

## SIEMENS STEM DAY ACTIVITY

# PROSTHETIC DESIGN

## OBJECTIVES

Students will be able to:

- **Research** the connection between the anatomy and physiology of various parts of the human body.
- **Design** a prosthesis that addresses a specific need.
- **Evaluate** computer aided designs presented by their peers.

## THIS LESSON FOCUSES ON Engineering Design Cycle

- Designing Solutions
- Creating or Prototyping
- Refine or Improve

## 21st Century Skills

- Collaboration
- Communication
- Critical Thinking
- Creativity

## OVERVIEW

Students will investigate the prosthetic industry as they explore the design and functionality of artificial limbs. In groups, students will receive a “patient card” that gives them the background information and specific needs for a fictional patient in need of a prosthesis. Students will research the anatomy of the assigned body part. Taking into consideration the jobs or activities of the patient, students will use online CAD design software to create a 2-D model of the prosthesis they think would be most successful for their patient. Groups will share their designs with their peers for feedback and revision.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

## MATERIALS

- Computers with internet access
- **Patient Cards** —one card per group
- CAD software

Note: Prior to engaging in this classroom activity, it is recommended that educators familiarize themselves and their students with CAD software. \*Free CAD software is available for educators and high school students from several online resources including:

- [Siemens PLM Solid Edge](#)
- [Google SketchUp](#)
- [Tinkercad](#)
- [Blender](#)

## HAVE YOU EVER WONDERED . . .

How are prosthetic devices designed?

## MAKE CONNECTIONS!

### How does this connect to students?

Whether it is congenital (from birth) or acquired, the loss of a limb or body part can have a devastating and limiting effect on a person's life and activities. Designing specialized and personalized prosthetic devices (artificial body parts) for people of all ages can allow them to continue to do the jobs, sports, and hobbies they enjoy.

### How does this connect to careers?

**Biomedical engineers** design biomedical equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems.

**Physical therapists** help injured or ill people improve their movement and manage their pain. These therapists are often an important part of rehabilitation, treatment, and prevention in patients with chronic conditions, illnesses, or injuries.

**Orthotists/Prosthetists** design and fabricate medical supportive devices and measure and fit patients for them. These devices include artificial limbs, braces, and other medical or surgical devices.

### How does this connect to our world?

The field of prosthetics is rapidly advancing as technology is becoming more and more integrated into the design of artificial limbs and body parts. As scientists and engineers continue to study and improve the link between the brain and the prosthesis, will we find that artificial body parts are more functional than natural ones?

## BLUEPRINT FOR DISCOVERY

1. Introduce students to prosthetic design by showing the following video: <https://youtu.be/7WaxyuS8vDc>
2. After viewing the video, ask students to think about the activities that they are involved in and brainstorm how a prosthesis could be designed to help people who are missing limbs do those things. How could a prosthetic hand be designed to help a person play the piano? How could a prosthetic leg enhance a person's ability to skateboard or ride a bike? Have students share their examples and ideas with the class.

3. Divide the class into 6 groups and provide each group with a **Patient Card**. Explain to students that they have been tasked to work as a team in the field of prosthetics and design an artificial limb or body part that will fulfill the needs of their patient.
4. Responding to the information on the card, students will use CAD software to design a 2-D model of a prosthesis for their patient. Groups should research the anatomy and physiology of the missing body part before beginning their design, considering the patient's jobs, hobbies, and activities. The students' goal should be to design a prosthesis that replaces or enhances the function of the missing body part.
5. Give groups and opportunity to display and share their models with the whole class, explaining how their design will meet the physical needs of the patient. Students should provide feedback on successes and areas for improvement for each design.

## TAKE ACTION!

Students can research and present how technology, such as bionics or ultrasound technology, could be applied to their model to improve its function.

## NATIONAL STANDARDS

Science

### Next Generation Science Standards

HS-ETS.1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS.1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-ETS.1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Technology Education	<p><b>3.</b> Knowledge Constructor—Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others: a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits, d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.</p> <p><b>6.</b> Creative Communicator—Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals: d. Students publish or present content that customizes the message and medium for their intended audiences.</p>
English Language Arts	<p>CCSS.ELA-LITERACY.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.</p>

## ADDITIONAL RESOURCES

<https://www.amputee-coalition.org/prosthetics-types-guide/>

<https://www.bls.gov/>

<http://www.opcareers.org/professionals/technicians/>

<https://medlineplus.gov/artificiallimbs.html>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1121287/>

## PATIENT INFORMATION CARD 1

### Patient Name

Konrad Hutton

### Gender

Male

### Age

23

### Job/Hobby/Activities

Michael is a former Olympic swimmer.

### Congenital or Acquired Amputee

Acquired

### History

Last year Michael was involved in an automobile accident; the injuries sustained in the accident required that his left leg be amputated below the knee.

### Prosthesis Required

Transtibial leg prosthesis

### Prosthesis Design Notes

Michael needs a prosthesis that will allow him to be able to continue to swim competitively.

**Patient Name**

Emilee Fox

**Gender**

Female

**Age**

35

**Job/Hobby/Activities**

Emilee is an infantry soldier in the United States Army.

**Congenital or Acquired Amputee**

Acquired

**History**

Emilee was involved in an explosion while on patrol as a part of her job duties with the military, damaging and requiring the amputation of her right leg.

**Prosthesis Required**

Transfemoral leg prosthesis

**Prosthesis Design Notes**

Emilee needs a prosthesis that will allow her to be able to fulfill her job duties as an infantry soldier, with the goal of returning to combat on the battlefield. Any design that can help or enhance her ability to do this is desired.

**Patient Name**

Griffin Alvarez

**Gender**

Male

**Age**

28

**Job/Hobby/Activities**

Griffin is a rock-climbing instructor and an amateur climber who has a goal of becoming a professional climber in the future.

**Congenital or Acquired Amputee**

Congenital

**History**

Griffin was born missing his left arm below the elbow.

**Prosthesis Required**

Transradial arm

**Prosthesis Design Notes**

Griffin is looking for a new, enhanced prosthesis that is designed to aid him in rock climbing.

**Patient Name**

Abbi Clegg

**Gender**

Female

**Age**

15

**Job/Hobby/Activities**

Abbi is a high school student and competitive softball player.

**Congenital or Acquired Amputee**

Acquired

**History**

Abbi contracted an infection in her right arm that required amputation above the elbow joint.

**Prosthesis Required**

Transhumeral arm prosthesis

**Prosthesis Design Notes**

Abbi would love a design that allows her to continue to play softball competitively.



**Patient Name**

Benny Traveno

**Gender**

Male

**Age**

17

**Job/Hobby/Activities**

Benny is a high school senior and has a goal of playing collegiate-level soccer.

**Congenital or Acquired Amputee**

Congenital

**History**

Benny was born without a left foot.

**Prosthesis Required**

Foot prosthesis

**Prosthesis Design Notes**

Benny is an excellent soccer player and would like an enhanced prosthesis that is designed to help him on the soccer field.

**Patient Name**

Kayleigh Acosta

**Gender**

Female

**Age**

24

**Job/Hobby/Activities**

Kayleigh works as an instructional aide at an elementary school but is pursuing a career in esports and would like to become a professional video gamer.

**Congenital or Acquired Amputee**

Congenital

**History**

Kayleigh was born missing her right thumb.

**Prosthesis Required**

Hand prosthesis

**Prosthesis Design Notes**

Kayleigh would like a prosthesis that is designed to allow and help her use a video game controller as well as be useful in her everyday life.