Driving Question:
What can we design to address the problem that matters most to us and our communities?

Overview
Engineering for sustainable communities relies on iterative decision making that includes perspectives of community stakeholders. This iterative process changes as new social and technological dimensions are (re)defined when collecting ethnographic data and during the analysis process.

However, before design iterations begin, we need to focus on the technological dimensions that are needed to create the design such as power requirements, and circuitry of the design. Social dimensions will drive the next set of design iterations as the design need to meet specific community needs. At the end of this lesson, students should develop an understanding that community feedback is important in the iterative design process.

Lesson Standards

| MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment | MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design is achieved |

Objective
Students will be able to design both the social and technical specifications of initial design ideas using an engineering for sustainable communities approach.

I Can Statement
I will sketch up both the social and technical specifications of my engineering design using an engineering for sustainable communities approach.

Materials
- Print outs of survey data
- Poster paper for designs
- Battery
- Lights
- Various electric small appliances
- Apples or 100 g masses

Equipment
- Solar panel
- Lamp
- Piezoelectric pads
- Handcrank
Background for Teachers
In this lesson, students will prepare their initial sketch up for their engineering design. It is useful to let students know that their designs will be altered multiple times based on interviews, and test done along the design process to optimize the sketch up.

These revisions should be done in the original sketch up by using different colors to note new revisions at each phase. Below are examples of how the Woot Wall sketch up was optimized.

**Phase I**

![Phase I Sketch Up]

This is the level of detail you are looking for in this lesson.

**Phase II**

Based on interviews, students will improve their design before they build. This helps them to create working prototypes and understand community desires more.

**Phase III**

Final revisions are made based on tests designed by the students. You can notice there have been multiple changes to the initial design and more details have been added.
Lesson Sequence

I. Modeling Sketch up A and B

II. Small groups sketch ups A and B

I. Modeling sketch up A and B

A. Begin class by explaining that today’s goal is to create a sketch up of the design solution to the problem each group decides to address.

B. Sketch up A: Model how to choose a problem and practical solution with the Woot Wall example. Using an example problem space chart about class morale.

Look at the problem space charts and ask out loud, “What problem seems to matter most to my community?”, “Which problem do I want to solve most? Why?” Answer those questions for yourself.

Ex. “I think I want to address the problem of low class morale. It seems to matter to both students and teachers. It matters a lot to me because my class is important to me, and I want everyone to feel part of a happy community. Also, both adults and kids think this is a problem.”

Emphasize that the problem that the groups share needs to have a technical solution not just a social solution.

TIP

• For groupings, consider how you can support individual students to have agency. Are there students who tend to dominate conversations and those who do not? How can you shift discourse patterns to support all students in your classroom?

C. Complete the hand-out for sketch up A by completing the hand-out below while talking out your answers with your students:

• I am going to address the problem of low class morale, and this is my rationale 1) I know that students do lots of great things that do not get noticed all the time, 2) 60% of students said class morale was a problem, 3) 50% of adults in the school said class morale was a problem.

• This is how I want to address this solution: We are going to create a light up bulletin board that uses a hand-crank generator. We will put up students’ accomplishments in the middles of the bulletin board. When members of our class see students do really great things, we will light up the board using the hand crank. We will call it a Woot Wall.

My idea is practical because it:

• Uses an available renewable energy source (piezoelectric pad, solar panel, hand crank generator): hand crank generator
• Uses these available materials: copper tape, 16 LED lights, bulletin board, hand crank generator, duct tape
• Does it make something light up: yes
D. Sketch up B (the actual drawing). Explain to students that after they complete sketch up A, they will share it with the teacher then draw their sketch up. First, you will sketch up the design. Model the initial design sketch up with the Woot Wall, by:

- Hanging up the sketch and explained the different parts of the sketch up:
- The sketch up shows how the design works.
- The materials needed.
- Sketching and labeling your design. Make sure to point out the different labels including the energy source, pathway, load and direction of electricity flow.
- Complete the technical specification sheet. Ask students for input in answering each question.
- Complete the social specification sheet. Ask students for input in answering each question.
- Check off each part of the sketch up checklist as you go. This checklist will help the groups work independently and move at their own pace.

E. Materials: Remind your students that they will need to use a green energy source (hand crank generator, piezoelectric pads or solar panels) to light up lights. They can also use other supplies available in the classroom like cardboard, tape, various craft supplies, parts of the actual classroom (bulletin boards, walls, etc…) that you are comfortable with and so forth.

- Invite each group to visit a table with supplies laid out for them to explore. Have the technical equipment and materials to test out. This will help them expand what types of solutions they may brainstorm and also help them stay within the constraints of the unit.

Note: We have budgeted one class period for this lesson with the understanding that this activity will take around fifteen minutes.

II. Solution Brainstorm

A. Have small groups decide what problem they want to solve.

- Have groups write their problem down and include three pieces of evidence that it is a problem. See hand-out.

III. As a whole class, discuss what problems the class wants to solve. Record the different problems. Discuss how their goals align with the class’ sustainability goals that they listed before administering the surveys. Revise the poster to reflect the goals.

A. Have students brainstorm solutions in their group for an engineering design that could solve the problem they defined using the materials available.

B. Model with the Woot Wall how to analyze both the social and technical specifications of the Woot Wall design in connection to the engineering for sustainable communities principles. See hand-out.

Have groups analyze both the social and technical specifications of their design in connection to the engineering for sustainable communities principles. See hand-out.
IV. Initial Design Sketch Up

A. Small groups complete their initial design sketch up by:

- Sketching and labeling their designs in groups on the large poster papers. Make sure to point out the different labels including the energy source, complete circuit and direction of electricity flow.
- Make sure that students put the dimensions on the sketch so that they are clear about the size of their design and related material needs.
- Complete the technical and social specification sheet.
- Have students complete steps #1-7 on their sketch up checklist, which they should attach to their sketch up. They will complete the other steps in lesson 7.
Group Members: ______________________________________________________

We are going to address the problems of ________________________________ and these are our reasons:

1) ____________________________ ________________________________________
2) ____________________________ ________________________________________
3) ____________________________ ________________________________________

This is how we want to solve it:

___________________________________________________________________________

Our idea is practical because:

• Who will use it? ____________________________
• How?
  _______________________________________________________________________
• It uses an available renewable energy source (piezoelectric pad, solar panel, hand crank generator):
  _______________________________________________________________________

Uses these available materials:

• Does it make something light up? ____________________________

Share this work with your teacher and get their signature: ____________________________
Group Members: ___________________________________________

### Sketch-Up Checklist

<table>
<thead>
<tr>
<th>Task</th>
<th>Put a check here when completed</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We agreed on a problem to address.</td>
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<tr>
<td>2. We came up with an idea for a solution.</td>
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<tr>
<td>3. We checked our idea with our teacher.</td>
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<tr>
<td>4. We drew our design.</td>
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<tr>
<td>5. We labeled the energy source____, the pathway _____.</td>
<td></td>
<td></td>
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<tr>
<td>direction of electricity flow ____., and lights _____.</td>
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<td></td>
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<tr>
<td>6. We listed all of the materials we need.</td>
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<tr>
<td>7. We checked our design plan with a teacher.</td>
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<tr>
<td>8. Wrote 4 questions to be answered by the community experts.</td>
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<tr>
<td>9. Made changes to the sketch-up based on community feedback.</td>
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<tr>
<td>10. We checked our revised design plan with a teacher.</td>
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<tr>
<td>11. Completed prototype plan.</td>
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</tbody>
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Follow these tips for group success:

- **Groups are Gold:** Stay with your group, and only leave them with the purpose of helping your group.
- **Two then me:** Ask for help from two students before you ask the teacher for help.
- **Everyone matters:** Each group member contributes and is cared for in their group.
Miembros del grupo: ____________________________________________________

Vamos a abordar los problemas de ________________________________ por las siguientes razones:
1) ________________________________________________________________.
2) ________________________________________________________________.
3) ________________________________________________________________.

Queremos resolverlo así:

Nuestra idea es práctica porque:

• ¿Quién lo usará? ______________________________
• ¿Cómo?

_______________________________________________________________

Usa una fuente de energía removable disponible (almohadilla piezeléctrica, panel solar, generador movido a mano):

_______________________________________________________________

Usa los siguientes materiales:

• ¿Hace que otra cosa se encienda? _________________________________

Comparte este trabajo con tu maestro y obtén su firma: ________________________________
Miembros del grupo: ____________________________________________________________

### Lista de cotejo del diseño

<table>
<thead>
<tr>
<th>Tarea:</th>
<th>Haz una marca de cotejo al completar la tarea.</th>
<th>Fecha completada:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acordamos abordar un problema.</td>
<td></td>
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</tr>
<tr>
<td>2. Nos inventamos una idea para solucionarlo.</td>
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<tr>
<td>3. Corroboramos nuestra idea con el maestro.</td>
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<tr>
<td>4. Dibujamos nuestro diseño.</td>
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<tr>
<td>5. Identificamos la fuente de energía _______, el conductor _______, la dirección del flujo de electricidad _______ y las luces _______.</td>
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<tr>
<td>6. Hicimos una lista de todos los materiales que necesitaríamos.</td>
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</tr>
<tr>
<td>7. Revisamos nuestro plan de diseño con un maestro.</td>
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<tr>
<td>8. Escribimos cuatro preguntas para que las respondieran los expertos de la comunidad.</td>
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<tr>
<td>9. Hicimos cambios al diseño basados en los comentarios de la comunidad.</td>
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</tr>
<tr>
<td>10. Revisamos nuestro plan de diseño modificado con un maestro.</td>
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<tr>
<td>11. Completamos el plan del prototipo.</td>
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</tbody>
</table>

**Sigue los siguientes consejos para tener éxito como grupo:**

- **Los grupos son un tesoro:** Quédate con tu grupo y no te quites, al menos que sea para ayudar al grupo.
- **Dos, después yo:** Pide ayuda de otros dos estudiantes antes de pedirle ayuda al maestro.
- **Todo el mundo es importante:** Cada miembro del grupo contribuye y es importante para el grupo.