BHS: Grade 9 Innovation Project

At Bow High School, we've embraced the PLTW Engineering courses as a great starting point for rigorous, relevant, project-based learning. They are open to everyone and a core of students go on to engineering and related fields. Starting this year, we have split IED into a 2-year sequence so we can emphasize more student generated, open-ended, group, design projects and still master the remaining content.

Our engineering courses also feature prominently in an innovation being piloted this year with the entire freshman class. About half of our freshman are in our introductory engineering course but they are all in the core freshman courses that include a team-taught language arts and social studies course called Studies in Humanities. The freshman engineering course has been modified to anchor the content to a year-long, open-ended, group innovation project. For the first time, all Humanities students will also use a design process to complete a year-long, group social innovation project. For those students in both classes, the engineering innovation will be related to the social innovation.

One of our Humanities teachers introduced innovation to their students with a news story about about a young woman who designed a combination coat and sleeping bag for homeless people – a great engineering innovation. The social innovation came about when the designer founded a start-up that hired and trained homeless women to manufacture the coat-sleeping bag. Within a few days of hearing about this example, our freshman decided to fundraise for ALS. With a little facilitation, the freshman planned and sponsored a “fire-hose” soaking fundraiser that raised over $1,000.00. The soaking happened in front of an ALS patient and speaker who were already coming to talk with the classes. Our 9th grade students experienced a social innovations by planning and completing a social innovation. They will spend the rest of the year choosing a problem to solve with a social innovation that they plan and implement.
Engineering Design

Design  The word “design” is often used as a generic term that refers to anything that was made by a conscious human effort or a decorative pattern. Engineering is the application of math and science to solve problems. Engineers solve problems using a systematic design process. Engineering design can be thought of as both a verb and a noun.
- “Design” as a verb refers to the process of both planning and/or implementing something new: product, process, system.
- “Design” as a noun refers to both the plan and/or the implementation of that plan for a product, process, system.
Ex. IED students design(plan) and design(implement) solutions. IED portfolios document designs(plans) and designs(solutions).

Implement  In engineering, implement is putting a plan into effect - applying the solution to the problem.

Invention vs. Innovation

Invention  A new product, process or system that has never existed before.
Ex. At some time, a person or persons made the first wheel – about 5,500 years ago.

Innovation  An improvement of an existing product, process or system.
Ex. The first wheels have been modified repeatedly for a variety of vehicles and related uses.
Most engineering designs are innovations. True inventions are rare. The word invention is frequently mistakenly used for innovation. IED students are expected to apply and document an engineering design process to solve a problem – most likely resulting in an innovation.

Flow Chart

Flow charts are diagrams showing how steps in a process relate to each other. This makes them useful tools for communicating how processes work and guiding activity.
Example: How to Repair ANYTHING
**IED Design Process: Guidelines for Engineering Problem Solving**

Scientists answer questions using a scientific method and engineers solve problems using a design process to produce inventions and innovations. **Design Process** A systematic, iterative problem-solving strategy that generally proceeds from focusing on a problem to solve, to proposing one design from many possible ideas, to evaluating the highest ranked design. The IED design process is summarized below with a flow chart.

**Iterative** A process that repeats a series of steps over and over until the desired outcome is obtained.

1. Define Problem
   a. Design Brief
   b. Problem Validation & Justification
2. Generate Concepts
   a. Brainstorm Solutions
      (1) Creative Solution Ideas
      (2) Workable Designs
   b. Select an Approach
3. Develop a Solution
   a. Technical Drawings
   b. Solution Justification & Validation
4. Construct and Test a Prototype
   a. Prototype Construction
   b. Prototype Testing
5. Evaluate Solution
   a. Effectiveness
   b. Reflection and Recommendation
   c. Optimization/Re-Design
6. Present Solution
IED Design Process: Vocabulary

1. Define Problem
   a. Design Brief - written documentation identifies a problem to be solved, proposed design, solution criteria, and problem constraints:
      Problem Statement - single, clear, concise sentence that summarizes the problem ONLY - NOTHING about the solution.
      Design Statement - single, clear, concise, sentence that summarizes what a design solution should do - NOT HOW to solve the problem.
      Criteria - means of judging the solution, based on needs, wants, etc.
      Constraints - limitation(s) or restriction(s) to solving the problem - examples include time, resources, etc.
      Deliverables - what needs to be produced – examples include documentation, products, etc.
   b. Problem Validation & Justification
      Problem Validation - demonstrating that the stated problem is a real problem:
      • Who says the stated problem is a real problem?
      • What are their needs and wants?
      • Has the problem already been solved? Are there prior solutions?
      Problem Justification - demonstrating that the problem is worth solving…for the consumer and company.

2. Generate Concepts
   a. Brainstorm Solutions
      (1) Creative Solution Ideas - begin with multiple ideas that do NOT have to meet all the criteria and constraints.
      (2) Workable Designs - multiple solutions that do meet all the criteria and constraints.
   b. Select an Approach - rate and rank workable designs based on criteria and constraints with a decision matrix.

3. Develop a Solution
   a. Technical Drawings – comprehensive documentation of highest ranked design.
   b. Solution Validation & Justification - demonstrating that the highest ranked design is worth testing.

4. Construct and Test a Prototype
   a. Prototype Construction - a working model used to test a design based on criteria and constraints.
   b. Prototype Testing - analyzing the prototype based on the criteria and constraints.

5. Evaluate Solution
   a. Effectiveness - extent to which design solves problem.
   b. Reflection and Recommendation - comments on design project.
   c. Optimization/Re-Design - the process of producing the best solution to the problem given specific criteria and constraints. The best solution maximizes the effectiveness and minimizes the needed resources (cost, material, effort, etc.).

6. Present Solution - communicate design process/product with engineering notebook, portfolio, presentation, etc.