



Northeastern University
Department of Mechanical and Industrial Engineering

ENGINEERING BASED LEARNING in HIGH SCHOOL STEM CLASSROOMS



connecting theory to the real-world

WHO WE ARE?



Abe ZEID is a Professor with the Department of Mechanical and Industrial Engineering at Northeastern University. His research topics include the use of mobile agents to facilitate information access in manufacturing environments, developing XML-based algorithms for mass customization, and developing a Java-based and Web-based system for disassembly analysis. The system allows users to disassemble the components of a PC, and calculate the disassembly cost associated with each component. Dr. Zeid has written textbooks in the areas of CAD/CAM and the Internet/World Wide Web. He is an ASME Fellow.



Jessica CHIN is a Ph.D. Candidate in the Department of Mechanical and Industrial Engineering at Northeastern University. Her research focuses on designing, using, and implementing engineering-based learning in high school STEM courses. Her Ph.D. focus is on the construction and design of robust control algorithms in imaging systems to monitor and track current wound state and wound progression in a quantitative method. She received her B.S. in Mechanical and Biomedical Engineering from Rensselaer Polytechnic Institute and her M.S. in Technological Entrepreneurship from Northeastern University.



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WHAT IS ENGINEERING-BASED LEARNING?

SYSTEMATIC STRUCTURE

ORGANIZED SET OF FINITE TOOLS

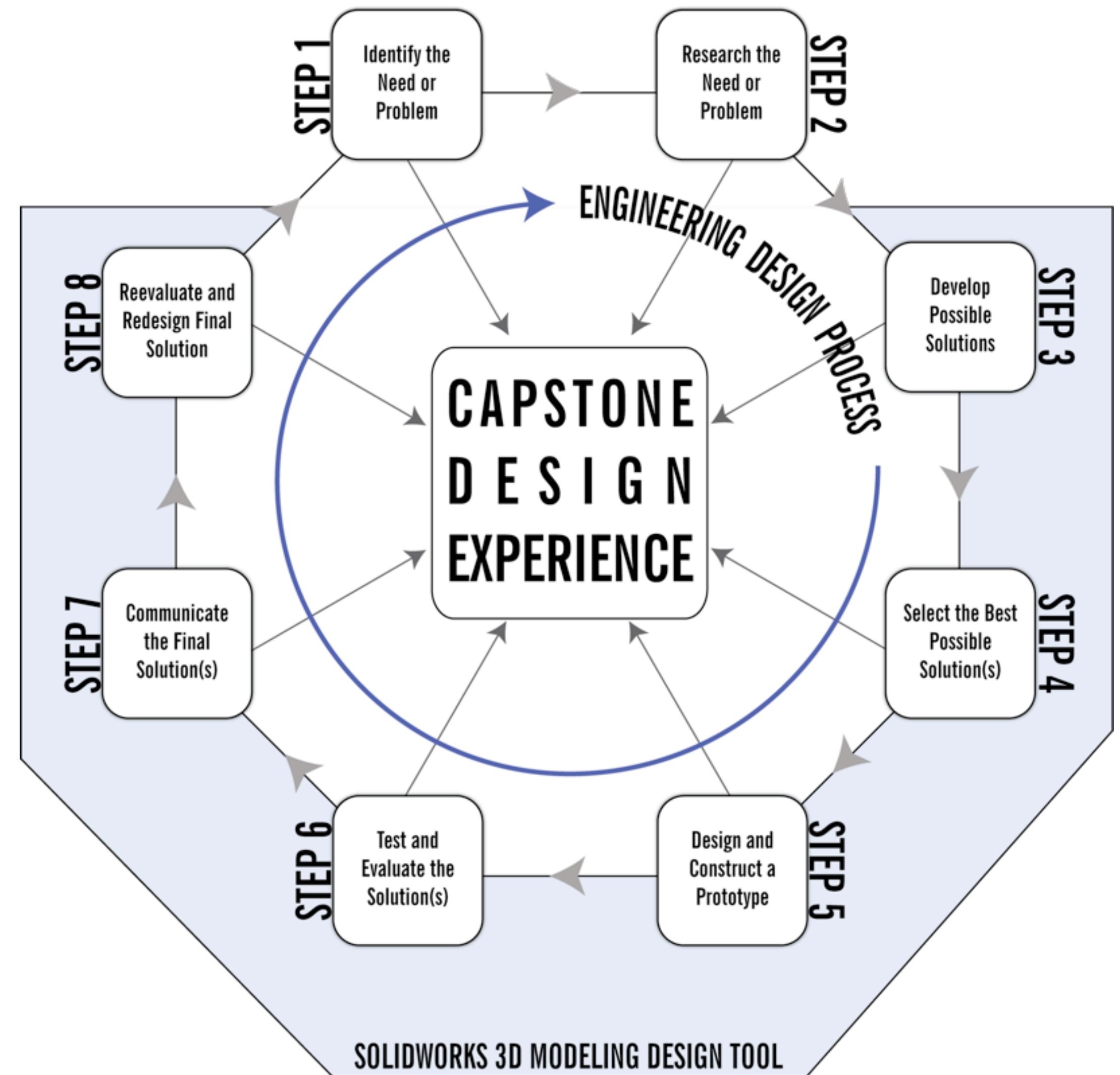
PROPER RESOURCES

HANDS-ON, REAL-WORLD EXPERIENCES

TRANSFERRABLE

ACROSS MULTIPLE STEM DISCIPLINES

CONSTANT CIRCLE OF IMPROVEMENT



THE TOOLS OF EBL

**COMPUTER-
AIDED DESIGN**

**ENGINEERING
DESIGN
PROCESS**

**CAPSTONE
EXPERIENCE**



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COMPUTER-AIDED DESIGN

3D MODELING TOOL

PRESENTS DIFFERENT PERSPECTIVE

ALLOWS VISUALIZATION ON A COMPUTER

PROVIDES CREATIVE ENVIRONMENT

HANDS-ON, REAL-WORLD EXPERIENCES

CONCEPTS CAN BE EASILY ILLUSTRATED

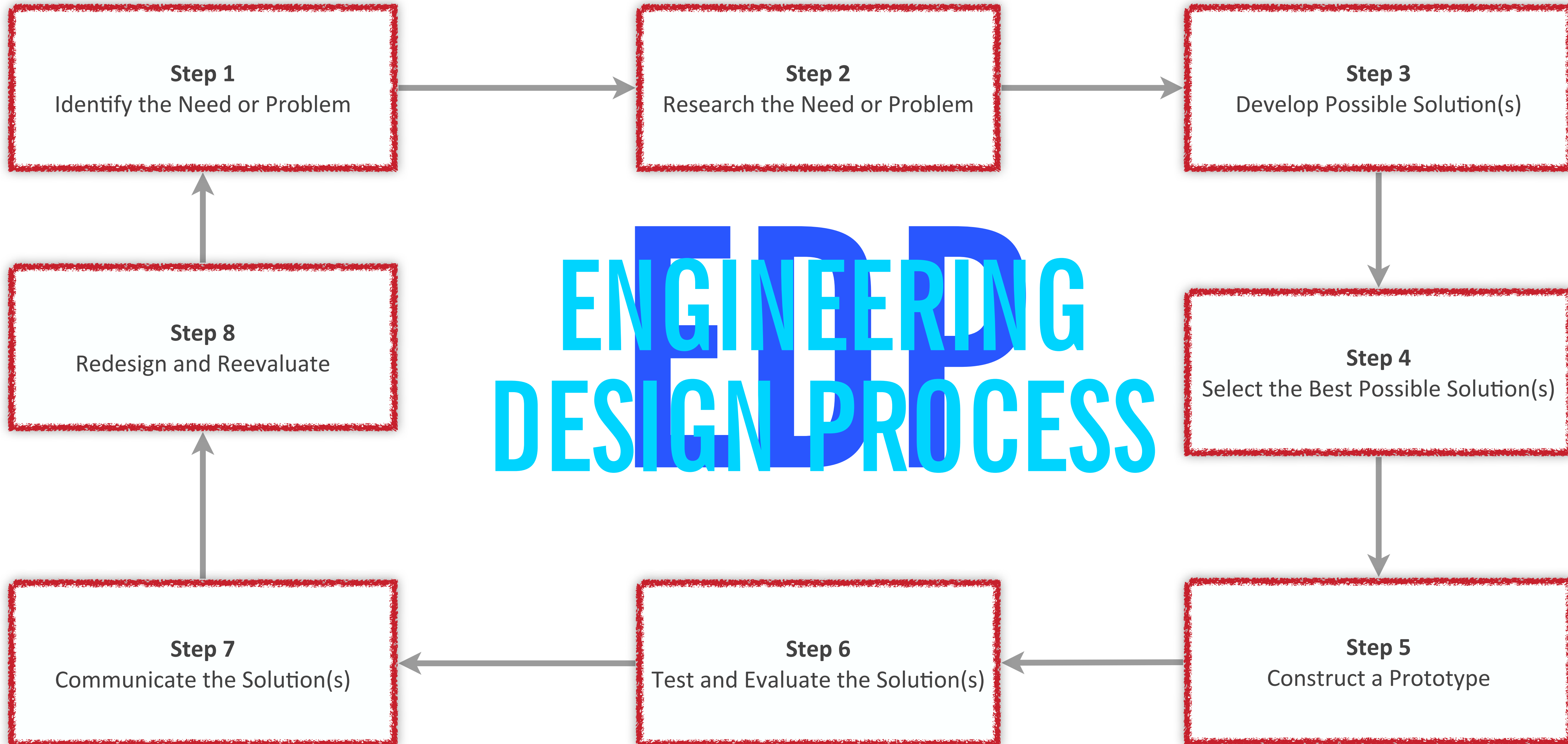
CAN ALTER DESIGN SEAMLESSLY

MODELS CAN SHOW POSSIBILITIES

MULTIPLE SOLUTIONS CAN BE CREATED



ENGINEERING DESIGN PROCESS



CAPSTONE EXPERIENCE

RELATES THEORY TO REAL-WORLD

PROVIDES A HANDS-ON EXPERIENCE

CULMINATION OF A SEMESTER/YEAR

PROVIDES CRITICAL ANALYSIS

IN DEPTH TEAM EXPERIENCE

TIME MANAGEMENT

NOT JUST A PROJECT

OPEN-ENDED PROBLEM SOLVING

MULTIPLE SOLUTIONS CAN BE CREATED



CHARACTERISTICS OF EBL TOOLS

Tools	Topics
Engineering Design Process	<ul style="list-style-type: none">• Problem-based Learning• Capstone Inquiry• University Capstone Projects
Computer Aided Design	<ul style="list-style-type: none">• Modeling in a Virtual Environment• CAD Part vs. Assembly• 3D Model Analysis (Stress, Strain)• Engineering Drawings
Capstone Experience	<ul style="list-style-type: none">• EDP and Design Process• Open-Ended Problem Solving• Constraints• Teamwork• Research Posters and Presentations

PROJECT-BASED LEARNING

**ACTIVE
LEARNING**

**STUDENT
CURIOSITY**

**CREATIVE
PROBLEM
SOLVING**

GROUP WORK

**DOCUMENTED
BENEFITS**

**SUPPORTS
LIFE-LONG
LEARNING**

**INJECTS REAL-
WORLD
PROBLEMS**

**HELPS
CONNECT
THEORY &
APPLICATION**

what PBL lacks...

WHY EBL in STEM HIGH SCHOOL TEACHING?

**PROPER
STRUCTURE**

**DEFINED
METHODOLOGY**

**SYSTEMATIC
METHOD**

**STUDENT-
CENTERED
LEARNING**

**PROVIDED
TOOLS**

**MODELS AND
RESOURCES**

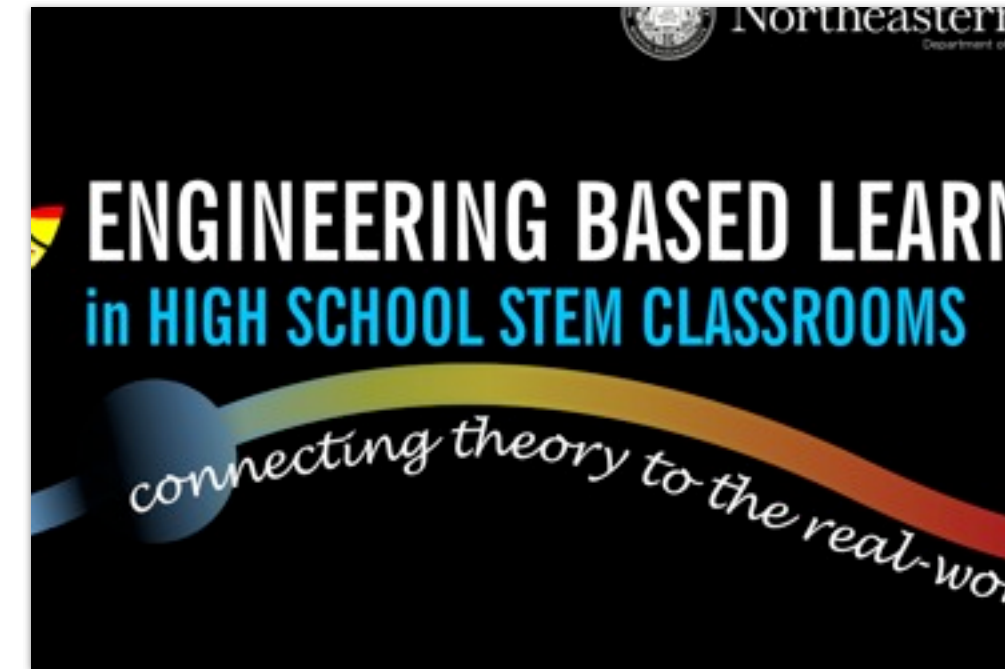
**INDUSTRY
EXPERIENCE**

**CULMINATING
EXPERIENCE**

DEFINITION:

Engineering-Based Learning (EBL) combines well-known tools from science and engineering to create a pedagogical process to enhance student-centered learning across multiple STEM disciplines. EBL enhances the idea of project-based learning by applying and leveraging necessary tools to increase the success of students in high school STEM courses. EBL is defined as a structured, cyclical paradigm that teaches active, open-ended problem solving using real-world examples.

WHAT IS ON THE WORKSHOP FLASH DRIVE?



Engineering-Based Learning as a Pedagogical Approach for Teaching STEM Classes

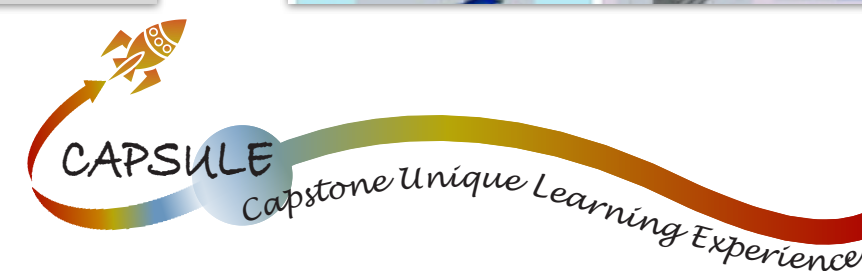
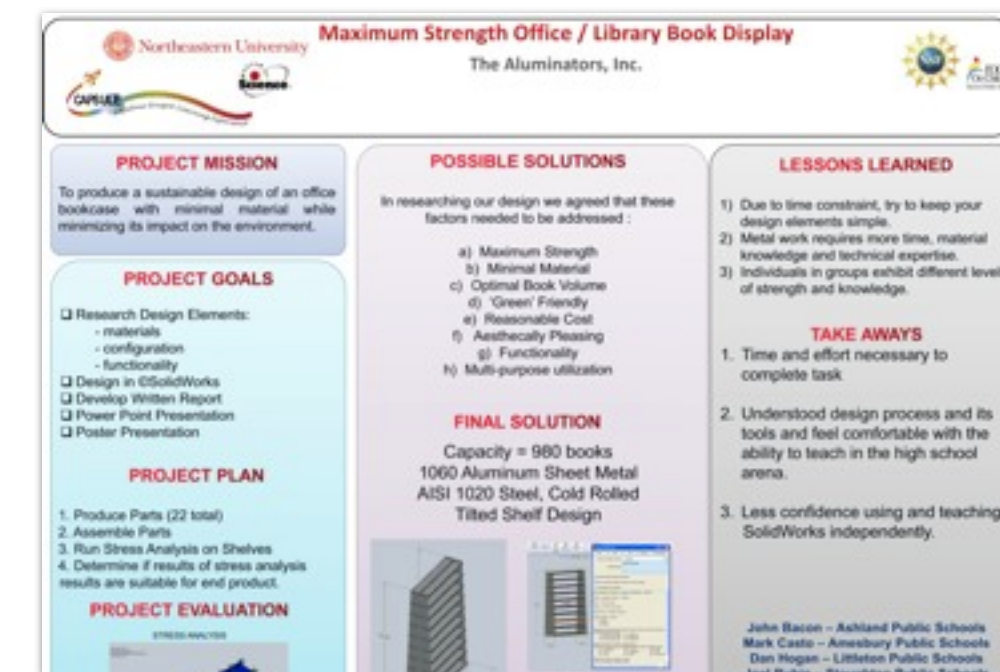
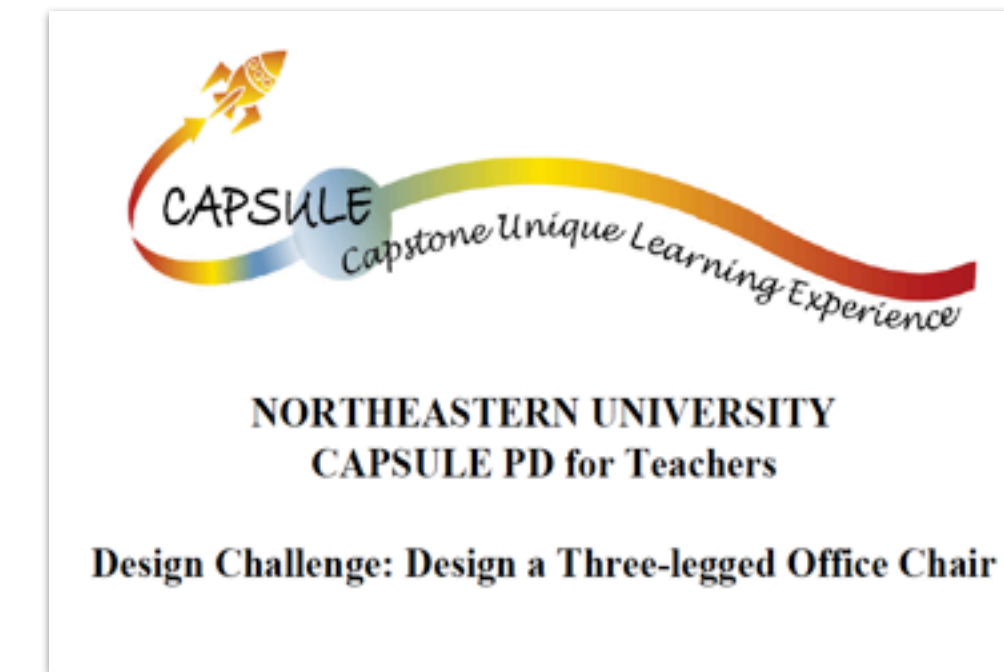
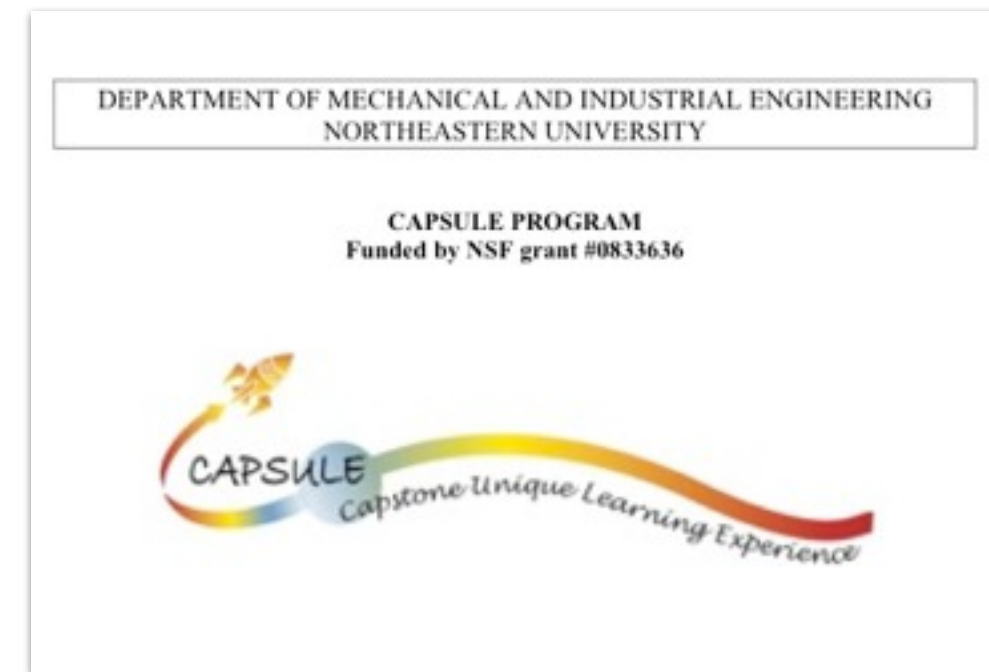
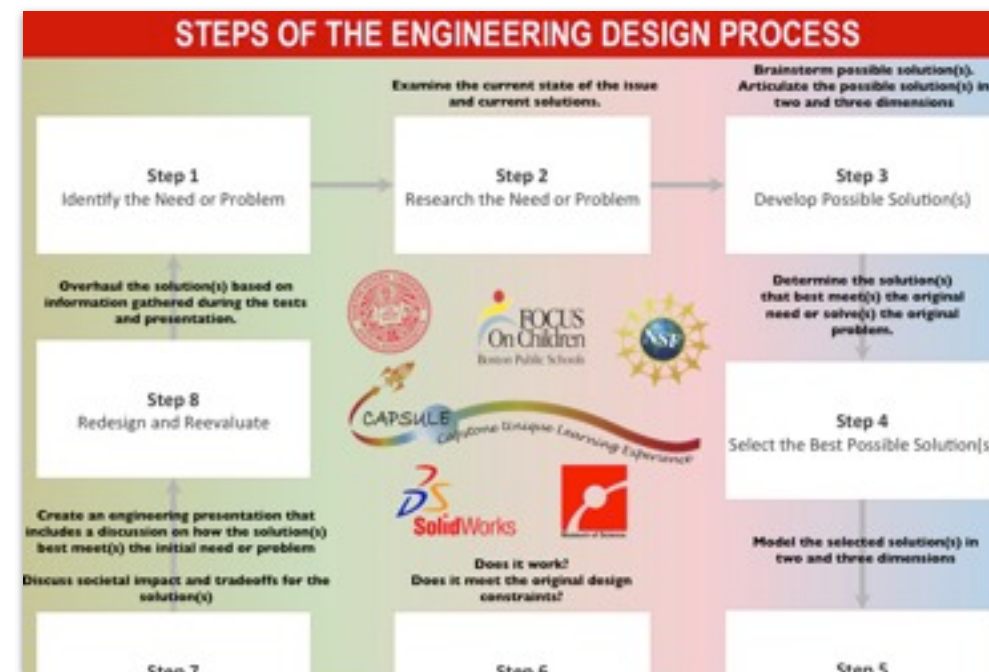
ABSTRACT

In Quincy Upper School (JQUS), a Boston Public School located in the Chinatown Bay Village neighborhoods, serves a socioeconomically and ethnically diverse population of students in grades 6-12. JQUS is the first Boston-area International Baccalaureate (IB) public school; through IB it aims to develop its students to be knowledgeable and productive members of a global society through an education that promotes cultural awareness, skillful use of information, and personal renewal along individual and community path-finding for the 21st century. The varied challenges of 21st century society and workforce necessitate the adaptation of pedagogies and

Implementing Engineering-Based Learning in Boston Arts Academy High School STEM courses

ABSTRACT

Boston Arts Academy is a unique urban high school in that its curriculum of arts and academics. Our school believes that art is essential and necessary for us to integrate arts into our STEM courses. Our school is challenged, so it is difficult for us to add new courses. Therefore, we need approaches to find ways to connect theory to practice, which has led to the implementation of STEAM (science, technology, engineering, arts, and math) as a guiding



THREE-LEGGED CHAIR ACTIVITY

DESCRIPTION

You are an engineer.

Speciality is designing and manufacturing office chairs.

Minimize impact on the environment (i.e. materials).

DESIGN GOAL

Design a chair that:
Uses the least amount of material

Uses environmentally friendly material

DESIGN SPECIFICATIONS

Has only 3 legs | Be stable and Safe | Aesthetically Pleasing

Comfortable | Have arm rests | Have a back rest

Ergonomically designed | Support Abe Zeid (sit or stand)

TEAM WORK

Your team must consist of 4-5 teachers

Everyone must contribute

CHALLENGE

60 Minutes to complete

Short 2 minute presentations for final result

Talk about design process

DESIGN CONSTRAINTS

Use the least amount of material

Cost less than \$150 (however, cheaper mfg. cost, more profit)

Recyclable at the end of life