

SIEMENS STEM DAY ACTIVITY

TO ADD OR SUBTRACT?

OBJECTIVES

Students will be able to:

- **differentiate** between characteristics of additive and subtractive manufacturing.
- **apply** additive and subtractive techniques for manufacturing prototypes.

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Creating or Prototyping
- Communicating Results

21st Century Skills

- Collaboration
- Critical Thinking
- Creativity

OVERVIEW

People have been manufacturing things for centuries: from simple tools to complex robots. In this activity, students will watch a video to gain an understanding of the difference between additive and subtractive manufacturing. Then, using various materials, students will create prototypes using these two forms of manufacturing. Last, students will create a video of their prototype development and demonstrate the main differences between additive and subtractive manufacturing.

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

- Building blocks
- Styrofoam plates and blocks
- Plastic knives
- Other miscellaneous building materials
- *Additive vs. Subtractive Manufacturing* handout, one per student
- *Manufacturing Video-Viewer Feedback* form, two sheets per page
- Device with video recording capability
- Projection device to play videos

HAVE YOU EVER WONDERED . . .

How has innovative technology impacted the way things are made?

MAKE CONNECTIONS!

How does this connect to students?

Many students have exposure to **3D printers**. This is an excellent reference point for explaining the difference between additive and subtractive manufacturing.

Historically, manufacturing facilities have been thought of as dark factories packed full of assembly lines. To combat this notion, students need to be exposed to the technological impacts of **advanced manufacturing**.

How does this connect to careers?

Production operators are also known as machine operators. Generally, they are a part of the manufacturing process. They maintain machines, work with high-tech equipment, and adhere to safety guidelines to meet quality standards.

Designing, integrating, and improving manufacturing systems are the key responsibilities of a **manufacturing engineer**. It is important for a manufacturing engineer to seek ways to change and improve any and all parts of the manufacturing process.

How does this connect to our world?

Manufacturing is the center of our **world economy**. Every day products are designed and made using additive and subtractive manufacturing techniques.

Continued advancements in technology have a direct impact upon improvements within our world. In today's fast-moving marketplace, **agile manufacturing** uses additive processes to rapidly produce custom prototypes to form the models for products that meet consumers' needs.

BLUEPRINT FOR DISCOVERY

1. In order to spark students' interest in this activity, ask them to create a concept map of what they know about manufacturing. Pass out blank paper and provide time for students to brainstorm their ideas. Then, facilitate a conversation about the students' background knowledge. Quite often students think of dark, dingy factories with assembly line production. Students might have limited exposure to advanced manufacturing that involves the use of technology to improve products and processes.
2. As an introduction to additive and subtractive manufacturing, watch the video "18 Differences Between Additive and Subtracting Manufacturing Processes." <https://www.youtube.com/watch?v=9jc2K37wY94>
3. Upon completion of the video, pass out the *Additive vs. Subtractive Manufacturing* handout, one to each student. Ask them to complete this follow-up activity to help evaluate their understanding of additive and subtractive manufacturing. Once all students have completed their work, facilitate a discussion centered around these statements. To assist you, an answer key is provided.
4. Ask students to form small groups of 3–4. Explain that they are going to collaborate to use a variety of resources to build two prototypes that represent additive and subtractive manufacturing. After the students see the supply materials, instruct them to first individually brainstorm ideas, then collaborate with their group.

5. Provide each group with a variety of supplies listed in the materials section. Encourage the students to think creatively and apply the information that they learned about additive and subtractive manufacturing. Also, explain that after they create their two prototypes, they are to create a brief video that demonstrates the differences between the additive and subtractive manufacturing processes used in their prototypes.
6. Circulate as the students work to assist them as needed. Provide reminders for the amount of time remaining to help the students stay focused.
7. Conclude the lesson by facilitating a “viewing party” to watch each group’s video. Pass out the *Manufacturing Video-Viewer Feedback* form, one per student. As students see each other’s work, encourage them to provide compliments, comments, and/or constructive criticism on the feedback form.

TAKE ACTION!

Access the website Manufacture Your Future (<https://www.manufactureyourfuture.com/>) for a variety of resources that the Arconic Foundation and Howmet Aerospace Foundation created in conjunction with Discovery Education. There are a variety of at-home and in-school activities for students in grades 3–12. These resources will help you engage in activities and discover skills related to a variety of manufacturing opportunities.

NATIONAL STANDARDS

[Standards for Technology Literacy](#)

Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

Standard 19: Students will develop an understanding of The Designed World. This includes selecting and using manufacturing technologies.

ADDITIVE VS. SUBTRACTIVE MANUFACTURING

Read each statement and decide whether or not it applies to additive manufacturing or subtractive manufacturing. Circle your choices.

- Additive or Subtractive **1.** The standard operation process is 3D modeling.
- Additive or Subtractive **2.** Material is removed from the workpiece.
- Additive or Subtractive **3.** The material is removed from the top down.
- Additive or Subtractive **4.** Material wastage is minimal.
- Additive or Subtractive **5.** There is wear of tools, requiring their replacement.
- Additive or Subtractive **6.** The layer by layer approach requires fewer components.
- Additive or Subtractive **7.** Suitable primarily for materials with a low melting point.
- Additive or Subtractive **8.** There are a wide range of the type of materials used.
- Additive or Subtractive **9.** Rate of production is relatively quick.
- Additive or Subtractive **10.** A much smoother surface finish can be obtained.
- Additive or Subtractive **11.** Complex shapes with hollow cavities can be produced.
- Additive or Subtractive **12.** Product has increased durability and lifespan.
- Additive or Subtractive **13.** Best for custom-made designs.
- Additive or Subtractive **14.** Generally, more costly for production.
- Additive or Subtractive **15.** Skilled machine operator is more necessary.

ANSWER KEY

Read each statement and decide whether or not it applies to additive manufacturing or subtractive manufacturing. Circle your choices.

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- Additive or Subtractive 2. Material is removed from the workpiece.
- Additive or Subtractive 3. The material is removed from the top down.
- Additive or Subtractive 4. Material wastage is minimal.
- Additive or Subtractive 5. There is wear of tools, requiring their replacement.
- Additive or Subtractive 6. The layer by layer approach requires fewer components.
- Additive or Subtractive 7. Suitable primarily for materials with a low melting point.
- Additive or Subtractive 8. There are a wide range of the type of materials used.
- Additive or Subtractive 9. Rate of production is relatively quick.
- Additive or Subtractive 10. A much smoother surface finish can be obtained.
- Additive or Subtractive 11. Complex shapes with hollow cavities can be produced.
- Additive or Subtractive 12. Product has increased durability and lifespan.
- Additive or Subtractive 13. Best for custom-made designs.
- Additive or Subtractive 14. Generally, more costly for production.
- Additive or Subtractive 15. Skilled machine operator is more necessary.

MANUFACTURING VIDEO-VIEWER FEEDBACK

<p>3 Fun Facts:</p> <ul style="list-style-type: none">•••	<p>2 Questions:</p> <ul style="list-style-type: none">••
<p>1 “Aha” Moment:</p> <ul style="list-style-type: none">•	

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