

SIEMENS STEM DAY ACTIVITY

LIFE CYCLE OF ENGINEERING

OBJECTIVES

Students will be able to:

- **Apply** a product life cycle audit for an item of their choice
- **Understand** that man-made products have a life cycle that can end by either being recycled or disposed which will impact the environment
- **Identify** ways to become more sustainable in everyday practices

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Refine or Improve
- Communicating Results

21st Century Skills

- Collaboration
- Critical Thinking

OVERVIEW

Students will use a life cycle audit to evaluate a product's environmental impact on society. Students will also propose a product design change in order to reduce the negative impacts on the environment. Students then determine the nature (type) of the product life cycle they conducted.

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

- **Life Cycle Audit** Handout, one per two students
- variety of man-made products

HAVE YOU EVER WONDERED . . .

Is there a better way to make and ship products that involves less waste?

MAKE CONNECTIONS!

How does this connect to students?

Products today are often used and then disposed of in ways that are harmful to the environment. By understanding a product life cycle, students can gain awareness of the environmental impacts of various products. Once informed, students can spread this knowledge to those around them to limit their negative impact on the environment.

How does this connect to careers?

A **Product Life Cycle Manager** is responsible for overseeing all aspects of a product's life span from conception to its end stage. This role is significant, because it follows the production of the product from introduction to growth to maturity to decline.

A **Product Designer** is responsible for designing, developing, and prototyping a product throughout each of its iterations. This role may involve creating new products or even redesigning existing problems to make improvements for quality and/or performance. Design skills and technical knowledge are requirements for this career.

How does this connect to our world?

A **Throwaway Society** refers to the excessive consumption of short-lived, disposable items even if the items still work or are still useful.

Reduce, Reuse, Recycle is a popular slogan that helps people think about the life cycle of products. Can you *reduce* by cutting back on the amount of trash you produce? Do you *reuse* items to lengthen their life span? How often do you recycle items so that materials can be reused in another form? These three R's have a positive impact on the environment.

BLUEPRINT FOR DISCOVERY

1. To hook students into this activity, share with them that the EPA estimates that "23% of landfill waste comes from packaging and containers."¹ Emphasize that this is almost 25% or one-fourth of landfill waste. In order to produce products with zero waste packaging, significant innovation is required.
2. Explain to students that today they are going to be conducting a product life cycle audit for a common household item. Instruct students to work with a partner to select one of the items on display.
3. Pass out the **Life Cycle Audit** Handout, one per two students. Ask the students to work with their partners to complete this activity.
4. Once everyone has completed the Life Cycle Audit, ask the partner sets to write their item and the audit's final total score on a post-it and place it on the board.

¹ <https://www.vox.com/the-goods/2019/1/28/18196057/zero-waste-plastic-pollution>

5. Next, ask for a few volunteers to rearrange the post-its and position the items from lowest to greatest total scores. As a group, take time to process this together. Does it make sense that certain items received lower audit scores? For the items earning high scores, can you identify why this would be?
6. Explain to the students there are different ways to perform a product life cycle assessment. Reference the images below the final score on the **Life Cycle Audit** Handout and ask which type of assessment they perform.
 - *Note:* Most of the students will have performed the cradle to cradle or the cradle to grave model, depending upon if their item was recycled or disposed.
7. After the group discussion, ask each partner set to join another partner set to form a small group of four students. Tell them to select an item (it does not need to be one of their initial items) that they will try to redesign either the item or its packaging. Encourage them to think about ways that the product of their choice could be improved to have less of an impact on the environment.
 - *Note:* Explain to the students that one way to tell if they have reduced the impact on the environment is to recalculate the life cycle audit for their new prototype.
8. Conclude the lesson by facilitating a discussion about what students have control over changing to help move us away from a throwaway society. Some ideas may include, but are not limited to: using reusable containers rather than disposable plastic bags, repurposing items rather than throwing them away (such as using old T-shirts as rags), etc.

TAKE ACTION!

- Students can compare like products and conduct a life cycle audit on the similar items. Students can create a campaign urging people to purchase the products with the smallest impact on the environment.

NATIONAL STANDARDS

Standards for Technology Literacy	<ul style="list-style-type: none"> • Standard 8: Students will develop an understanding of Design. This includes knowing about the attributes of design. • Standard 9: Students will develop an understanding of Design. This includes knowing about engineering design. • Standard 13: Students will develop Abilities for a Technological World. This includes becoming able to assess the impact of products and systems.
Next Generation Science Standards	<ul style="list-style-type: none"> • HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. • HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

What product are you evaluating? _____

<p>STEP 1</p> <p>Raw Material Acquisition is the gathering and transporting of materials in their purest state.</p>	<p>Raw Material Acquisition List each of the raw materials (such as wood, metal, plastic) in the product.</p>	
	Raw Material	Points
		1
		1
		1
		1
		1
	Total Points	

<p>STEP 2</p> <p>Material Processing is a series of steps needed to turn raw materials into a useful form for manufacturing.</p>	<p>Material Processing List any materials (such metal or plastic) in the product that must be processed before it can be manufactured.</p>	
	Material Type	Points
		1
		1
		1
		1
		1
	Total Points	

<p>STEP 3</p> <p>Manufacturing is the process of assembling the processed materials into the useful product.</p>	<p>Manufacturing List each of the parts needed to manufacture the product.</p>	
	Pieces in the Product	Points
		1
		1
		1
		1
		1
	Total Points	

<p>STEP 4</p> <p>Packaging includes any materials needed to package the product.</p>	<p>Raw Material Acquisition Check off all of the packaging materials needed for the product and then total up those points.</p>	
	Packaging	Points
	<input type="checkbox"/> Instruction sheet included	5
	<input type="checkbox"/> Paper / cardboard packaging	5
	<input type="checkbox"/> Plastic packaging	10
	<input type="checkbox"/> Styrofoam / rubber packaging	15
	<input type="checkbox"/> No packaging required	0
	Total Points	

<p>STEP 5</p> <p>Transportation involves moving the created product(s) to the location where they will be sold. This takes into account the fuel that is needed to produce the energy for transportation.</p>	<p>Transportation Check off all of the forms of transport needed for this product and then total up those points.</p>	
	Transportation	Points
	<input type="checkbox"/> Truck	1
	<input type="checkbox"/> Railway	1
	<input type="checkbox"/> Boat	1
	<input type="checkbox"/> Airplane	1
	<input type="checkbox"/> No transportation required	1
	Total Points	

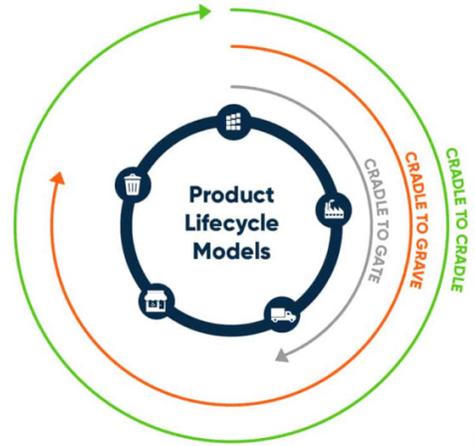
<p>STEP 6</p> <p>Product Life Span pertains to the amount of time that the product is used and reused.</p>	<p>Product Life Span Usage Check off the life span below that best suits this product.</p>	
	Life Span	Points
	<input type="checkbox"/> Used for over 10 years	5
	<input type="checkbox"/> Used for about 5 years	10
	<input type="checkbox"/> Used only once	15
	Total Points	

<p>STEP 7</p> <p>End Phase refers to what happens at the end of the product's life span.</p>	<p>End Phase Check off the life span below that best suits this product.</p>	
	End Phase	Points
	<input type="checkbox"/> All of the product can be recycled	0
	<input type="checkbox"/> Some parts can be recycled	10
	<input type="checkbox"/> Product must be disposed	20
Total Points		

<p>Life Cycle Audit Final Score Total up all of the point from Steps 1–7.</p>	<p>Total Points: _____</p>
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THREE TYPES OF PRODUCT LIFECYCLES REFERENCE GUIDE

1. Cradle to Cradle:
 - o Raw materials to recycling
2. Cradle to Grave:
 - o Raw materials to disposal
3. Cradle to Gate:
 - o Raw materials to manufacturing before transportation to the consumer



Works Cited

- http://www.susted.com/wordpress/content/teaching-life-cycle-assessment-with-sustainable-minds-a-discussion-with-examples-of-student-projects_2014_12/
- <https://research.cnr.ncsu.edu/sites/fbshortcourses/environmental-life-cycle-assessment-hands-on-workshop/>
- https://www.teachengineering.org/activities/view/cub_life_lesson01_activity1
- <https://www.smartsheet.com/product-life-cycle-management>
- <https://ecochain.com/knowledge/life-cycle-assessment-lca-guide/>