

Student Self-Paced Module Educator Guide

All
GRADE
LEVELS

Overview

Suggested grade level

Although this module may be used for all grade levels, the content was designed for grades six through eight.

Hardware recommendation

Modern Manufacturing: Do You Have What It Makes? is accessible on any device, however, for optimal user experience it is recommended modules are accessed via desktop or tablet. This module is functional for use on mobile devices (iOS and Android).

Technical Specifications

While the **Modern Manufacturing: Do You Have What It Makes?** module will function in all browsers, including Internet Explorer, Safari, Chrome, and Firefox, browser load speeds will vary. For best performance, it is recommended that the most current version of your browser of choice is used when accessing the modules. Please note, connection speeds may be impacted by factors such as highly trafficked shared Wi-Fi access, public Wi-Fi, and accessing modules behind a firewall.

Module summary

Modern Manufacturing: Do You Have What It Makes? is an interactive self-paced module designed to help students learn about advanced manufacturing. In this module, students discover that advanced manufacturers work in teams to solve complex problems that improve processes, products, and people's lives. Students will investigate the applications of 3D printing, robotics, and computers, and consider how each of these technologies help manufacturers solve practical problems. Along the way, students will discover the relationship between advanced manufacturing careers and the products they build that shape the world. This student interactive module is designed to take approximately 40 minutes to complete.

Key learning objectives

- ◇ Technology helps humans solve practical problems.
- ◇ Advanced manufacturers rely on cutting edge technologies.
- ◇ Different technologies have benefits and tradeoffs.
- ◇ Many factors influence how products are manufactured.

Procedure

This module is designed to be flexible to meet the needs of many different learning environments.

One-to-one environment

Students using the module for independent, self-paced learning, can simply move through the module at their own pace.

Working in pairs or at centers

Students can take turns answering the questions throughout the module and in this guide, or they can work together to answer the questions. As students may have different reading levels, you will want to guide them to provide each group member with an opportunity to read and comprehend the information before moving on.

Class environment

If you are leading a group in a one-to-many environment, you can use a projector and screen or whiteboard to make the module the focus of instruction and discussion. Use the questions in this guide and a show of hands during each topic to gauge student comprehension.

Customized instruction

You may also choose to use discrete elements from the module (e.g., video, activity, assessment) that fit your timeframe and curriculum. The navigation at the upper left corner of the module can help you select specific parts once you have reviewed the module.



Background Information about the topic

The module is divided into three topics.

Topic 1

Advanced manufacturing allows us to create products that solve complex problems.

The first topic of the module teaches students about the types of products advanced manufacturers create. Advanced manufacturers design and innovate products and processes that impact all of our lives. These innovations are most likely inspired by a problem to solve. Problems may come from solving an inconvenience people have or an inefficiency in everyday processes. Problem-solving is critical when working in advanced manufacturing environments.

In order for advanced manufacturers to create a successful product, it needs to solve a problem. Advanced manufacturers work to make things more efficient and cheaper.

Topic 2

Advanced manufacturers work with cutting edge technologies.

The next topic of the module invites students to explore how advanced manufacturing is always changing. Especially as technology continues to advance, manufacturing techniques improve product design and development.

Technologies featured in this module include rapid prototyping, computers, and robotics. Rapid prototyping is an additive method in which parts are built layer by layer. One machine can produce any part that fits within its constraints and is appealing to advanced manufacturers in increasing automation, reliability, and reducing excess mass. Robots are machines that can be used alongside humans or instead of humans to do a job. Robotics can be programmed to complete tasks or controlled by a human. Advanced manufacturers use the strengths of both humans and robots to accomplish tasks. Finally, computers are used in product design and automation. They cover a wide scope of advanced manufacturing applications from computeraided design to analyzing data.

Topic 3

Advanced manufacturing shapes our world.

The final topic of the module shows students how advanced manufacturers enable us to have the exciting products we use every day and prepare for innovations of the future. The work of advanced manufacturers influences our lives every day. They help design and develop innovations that would be difficult to live without. Products designed and made by advanced manufacturers both influence and are influenced by society. They can cause cultural, social, economical, and political changes as well as provide safety and comfort.



Teaching the Module

Preparation

It is recommended that you complete the module yourself prior to sharing it with students. This will allow you to build your background knowledge and experience what students will experience so that you are better able to anticipate their reactions, questions, and misconceptions.

To help students navigate the module, you will need:

- ◇ a computer or other device with Internet access and web browser.

Key vocabulary

Advanced Manufacturing	The use of technology to improve products and processes.
Computer-Aided Design	The use of computers to optimize designs.
3-D Printers	A tool that builds up three-dimensional objects one layer at a time using plastics, metals, synthetics, food, and ceramics.
Robotics	A branch of technology that deals with the design, construction, operation, and application of robots.

Pre-module guiding questions

The following questions can be used to activate students' prior knowledge and extend their learning throughout the module.

- 1** What are three things that come to mind when you hear the word manufacturing?
- 2** What factors influence changes in advanced manufacturing?
- 3** What types of technologies are used in advanced manufacturing?

Discussion questions

Consider pausing at the end of each module topic to pose questions to students. Suggested questions and prompts are provided below.

Topic 1

Advanced manufacturing allows us to create products that solve complex problems. In this topic, students learn that advanced manufacturers design and innovate products and processes that impact all of our lives. They also discover that the first step in designing products that solve problems is often to identify the problems themselves.

Topic 1 questions:

- 1** What problems have you seen in your school or community that could be solved through engineering? Think of some challenges that you see around you, that you would like to solve. <**Possible answers:** How to reduce food waste, how to grow food or raise chickens in an urban environment, or a way to save space when storing bikes or skateboards at school.>
- 2** Engineers and scientists likely start with a problem or question they are interested in solving. What are ways you can discover potential problems? <**Possible answers:** immerse yourself in a situation to find missed opportunities, make observations, or interview people to share about challenges they face.>
- 3** What are experiences you have that are relevant to engineering? <**Possible answers:** Household examples could include identifying and solving problems when cleaning or when something breaks, improving functionality in the home, reducing energy costs, or constructing furniture. Recreational examples could include playing video games related to design and using technology when exercising.>

Topic 2

Cutting-edge technology is the most current techniques and technological devices that make our lives more convenient and fun. Modern manufacturing relies on cutting-edge technologies. In this topic, students explore how technologies have changed over time and how advanced manufacturers work with or alongside cutting-edge technologies every day.

Topic 2 questions:

- 1** How could rapid prototyping be used during extended space travel? <**Possible answers:** Repair broken items, create new designs, create custom parts, and solve unexpected challenges.>
- 2** Identify a technology that has evolved over time. What do you think may have influenced the changes? <**Possible answers:** Cell phones, cars, or headphones.>

Topic 3

Society plays an important role in the development and use of technology. In this topic, students investigate the relationship between advanced manufacturing and society's wants and needs.

Topic 3 questions:

- 1** Unmanned Aerial Vehicles, commonly known as drones, are essentially a flying robot. Drones can carry film cameras high in the sky for a wide range of shots and can deliver aid to difficult to access areas. What are other examples of how drones could be used now or in the future? <**Possible answers:** Farming, archeology, delivering food and packages, and covering the news.>
- 2** A Maker Faire is an opportunity to showcase people who enjoy making things and their projects. What are different things you might do now, or are interested in making, that you could share? <**Possible answers:** Math art, hobbies, engineering challenges, robotics, and science experiments.>



Assessing Student Learning

Post-test questions, answers, and scoring

Students answer assessment questions that measure their understanding of, and ability to apply, the module content. Each question is crafted to reveal complete understanding, partial understanding, or very little to no understanding of the standard being measured.

- 1** Society's role in the development and use of technology can best be described as _____.
- A. Influential. Society can drive the development and use of technology.
 - B. Stationary. Society does not impact development and use of technology.
 - C. Insignificant. Society has little impact development and use of technology.
 - D. Unproductive. Society does not provide any new ideas to impact development and use of technology.

Correct Answer: A

- 2** Economic, political, and cultural issues are influenced by the development of products that advanced manufacturers make. Which of the following is an example of how society has influenced a product?
- A. Poor audio quality on headphones led to the incorporation of noise cancellation technology.
 - B. Materials used for swimsuits in the Olympic games gave athletes a competitive edge.
 - C. The camera was developed to document and preserve an image for a lifetime.
 - D. Portable solar chargers were created to supply electricity to small electronics.

Correct Answer: C

- 3** Which of the following technologies is most likely used in advanced manufacturing to make a prototype or model?
- A. Computers and 3D printers
 - B. Robotics and unmanned vehicles
 - C. Computers and SmartPhones
 - D. Robotics and video cameras

Correct Answer: A

- 4** How would you describe the range of careers found in advanced manufacturing?
- A. There are limited opportunities.
 - B. There are a variety of opportunities.
 - C. Most of the work is physically demanding.
 - D. Most of the work is completed in factories.

Correct Answer: B



Extending Student Learning

The following activities are designed to help students continue their exploration of key concepts. They are intended to be used after students have completed the module.

- ◇ Innovators from around the world identified challenges for engineers in the 21st century. Invite students to explore the Grand Challenges for Engineering.
- ◇ Invite students to research one of the careers featured in the module using the [Bureau of Labor Statistics](#) and [STEM 101 Intro to Tomorrow's Jobs](#). Invite them to research the following information about the career they have chosen:
 - ◇ Projected job openings, if available
 - ◇ Current classes that could help with this career
 - ◇ Courses and after-school activities that could help build up skills and experiences for getting started in these careers

Related Resources for Students

An overview of how NASA uses advanced manufacturing.	http://www.nasa.gov/topics/technology/features/hi_tech_manufacturing.html#.V_KYHJMrKCQ
Provides examples of how The U.S. Department of Energy supports and funds manufacturing technologies.	http://energy.gov/eere/efficiency/advanced-manufacturing
Source of career guidance featuring many advanced manufacturing careers.	http://www.bls.gov/
Includes several examples of how technology drives exploration.	https://www.nasa.gov/topics/technology/manufacturing-materials-3d/index.html



National Education Standards

Materials and Resources are designed to align to the following education standards:

ITEEA:

- ◇ Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- ◇ Standard 5: Students will develop an understanding of the effects of technology on the environment.
- ◇ Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

Next Generation Science Standards:

Influence of Science, Engineering, and Technology on Society and the Natural World

- ◇ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- ◇ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)