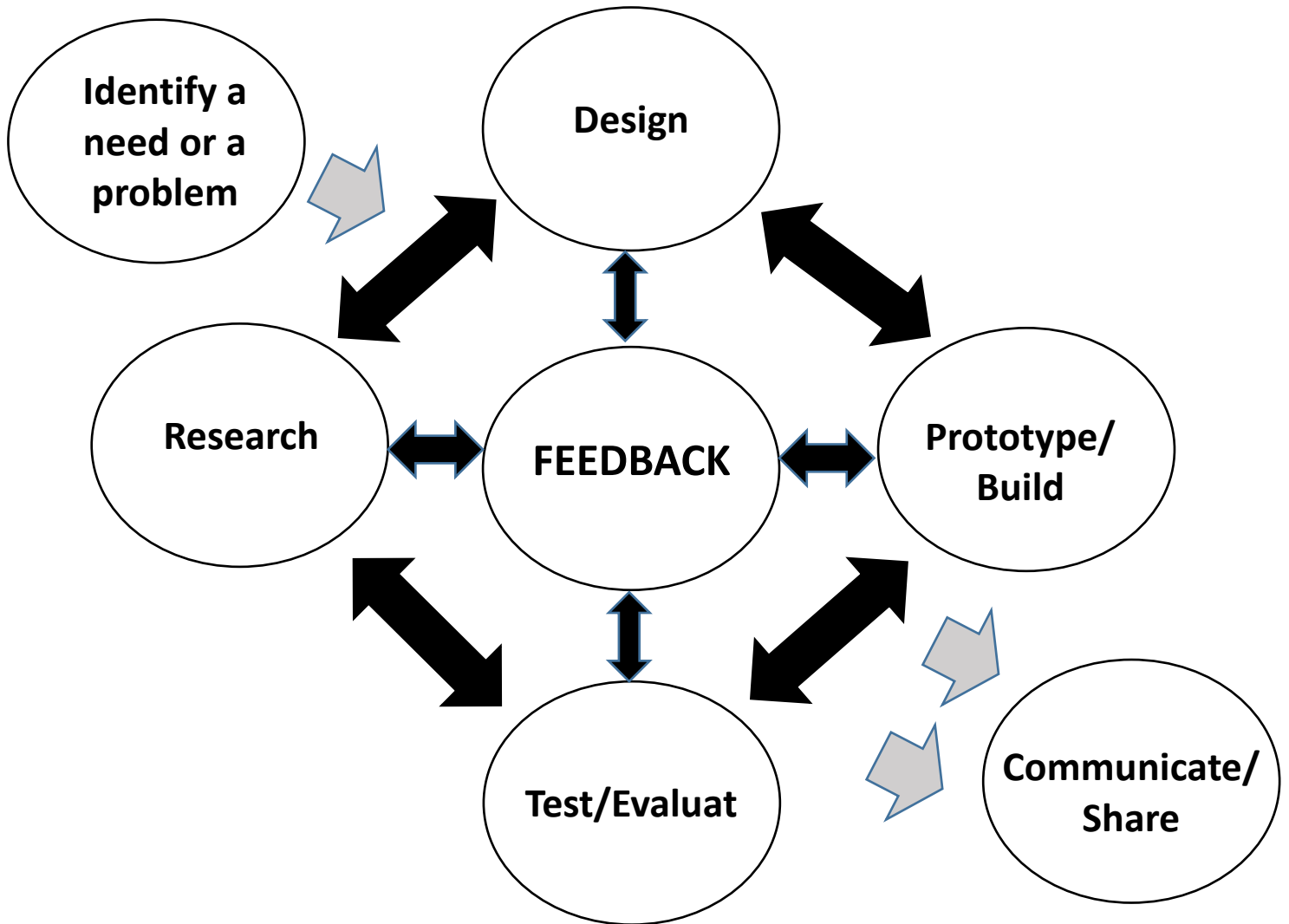
Prior Knowledge Required: None

Estimated Time: 200 mins (5 classes)

Resources for Lesson:

EDP Assessment Tool (provided) ¹	MA DOE EDP Model (provided) ²	Access to internet to research “innovative schools” (provided)
Colored pencils	Rulers, drawing tools	Poster Paper

Engineering Design Process



Standard(s)/Unit Goal(s) to be addressed in this lesson:

Topic	STE Standard
Engineering Design Process (ED)	ETS1-5(MA). Create visual representations of solutions to a design problem; ETS1-6(MA). Communicate a design solution to an intended user, including design features and limitations of the solution.

Objectives: By the end of the section, you should be able to:

- (a) List the six steps involved in the engineering design process,
- (b) Explain the iterative role of feedback throughout the process, and
- (c) Apply the EDP to creating positive change (innovation) within the school.

Engineering Design Definitions:

Identify a need or a problem. To begin engineering design, a need or problem must be identified that an attempt can be made to solve, improve and/or fix. This typically includes articulation of criteria and constraints that will define a successful solution.

Research. Research is done to learn more about the identified need or problem and potential solution strategies. Research can include primary resources such as research websites, peer-reviewed journals, and other academic services, and can be an ongoing part of design.

Design. All gathered information is used to inform the creations of designs. Design includes modeling possible solutions, refining models, and choosing the model(s) that best meets the original need or problem.

Prototype/Build. A prototype is constructed based on the design model(s) and used to test the proposed solution. A prototype can be a physical, computer, mathematical, or conceptual instantiation of the model that can be manipulated and tested.

Test and evaluate. The feasibility and efficiency of the prototype must be tested and evaluated relative to the problem criteria and constraints. This includes the development of a method of testing and a system of evaluating the prototype's performance. Evaluation includes drawing on mathematical and scientific concepts, brainstorming possible solutions, testing and critiquing models, and refining the need or problem.

Provide feedback. Feedback through oral or written comments provides constructive criticism to improve a solution and design. Determining how to communicate and act on feedback is critical.

Communicate, explain, and share. Communicating, explaining, and sharing the solution and design is essential to conveying how it works and does (or does not).

Targeted Academic Language

Unit	Key Term	Definition
Unit 1	Assess	To thoroughly and methodically analyze accomplishment against specific goals and criteria.
Unit 1	Assessment	An evaluation technique for technology that requires analyzing benefits and risks, understanding the trade-offs, and then determining the best action to take in order to ensure that the desired positive outcomes outweigh the negative consequences. Techniques used to analyze accomplishments against specific goals and criteria. Examples of assessments include tests, surveys, observations, and self-assessment.
Unit 1	Brainstorm	A group technique for solving problems, generating ideas, stimulating creative thinking, etc. by unrestrained spontaneous participation in discussion.
Unit 1	Client	A person using the services of a professional person or organization.
Unit 1	Creativity	The ability to make or bring a new concept or idea into existence; marked by the ability or power to create.
Unit 1	Criteria	A means of judging. A standard, rule, or test by which something can be judged.
Unit 1	Constraint	1. A limit to a design process. Constraints may be such things as appearance, funding, space, materials, and human capabilities. 2. A limitation or restriction.
Unit 1	Design	1. An iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants or solve problems. 2. A plan or drawing produced to show the look and function or workings of something before it is built or made. 3. A decorative pattern.
Unit 1	Design Brief	A written plan that identifies a problem to be solved, its criteria, and its constraints. The design brief is used to encourage thinking of all aspects of a problem before attempting a solution.
Unit 1	Design Process	A systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants and to winnow (narrow) down the possible solutions to one final choice.
Unit 1	Design Statement	A part of a design brief that challenges the designer, describes what a design solution should do without describing how to solve the problem, and identifies the degree to which the solution must be executed.
Unit 1	Designer	A person who designs any of a variety of things. This usually implies the task of creating drawings or in some ways uses visual cues to organize his or her work.
Unit 1	Engineer	A person who is trained in and uses technological and scientific knowledge to solve practical problems.

Unit	Key Term	Definition
Unit 1	Engineering Notebook	A book in which an engineer will formally document, in chronological order, all of his/her work that is associated with a specific design project.
Unit 1	Innovation	An improvement of an existing technological product, system, or method of doing something.
Unit 1	Invention	A new product, system, or process that has never existed before, created by study and experimentation.
Unit 1	Iterative	A process that repeats a series of steps over and over until the desired outcome is obtained.
Unit 1	Justifiable	Capable of being shown as reasonable or merited according to accepted standards.
Unit 1	Problem Identification	The recognition of an unwelcome or harmful matter needing to be dealt with.
Unit 1	Product	A tangible artifact produced by means of either human or mechanical work, or by biological or chemical process.
Unit 1	Prototype	A full-scale working model used to test a design concept by making actual observations and necessary adjustments.
Unit 1	Research	The systematic study of materials and sources in order to establish facts and reach new conclusions.
Unit 1	Valid	Well-founded on evidence and corresponds accurately to the real world.

STEM-Innovation Chrome Book Search

Use the web sites below to search on engineering design process and innovative schools, and list your ideas on the project planning sheet. Be prepared to build a poster on your team's ideas on creating an innovative school.

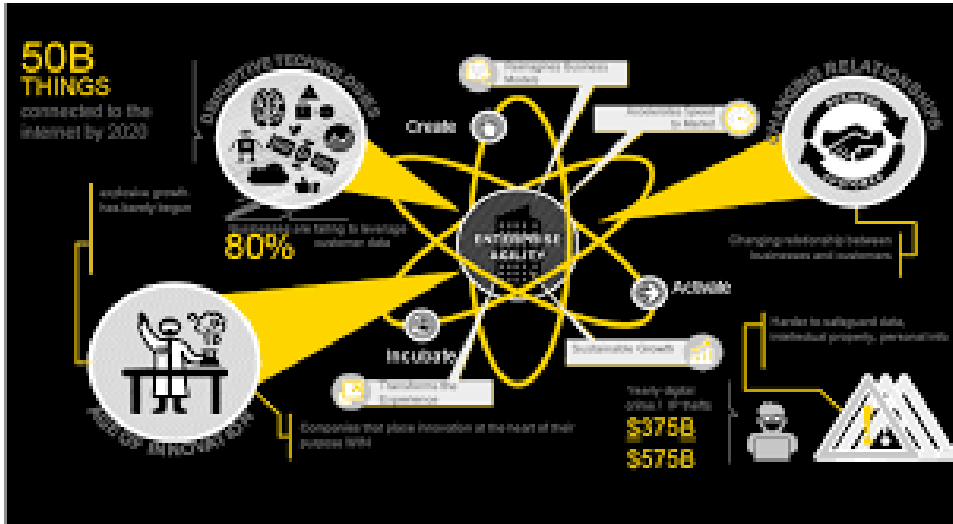
1. Search term-Engineering Design Process
 - a. <https://www.youtube.com/watch?v=fxJWin195kU>
 - b. <https://www.youtube.com/watch?v=wOBJHeV7ezI>
 - c. <https://www.youtube.com/watch?v=5Dp2qHz8r2U>

2. Search term-Innovative Schools
 - a. https://www.youtube.com/watch?v=xdrC5wo_9UA
 - b. <https://www.youtube.com/watch?v=LZVUFRUdggg>
 - c. <https://www.youtube.com/watch?v=70VaFl47NIA>

Notebook Check Rubric

Category	5	4	3	2
Overall organization	Notebook is labeled and papers are in order. The correct tabs are in place.	Notebook is labeled and the correct tabs are there but they are not in order	Notebook is missing 1 or more categories and it lacks organization	Notebook is not labeled and is missing more than 2 categories and is not organized.
Neatness, Completeness and Proper Use	Neat pages, legible handwriting. Use of a writing utensil that is school appropriate.	Mostly neat, mostly legible. Contains items from other classes that should not be in this folder.	Sloppy or unorganized. Handwriting is sometimes illegible. Contains many things from another class. Inappropriate usage of writing utensils	The work appears sloppy and unorganized. It is hard to know what information goes where. Notebook is not used for just HS 101
Daily Section	All papers under this label are daily assignments and homework. Each sheet has the students name and date on the sheet visible to the teacher.	Most papers under this label are daily assignments and homework. Some papers are missing a name and date on them	Papers are not in any order and are not under the correct tab. Some papers are missing a name and date on them.	Papers are missing from the daily section. Name and date is not on most of the papers.
Test Section	All projects and handouts for projects, and study guides are in this section. Papers are neat and organized with a name and date on them.	All handouts for tests and projects are under this label. Some are missing the name and date on them	Most handouts for test and projects are under this label. Some have name and date on them	Most handouts are missing from this section. Most sheets do not have a name and a date on them.

Images of Innovation



Sources:

1. https://www.teachengineering.org/curricularunits/view/cub_creative_curricularunit
2. Science and Engineering Practices Progression Matrix -
 - <http://www.doe.mass.edu/stem/review.html>