4H3040

WEAR TEC

BOOK 4 | DESIGN CHALLENGES

sparkfun ELECTRONICS

N EXTENSION

WHAT IS WEARTEC?

The Nebraska 4-H Wearable Technology (WearTec) is a National Science Foundation (NSF) funded project focused on activities related to wearable technologies. The goals of the project are to develop an intervention that focuses on solving real world problems and practicing the engineering design process while immersed in the innovative area of wearable technologies.

This curriculum was developed for youth in grades 4 to 6 to teach engineering design, computer programming, basic circuitry and sewing. The curriculum has been designed to encourage connections between in-school and out-of-school time instruction. Wearable technologies provide a powerful, personally expressive tool for use in both formal and informal learning environments.

These technologies bring together engineering and computing to make computers, which are "soft, colorful, approachable, and beautiful". Wearables offer a window into the world of technology enabling students to develop technology literacy in a more inclusive manner than game development or educational robotics. The electrical components of wearable technologies expose the connections and circuitry that is normally hidden from students. Students can literally see the connections between the electrical and technical components when creating circuits with conductive thread or copper tape. This provides a tangible artifact that brings relevant theories from physics, engineering, and computing to life. Crafting and aesthetics are key components of designing wearable technologies further increasing the attractiveness and accessibility to students.

Creating wearable technologies provides an outlet for personal expression as the end product can be worn. This has particular power in attracting female students who tend to be more interested in aesthetics, textile design and social connections than their male counterparts.

This material is based upon work supported by the National Science Foundation under Grant No. ITEST #1433822 awarded to the University of Nebraska-Lincoln. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Contact Information

Bradley Barker
Principal Investigator
bbarker1@unl.edu

Neal Grandgenett
Co-Principal Investigator
ngrandgenett@unomaha.edu

Jennifer Keshwani
Co-Principal Investigator
jmelander7@unl.edu

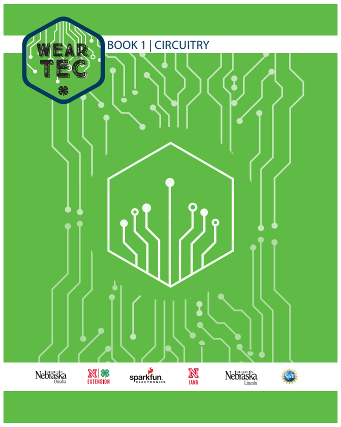
Carl Nelson
Co-Principal Investigator
cnelson5@unl.edu

Gwen Nugent
Co-Principal Investigator
gnugent1@unl.edu

Ann O'Connor
Instructional Designer
aoconnor2@unl.edu

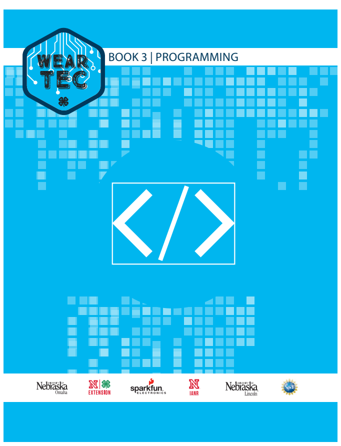
Dagen Valentine
dvalentine2@unl.edu

WEARTEC CURRICULUM

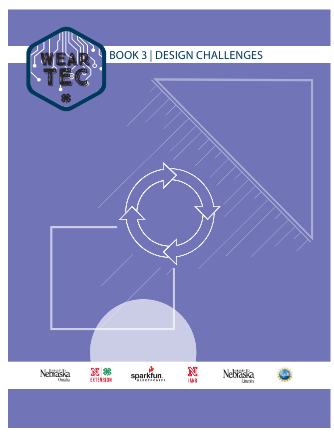


BOOK 1 | CIRCUITRY

BOOK 2 | SEWING & MICROCONTROLLERS



BOOK 3 | PROGRAMMING



BOOK 4 | DESIGN CHALLENGES

TABLE OF CONTENTS

ENGINEERING DESIGN PROCESS

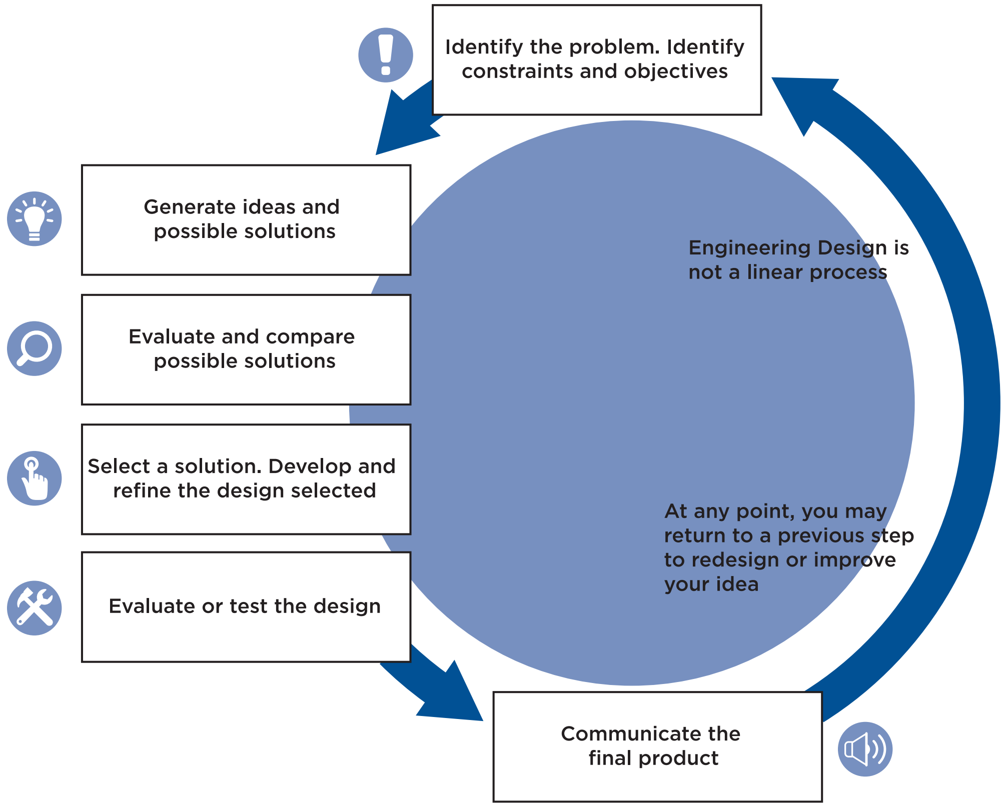
Engineering Design Process (EDP) Overview

The engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times the solution involves designing a product that meets certain criteria and/or accomplishes a certain task. This process is different from the steps of the scientific method. While scientists study how nature works, engineers create new things, such as products, websites, environments, and experiences. Because engineers and scientists have different objectives, they follow different processes in their work. Scientists perform experiments using the scientific method; whereas, engineers follow the creativity-based engineering design process.

It's important to note that the EDP is flexible. There are as many variations of the model as there are engineers. With WearTec, students work through all six steps, but in real life, engineers often work on just one or two steps, then pass their work to another team.

Note that the EDP is non-linear. At any point, you may return to a previous step to redesign or improve your idea. **The EDP is reliant on the iterative process.** An iterative process is a process for reaching a desired result by means of a repeated cycle of operations (steps). The cycle should come closer to the desired result as the number of iterations increase. For example, after you improve your design once, you may want to begin all over again to refine your technology. You can use the EDP again and again!

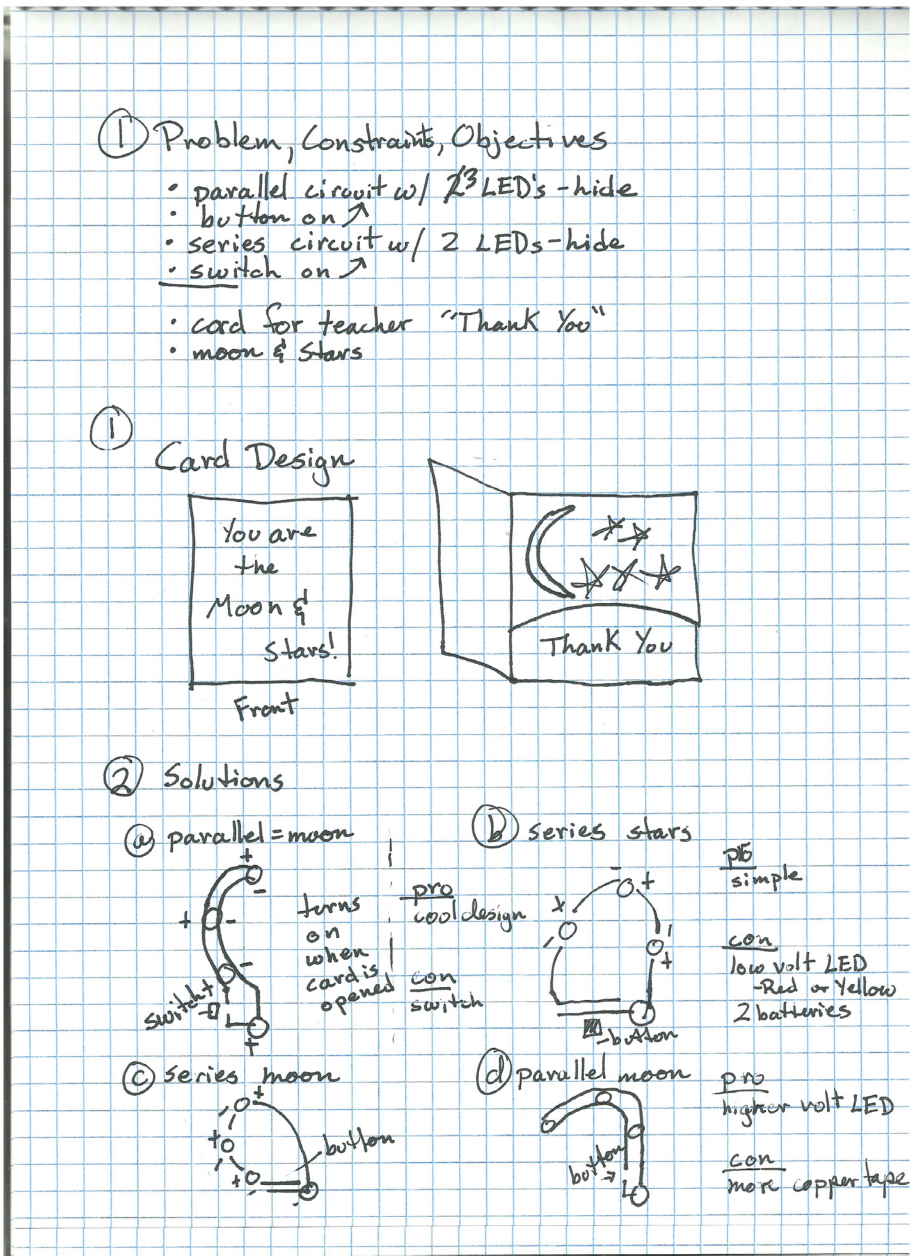
In the WearTec curriculum you will notice symbols to represent each step in the EDP. These symbols are intended to help you identify each steps of the EDP and bring about the thinking associated with that step. The symbols can be used for short-hand inclusion in the engineering journal. A one-page printable format of the EDP is found at Appendix A.



EDP Journal Explanation and Use Guidelines

An engineering design process (EDP) journal is a working document. It is where ideas, sketches, and student reflections are recorded. It is a journal the students will use to document their learning and discovery through drawings, data, and record keeping. The journals should show thought behind strategy, designs, innovations, and organization. The journals are evidence of how students have grown and overcome obstacles in their designs. Each step of the engineering design process should have a corresponding journal entry.

Professional engineers use design notebooks to record their thoughts and learn from their experiences. By using a design journal, students are engaging with real-life tools and experiences important for skill and interest development.



Key elements to incorporate in Engineering Journal

- Use dates
- Indicate step of engineering design process
- Write notes on inclusion or exclusion of ideas
- List pros and cons of solutions
- Describe reasoning for iterations

WHAT YOU'LL NEED

Electronic Components

* Components needed for each student/participant

Sparkfun supplies*	***Total***
Simple Board	1
Lily LED	5
Light Sensor or temperature sensor	1
buzzer, tri-color LED, or vibe board	1
Conductive Thread	1

General Supplies

Floss
Fabric
String/elastic
Drawing supplies
Other art supplies

CHALLENGE INTRO

ACTIVITY OVERVIEW

This lesson introduces a design challenge using a temperature sensor or light sensor. Additional components include, LEDs and a tri-color LED, vibe board, and buzzer.

Established Standards

NGSS standards

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Nebraska State Standards

- SC8.1.3 Students will solve a design problem which involves one or two science concepts.
- SC8.1.3.a Identify problems for technical design.
- SC8.1.3.b Design a solution or product.
- SC8.1.3.c Implement the proposed design.
- SC8.1.3.d Evaluate completed technological designs or products.
- SC8.1.3.e Communicate the process of technical design.
- SC8.1.3.h Recognize that solutions have intended and unintended consequences.

Learning Objectives:

Students will be able to:

- apply the engineering design process in solving a design problem
- research their problem to determine possible solutions
- design a solution to their problem
- build a prototype of their solution

Supplies needed for each student:

- LilyPad Arduino Simple board
- 4-5 LEDs
- Light Sensor or temperature sensor
- 1 RGB LED (optional)
- Vibe board (optional)
- Buzzer (optional)
- Button (optional)
- Switch (optional)
- Alligator clip test leads
- Felt Pieces or fabric
- Snaps (optional)
- Craft Glue
- Embroidery Floss
- Conductive thread
- Needle
- Stickpins (optional)
- Scissors
- Marking pencil
- FTDI breakout board
- Computer with Arduino programming software
- USB cable

Before the Project:

- Gather materials, journal
- Provide journals

Project Outline	*Time*
Design Problem Introduction	15 minutes
Identify Constraints and Objectives	30 minutes

Vocabulary

Design Thinking - creative resolution of problems and creation of solutions, with the intent of an improved future result

Research - investigation into and study of materials and sources in order to establish facts and reach new conclusions

DESIGN CHALLENGE ORDER

All steps should be recorded in engineering design notebook

- ☐ Identify Problem and Constraints.
  a. research
- ☐ Generate many possible ideas to solve the problem.
  a. research
- ☐ Choose ONE solution to develop
- ☐ Code and test on development board.
  a. combine code from programming lessons
- ☐ Design aesthetics.
- ☐ Design your circuit.
  a. sensor pin into Analog (A) i.e. A5
  b. positive pin of sensor pin into programmable pins
  c. programmable pins (the positives)
  d. negative trace (versatile)
- ☐ Change pin numbers in code for project.
  e. program negative or positive pins if applicable
- ☐ Upload code to project simple board.
- ☐ Sew circuitry
- ☐ Complete aesthetic Design
- ☐ Evaluate & Test design
- ☐ Communicate the project

INTRODUCE DESIGN PROBLEMS

These design problems could be introduced in several different ways depending on how you would like to set this lesson up and the time that you have to complete it. There are different design problem options that you can choose from or allow your students to choose from. Some of the design problems will involve more research than others to give students more exposure to steps one and two of the engineering design process. Other problems are designed to work more on steps 3-4 of the process.

If you are selecting the design problem for the class, then I would recommend printing out the design challenge and cutting them apart so that each student has a copy of the problem. Then students can glue these into their journals and refer to them as they work. These can be glued in the book 4 design notebooks on the page after the post-test.

If you would like to have your students select their own design problem, you can refer to the Appendix in this curriculum for a printable sheet of the design problems. You can allow your students to select from all of them or some of them and print them out, the ones you want.

The following are the design problems:

Temperature

- develop an e-textile that will warn the wearer when body temperature is changing too much to produce hypothermia or heat exhaustion
- design something that tells me what I want to wear each day

Light sensors

- develop a device called a sunsetometer; your device should show how close the sun is to setting
- design something that gives me a countdown to bedtime for someone based on the setting sun

The constraints of materials:

- Simple board
- 4-5 LEDs
- Light OR Temperature Sensor
- Tri-color LED OR buzzer OR vibe board

Identifying Constraints and Objectives

Once students have received or chosen their design problems they should record this in their engineering design notebook.

After the problem has been presented, students can work together in teams to work on their designs. If students work in teams they should still each do a project so that each student gets to design, program and sew their circuits to review all the things they have learned so far. If each team comes up with a group of solutions for their problem, then everyone in the group could use the same solution, but make slight modifications to suit what they want. However, the students could each try a different solution and see which one they think solves their problem the best. You could also allow students to develop their own criteria as to how they would evaluate their designs, but the time this would take is not included in the time estimates for this lesson.

Each student can also work alone on their designs. However, engineers often work in teams, especially to come up with ideas and brainstorm solutions. Students could also work together on the research for their designs. This might be helpful if you want to decrease the amount of time students spend researching so they have more time to work on their projects. Students could divide up their research questions and then share their findings with the rest of their group.