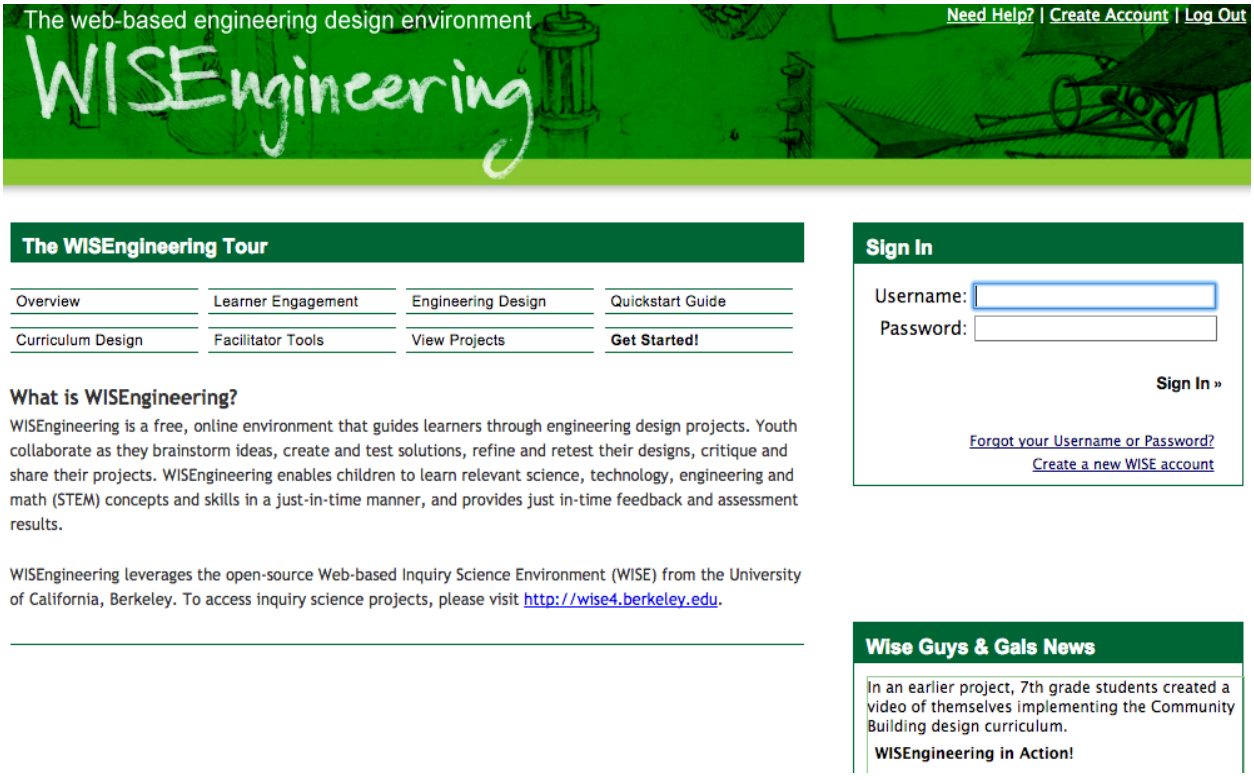
Advances in Wise Guys & Gals—Boys and Girls as WISEngineering STEM Learners

The project staff has been very busy from before the official start of the project to assure a smooth and productive year. There have been several initiatives we have undertaken to enhance the quality and the project. In this project, we work as a whole, supporting each other's primary efforts. Regarding terminology, the people who provide face-to-face instruction for the youth in the Boys & Girls Clubs (BGCs) are Learning Facilitators; the youth are Learners; and the project staff that provides professional development are Project Liaisons. The curriculum development team members create activities that are initiated by the whole team with the support of the Advisory Board. The Project Liaisons test out activities and report findings to the Curriculum Team for incorporation in the final activity design. A similar process occurs with the software development, led by co-PI Xiang Fu. The whole team provides feedback to evolving and improving the WISEngineering learning environment. An important feature of Wise Guys & Gals (WGG) is that the Learning Facilitators are not content providers, but rather provide a safe learning environment for the activity to occur. The WISEngineering environment provides all the content information and the assessment; and because it provides automated assessment, we are able to track youth learning and participation.

Activity Development

Signing in requires a Facilitator to provide youth with information about the course; here is the login page:

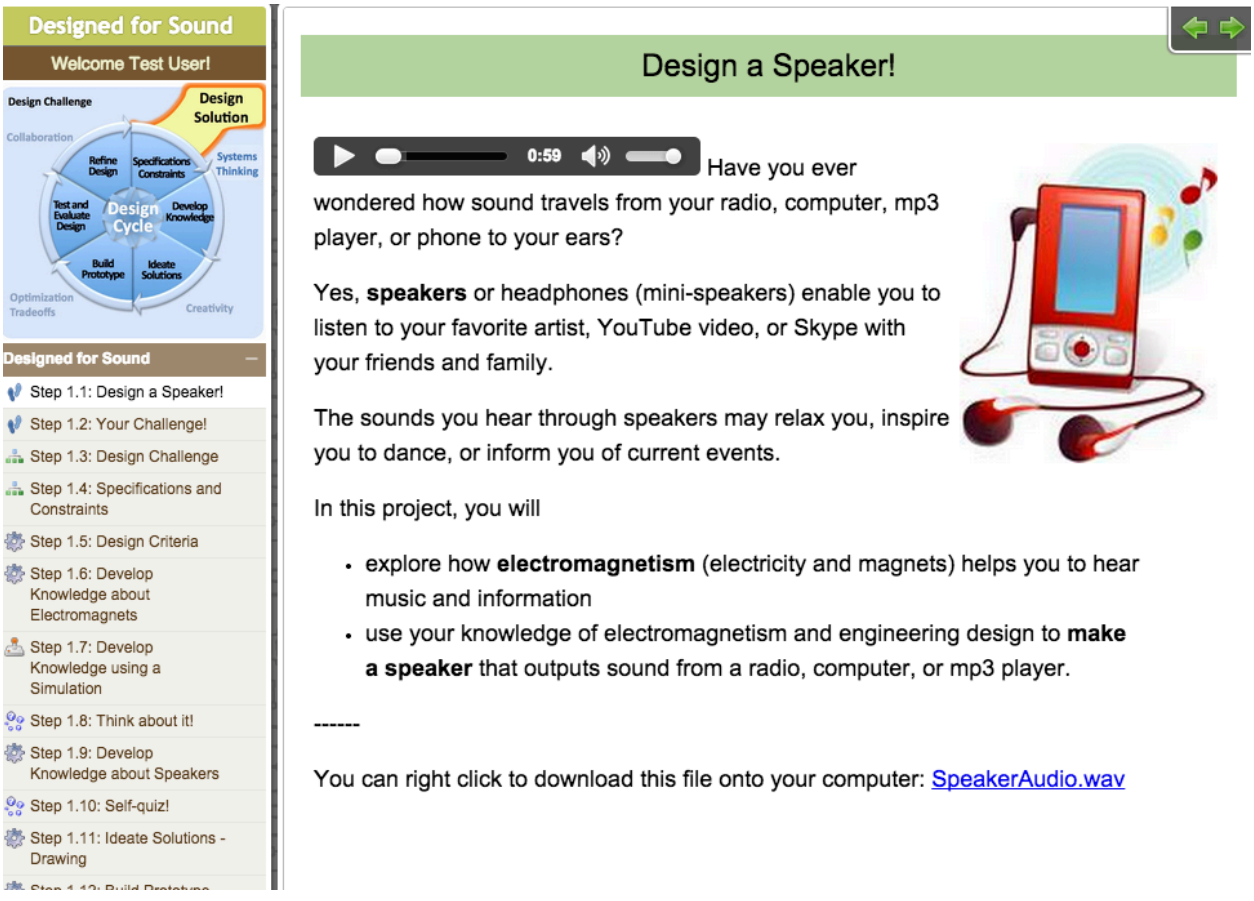


The project team decided that an easy on ramp was needed to introduce BGCs to WISEngineering. The first experience was for youth to learn to log in and create their own avatar through the High Five activity, where after youth successfully login, they create their own avatar and give the Facilitator a 'high five.' This proved to be a very engaging activity and encouraged continuing participation.

As the activities evolved, we refined the framework, paying attention to the constraints of limited time—designing for 75 minutes. In terms of STEM careers, each activity is framed in terms of an engineering discipline (e.g. Mechanical, Electrical, Civil), and a video clip discusses challenges engineers within the discipline encounter. The activities are based on the informed engineering design pedagogy, where Knowledge and Skill Builders (KSBs) provide the scaffolding information about the challenge so the youth understand why and what they are doing. We mined the resources of teachengineering.org at the suggestion of Advisory Board member, Dr. Jacquelyn Sullivan, lead architect for the teachengineering project and developed additional activities to share with them.

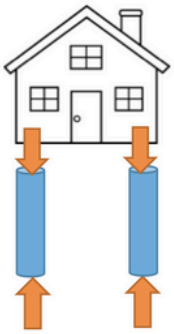
Short Activity Snapshots


Prosthetic Challenge
Welcome Test User!
Design Challenge
Design Solution
Collaboration
Systems Thinking
Refine Design
Specifications Constraints
Test and Evaluate Design
Design Cycle
Develop Knowledge
Build Prototype
Ideate Solutions
Optimization Tradeoffs
Creativity
Prosthetics Challenge
Step 1.1: Design an artificial leg!
Step 1.2: What is Engineering Design?
Step 1.3: Design Challenge
Step 1.4: Specifications and Constraints
Step 1.5: Design Criteria
Step 1.6: Develop
Design an artificial leg!
Many people require replacement body parts, like soldiers or other people who might lose limbs because of injury or disease. One aspect of biomedical engineering is designing and researching new and better prostheses (replacement body parts). Biomedical engineers continually improve the strength, durability, longevity and lifelikeness of prosthetics so amputees can lead full lives.
Your challenge is to make a stable and comfortable model of a prosthetic leg that you will be able to wear and walk around in, like the picture on the right.
You will have limited time and materials for constructing your prosthetic leg.


Designed for Sound
Welcome Test User!
Design Challenge
Design Solution
Collaboration
Systems Thinking
Refine Design
Specifications Constraints
Test and Evaluate Design
Design Cycle
Develop Knowledge
Build Prototype
Ideate Solutions
Optimization Tradeoffs
Creativity
Designed for Sound
Step 1.1: Design a Speaker!
Step 1.2: Your Challenge!
Step 1.3: Design Challenge
Step 1.4: Specifications and Constraints
Step 1.5: Design Criteria
Step 1.6: Develop Knowledge about Electromagnets
Step 1.7: Develop Knowledge using a Simulation
Step 1.8: Think about it!
Step 1.9: Develop Knowledge about Speakers
Step 1.10: Self-quiz!
Step 1.11: Ideate Solutions - Drawing
Design a Speaker!
0:59
Have you ever wondered how sound travels from your radio, computer, mp3 player, or phone to your ears?
Yes, speakers or headphones (mini-speakers) enable you to listen to your favorite artist, YouTube video, or Skype with your friends and family.
The sounds you hear through speakers may relax you, inspire you to dance, or inform you of current events.
In this project, you will
explore how electromagnetism (electricity and magnets) helps you to hear music and information
use your knowledge of electromagnetism and engineering design to make a speaker that outputs sound from a radio, computer, or mp3 player.

You can right click to download this file onto your computer: SpeakerAudio.wav

Need Some Support



One type of force civil engineers are concerned about is compression. The weight of a structure pushes down on the ground. The ground pushes back on the building. What they build must be strong enough to withstand this "squeezing" force.

Your **challenge** is to make a strong and stable model of the foundation for a structure that can support weight (5 textbooks) for at least 15 seconds at least 5 inches above the surface.

In the figure on the upper left of your screen, you can see steps in an engineering design cycle. It is a cycle, so you can always go back to any step and revise your designs, learn more about the problem, or think of more solutions to your problem. Just click where you want to go!

You will have **limited time and materials** for constructing your structure. You can use the following: 10 (3 x 5 inch) index cards, 2 pieces of paper and 12 inches of masking tape. You will have available rulers, scissors and paper for sketching.

Hover above it all!

Have you ever tried to run through water in a pool or river? Is it easier or harder to move than when you run through just air? Since the late 1800s **mechanical engineers** have been experimenting with how to reduce friction to make vehicles move efficiently. In the mid 1950s they developed vehicles that glide on a bed of air. These are called hovercraft or air-cushion vehicles. Hovercraft have been used in disaster relief, to transport people, and for the military. They can be used over land, water, or ice.

Is All Slime Engineering Equally?

You're hired!

In the past few months, Slime Inc. has become overwhelmed with an increase in orders for our flagship product — SlimeY, a playful polymer!

To meet the demand, we have hired you as a chemical engineer to create and test SlimeY.

In this project, you will work on the production team to

- make SlimeY using our secret recipe, which we share later 🙂.
- test our slime to make sure we consistently ship a high-quality product to our customers.

Filtering Yucky Water

Creating clean water is very important; there are many parts of the world, and in this country, where the water quality is not good; not suitable for drinking. Clean water is essential for a healthy life. Environmental Engineers can make a difference by turning yucky water into drinkable water by designing water purification systems.

Your challenge is to work with a team member as Environmental Engineers to remove the smell and color from the yucky water sample your facilitator gives you. You will be given the following materials:

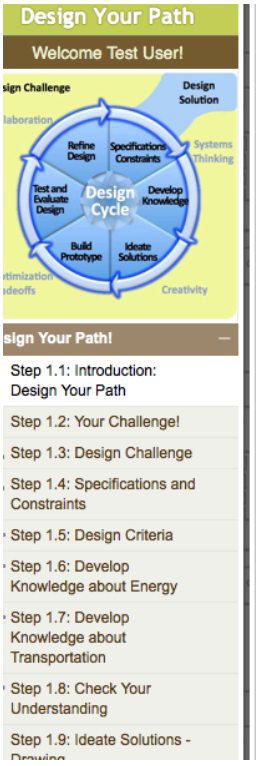
- 1/2 cup Zeolite - $1.00
- 1/2 cup Activated Charcoal - $2.00
- 2 cups Sand - $0.75
- 0.5 liter water bottle

Your filter will be **judged** by how effectively it cleans the water for the cost of the materials:

Filter rating = Smell x Clarity x Cost

You want your design to have the **lowest** filter rating.

Design Your Path



Have you ever traveled down a winding road or path?

- How did it feel — fast, scary, or safe?
- Why do you think the path was winding instead of straight?
- How do these paths affect how far and how long an object travels?

In this project, you will put on your transportation engineering hat ( )to

- learn how different paths help safely transport people and objects from high to low locations
- investigate transportation tradeoffs related to time, distance, and safety
- design and test a transport model that moves an object form high to low locations.

Lombard Street in San Francisco

Tianan Mountain Winding Road, China

Dance Party!

Everything from cell phones, videogames, and even your electricity depends on software engineering. Software Engineers make a difference by designing programs that tell computers what to do, resulting in videogames, cell phones, and even how power gets to your house or school.

Your challenge is to work as a software engineer to make a program for a dance party. You are going to be working in a programming environment called Scratch. Your program needs to:

- Have one dancer do at least two dance moves
- Play two different instruments as part of the dance move
- Have your dancer say something by pressing a key

Magical Mirrors—Kaleidoscope Design

While kaleidoscopes seem almost magical, they are governed by the rules of the physical world that relate to light.

Kaleidoscopes were invented by Sir David Brewster. Their name comes from three Greek words:

kalos "beautiful"
eidos "form/shape" and
skopeo "to look at"

In this activity, you will work to as optical engineers (engineers that develop technologies related to the science of light) and artists as you explore how to design a kaleidoscope – a device that "makes beautiful forms you can look at." Kaleidoscopes use reflective materials to create a grid of duplicate images, such as these: