



Lesson 1 - Manufacturing in the 21st Century

Grades 6-8

Essential Questions:

- How do humans affect the planet?
- How does technology influence society?
- What factors influence manufacturing processes and decisions?

Lesson Overview:

This lesson explores how manufacturing has changed over time and facilitates opportunities for students to engage with the exciting technologies used by engineers and designers. Students will investigate the history of manufacturing to evaluate the evolution of manufacturing processes. Students will explore how manufacturing careers have changed over time and how technology has changed the manufacturing process. Students will apply what they learned to design a plan for a driverless car. Advanced manufacturing today includes a wide range of skill-based and professional careers, all projected to grow in the next decade by the U.S. Department of Labor. Teachers in science courses can use this lesson to highlight these careers and emerging technologies in STEM-related fields. Engineering and technology education teachers can use this lesson to explore how technology and manufacturing have changed over time. They can also expand on the technologies highlighted -- 3-D printing and Augmented Reality -- by facilitating opportunities for students to apply these technologies in the classroom. 3-D printers are available inventory in popular supply stores and the software to develop AR applications can be found online. Social Studies teachers can emphasize the societal influences that have driven changes in manufacturing processes and technology.

Content Objectives:

- Understand and define advanced manufacturing.
- Evaluate how and why manufacturing has changed over time.
- Apply an understanding of modern manufacturing to design a new product.

National Curriculum Standards:

Standard F: Science in Personal and Social Perspectives. Students understand technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.

Time Frame:

3 class periods (45 minutes each)

[Day 1 Lesson Plan](#)

[Day 2 Lesson Plan](#)

[Day 3 Lesson Plan](#)

Background for the Teacher:

As Yogi Berra once said, “the future is no longer what it used to be.” The same could be said for the world of manufacturing. While once a field that involved making things by hand and then by assembly line, manufacturing is now being shaped by advances in 3-D printing, human-robot interactions, and extreme customization.

As manufacturing advances, opportunities for a highly-skilled workforce grow. Since January 2010, the manufacturing industry has added over 600,000 jobs. In fact, if the U.S. manufacturing sector was its own country, it would rank as the eighth-largest world economy. As jobs in this sector gain momentum, manufacturers are looking for highly-skilled production workers and engineers. Hearing the word manufacturing at one time might have made us think about dark factories crammed with people assembling products; it should now bring to mind images of innovation and collaboration with people working to build the future. This lesson will explore how manufacturing has changed over time and facilitate opportunities for students to engage with the exciting technologies used by engineers and designers.

According to the President’s Council of Advisors on Science and Technology Report to the President on Ensuring American Leadership in Advanced Manufacturing: Advanced Manufacturing is “a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies.”

The Public Perception Index has found that the U.S. public greatly supports the manufacturing industry. Research shows that the public would choose to have a manufacturing plant open in their region over other types of employers. President Obama has launched a partnership with industry and university leaders to identify and invest in new technologies that will make U.S. manufacturers more competitive. Modern manufacturing facilities are already producing advances in robotics, automation, and 3D printing.

Advanced manufacturing includes technologies such as rapid prototyping and 3D printing (both of which are explored in the lesson). Rapid prototyping, also commonly called 3D printing, is a method used to accelerate the innovation process. Traditional manufacturing techniques would carve objectives out of a larger block of material or cast in molds and dies. This type of additive manufacturing builds objects layer by layer. This technique can quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. This scale model can allow scientists and engineers to evaluate their design before production. For example, modified car or robot parts can be printed out of plastic before considering more durable or lightweight materials.

Looking into the future of manufacturing, Augmented Reality (AR) is already evolving to be a mainstream experience making a presence in publications, games, news, medicine, military, and advertising. The basic idea of augmented reality is to superimpose graphics, audio and other sensory enhancements over a real-world environment in real time. This is different from virtual reality, which creates a completely immersive, computer-generated environment. AR overlays on to the natural world as it exists. For example, the application Word Lens is an augmented reality app that translates text using your device's camera. Open the application, point your camera at the text you want to translate and your phone will overlay the translation.

Note: In the introductory activity, students are asked to identify words or phrases that describe or define manufacturing. While the activity is designed to prompt students to think about modern manufacturing, it's important to note that common definitions of manufacturing have five main characteristics. They include:

- Design and engineering (problem solving/what do make)
- Materials science (what to use)
- Process technology (how to make it)
- Quality (ways to make a difference)
- Management (supply chain, sales, process chain/writing instructions)

Background Information is from The Manufacturing Institute and the Society of Manufacturing Engineers

Materials:

Internet access

For each student:

- Several sticky notes
- [Agree & Disagree Statements](#)
- [Case Study: Advanced Manufacturing and Autonomous Cars](#)

For each small group:

- [Manufacturing Cards](#)
- [Question Cards](#)
- [Car Interior Images](#) (one set per group of students)
- [Optional AR Marker](#)
- Optional [AR Information](#) and [Additive Manufacturing Information](#)

Day 1

Engage (15 minutes) – What Is Manufacturing?

Teacher Note: Depending on students' previous knowledge about manufacturing, teachers can customize which step to start with in this section. If you need to support students with background about what manufacturing is, start with defining the word in Step 1 and then continue to Step 2. If students already know what manufacturing is, start with Step 2 to uncover misconceptions they might have.

1. Distribute sticky notes to students, and invite them to write five words or phrases that come to mind when they hear the word "manufacturing." Ask students to get into small groups to share and discuss their choices. Invite each group to select and explain three words that best describe manufacturing. After all groups have presented, invite students to draw conclusions about their impressions of manufacturing. Explain that these words will be revisited at the end of the lesson, and students will

have the opportunity to revise their descriptions. Direct students to post their sticky notes on a wall, to be revisited later in the lesson.

2. Distribute the **Agree & Disagree Statements** activity sheet to each student. Guide students to complete the **Agree & Disagree Statements** to help them uncover misconceptions they might have about manufacturing processes and products. Students will complete the statements first individually, and then discuss the statements with a partner. Circulate around the room to address any questions or to clarify statements or images. (Students might come in to this lesson with misconceptions about what manufacturing looks like today. This could include inferring the assembly line model is the only process to manufacture products, employees are not highly skilled, and/or technology is outdated. These misconceptions will be clarified throughout the lesson.)
3. Share the following video to help students begin to check their statements (<http://shows.howstuffworks.com/fwthinking-show/fwthinking-ep2-3d-printing-video.htm>). Guide students to capture their learning in the second column of the **Agree & Disagree Statements**. The video highlights 3-D printing, different types of engineers, and examples of manufactured products.

Note: Students will learn more about 3-D printing in this lesson as one example of an advanced manufacturing process. There are other examples of 3-D printing videos available on the web to continue to engage students in wanting to learn more about advanced manufacturing.

4. Guide students to review their **Agree & Disagree Statements** with a partner after they watch the video. Summarize by asking students what they think manufacturing is based on the statements they reviewed and the video. This will be further clarified in the explain section.

Explore (30 minutes) – How Has Manufacturing Changed Over Time?

Teacher Note: **Grouping Cards**, **Manufacturing Cards**, and **Question Cards** all need to be prepared ahead of time. Designate areas in the room for the students to meet to discuss their manufacturing questions by creating signs or table tents.

1. Introduce this section by explaining to students that humans have been manufacturing things for centuries, from simple tools to complex robots. Manufacturing is the process of converting raw materials into physical goods. We continuously look for ways to refine basic processes and build things faster and cheaper to meet consumer demand. Manufacturing changes in production and engineering over time based on changes in society, engineering, and technology.
2. Show students the two images of cell phones using **Then and Now: Cell Phones**. Ask:
 - What are the two images in the photographs? (cell phones)
 - What are the most significant differences between the 1987 cell phone and the 2012 cell phone? (size of device, antennas, flat screen buttons, color, display, camera)
 - Why do you think these changes were made? (smaller size for convenience, flat screen buttons to avoid 3D buttons being activated accidentally, internet and applications for navigation, camera for convenience of “all in one” device)

- What factors do you think have influenced these changes? (consumer demand, changes in technology, materials becoming less expensive). Summarize with students that the function has remained the same while the range of needs, uses, and manufacturing technologies have expanded.
3. Guide students to form groups of three so they can explore how manufacturing processes have changed over time. Distribute the **Manufacturing Cards**, cut and shuffled. Ask students to organize the cards from oldest to newest. (The anticipated timeline is as follows: craft production, industrial revolution, assembly line, industrial revolution, green manufacturing, rapid prototyping, and then augmented reality.)
 4. Ask students what they generally notice about how and why manufacturing has changed. They might note advancements in technology or human and robotic interactions. To further explore how manufacturing has changed over time, students will participate in a **Jigsaw** to discuss the following questions:
 1. What ways have the use of materials in manufacturing changed over time?
 2. How have manufacturing processes changed over time? Consider the role of humans.
 3. What influences changes in manufacturing?

Note: **Jigsaw** is a cooperative learning strategy that helps students work collaboratively to divide a task into manageable chunks. Each student is responsible for reading and summarizing part of the information on the topic. The student will present the summary of the information to the small group. Each student's part is essential, just like all pieces of a jigsaw puzzle are necessary for the complete picture.
 5. Distribute the **Question Cards** to each group of students. Each student in the group will select one of the three questions. Ask students to find the table tent or the sign in the room that matches the question they have. Depending on your class size you might have more than one station for each question. Limit each station to four or five students. Allow students 10-15 minutes to discuss their question in groups, referring to a set of the **Manufacturing Cards** for information. Remind students they will be responsible for teaching their home group (their group of three) about what they discussed. Circulate around the room to listen to group discussions and monitor that they are coming up with some of the anticipated responses bulleted below.
 1. What ways have the use of materials in manufacturing changed over time? (wood versus metals, physical models versus digital models)
 2. How have manufacturing processes changed over time? Consider the role of humans. (role of humans versus the role of machines, the number of employees)
 3. What influences changes in manufacturing? (raw materials available, changes in technology, cost, consumer demand)
 6. Guide students to return to their home groups of three and allow them 5-10 minutes to share their questions and what they learned. Ask students to refer to their **Manufacturing Cards** as evidence as they explain what they learned to their group.
 7. Summarize by asking students to review their **Agree & Disagree Statements** (from the Engage section) with their group to continue filling out the second column.

Day 2

Explain (25 minutes) – What Does Manufacturing Look Like Today?

1. Remind students that manufacturing changes in processes and production over time are based on changes in society, engineering, and technology. Explain to students that they will be taking a closer look at what manufacturing looks like today based on those factors.
2. Distribute the [*Manufacturing the Future: Autonomous Cars*](#) reading to explore a societal need driving changes in manufacturing. Explain to students that they will construct a definition of “Advanced Manufacturing” as they read the text. Clarify to students that they will fill out the chart to extract information to formulate their definition at the end. (Example definition: Advanced manufacturing is the use of innovative technology to improve products or processes. Advanced manufacturing improves existing or creates entirely new materials, products, and processes via the use of science, engineering, and information technologies; high-precision tools and methods; a high-performance workforce; and innovative business or organizational models.)
3. Summarize with students that concerns over human error driving a car have influenced manufacturing processes by creating a need to develop cars that do need a human driver.
4. Show the video **Manufacturing Plants: Then and Now (4:58)** to explore a change in engineering: using robotics. Prior to viewing, display the following questions on the board and encourage students to consider them while they watch:
 - What do you notice about the number of people employed in the factory over time? (fewer people were employed over time)
 - What does manufacturing look like today? (humans and robots working together, less people, highly skilled workers, high tech facilities)
 - How do humans and technology work together? (humans program robotics and other technologies to do a job, humans will do intermediate steps of manufacturing processes and then pass it back to robots)

Explain that manufacturing facilities used to employ thousands of people. Now, many of today’s manufacturing jobs require fewer people, the ability to operate complex machines, and an understanding of how to maximize efficiency.

5. Explain to students that manufacturers use several new technologies today. Ask students to recap what technologies they have seen so far. Manufacturing uses rapid prototyping, also known as 3-D printing, to test out new designs with cheaper materials before going into production. Rapid prototyping enables designers and engineers to quickly see, touch, and test versions of individual components without having to make changes to production tooling. Recently a car manufacturer wanted to refresh a car model’s interior. They wanted to test out new smartphone holders and re-sculpt the front seat back panels to improve rear seat access and passenger comfort. This allowed for over an inch more legroom than an earlier model. They could test out several models before committing to the final design for production. **Teacher Note:** Information sheets about Augmented Reality and Additive Manufacturing are provided as optional resources. Each overview includes a marker and directions for students to see each technology in action using a smart device. The

information sheets can also be used to obtain information to support student responses to the questions posed in step 6.

6. Explain to students that Augmented Reality (AR) is another method manufacturers are exploring to test out design before going into full production. Ask students if they are familiar with AR. Refer to the image in their *Agree & Disagree Statements* as an example. Students might be familiar with AR use in football games on TV overlaying first-down lines, popular cartoon photo apps, and advertisements.
7. Explain that the basic idea of augmented reality is to superimpose graphics, audio, and other sensory enhancements over a real-world environment in real time. This is different from virtual reality, which creates a completely immersive, computer-generated environment. AR overlays onto the natural world as it exists. Ask:
 - What are advantages and disadvantages of 3-D printing and Augmented Reality? (3-D printing provides a physical model, AR is digital)
 - How are these technologies helping companies be green? (use limited or cheaper materials or no materials for prototyping)
 - How is this different from what manufacturers used before to test out ideas? (Students might want to refer to their *Manufacturing Cards*)

Summarize with students that both of these methods (3-D printing and AR) allow manufacturers to test out models using innovative technology before committing to a final design.

Elaborate (20 minutes) – Manufacturing in Action

1. Ask students to take on the role of a manufacturer, and use what they have learned to design what the interior of an autonomous car could look like. In their same groups of two or three students, ask students to sketch out their designs and respond to the following questions that discuss the societal, engineering, and technological advancements that will guide their design choices.
 - What are some needs in society that have led to the consumer demand of autonomous cars? (People can work in their cars during long commutes, drive somewhere overnight and sleep in the vehicle)
 - What are some features you could design to help consumers make the transition? (outlets to plug in electronics, rearrange the seats for conversation, seats could convert to beds)
 - How did you determine which features to re-design? (if you don't have to focus on driving the car, humans might use their cars for meetings or sleeping)
 - What are items important to society that consumers would want in these new cars? (outlets for electronics, a business owner might want a table in their car for meetings, a person who travels a lot might want space to exercise)
 - What technologies did you learn about (rapid prototyping and AR) that you could incorporate into the car? (Designs could be tested and manipulated before final production, AR technology could be used to overlay traffic information or site seeing information on the actual objects as you drive).

Optional: If students need ideas to get started, distribute the images of car interiors changing over time to students in small groups. Ask them to evaluate the different images by discussing the following questions:

- What are some similarities and differences in the car interiors? (Things that changed were music players and displays are digital) (all interiors have a steering, wheel, pedals)
 - How has technology changed? (digital screens, touch screens, heated seats, surround sound, heated cup holders, music players)
 - Why do you think manufacturers make changes over time? (new technologies)
 - What types of problems do manufacturers solve? (making interiors more modern, adding conveniences for drivers and passengers, reducing fuel costs)
8. Invite groups to present and explain their driverless car designs.
 9. Guide students to review their *Agree & Disagree Statements*, from the Engage and Explore sections, with a partner. Ask students how the *Manufacturing the Future: Autonomous Cars* activity helped to further shape their definitions of advanced manufacturing.

Day 3

Evaluate (15 minutes)

1. Ask students to revisit their three words from the *Engage* part of the lesson and make any changes based on what they have learned about manufacturing.
2. Then, invite students to draw conclusions about how and why manufacturing has changed over time. They can summarize what they learned using the *Advanced Manufacturing Summarizer*.

Extend (20 minutes) – Exploring Careers in Advanced Manufacturing

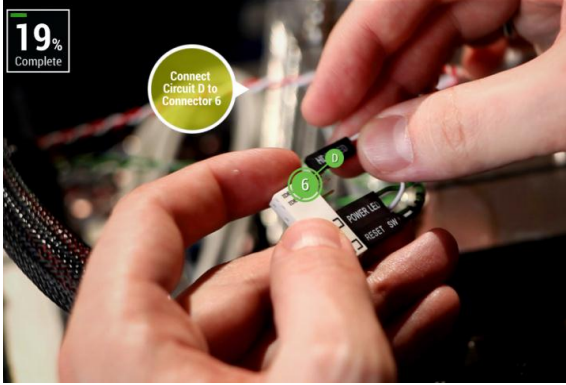
1. Invite students to use *Career Cards* to obtain information about professions in manufacturing.
2. Pass out the cards and guide students to go through their role with a highlighter to mark key facts. This might include the job requirements, work location, salary and how this job impacts humans.
3. Provide students the opportunity to share out their main facts with their team.
4. Ask students to consider the following:
 - Which job would you like to have? Why?
 - What is a common requirement among many of the jobs?
 - Which job seems the most challenging? Why?
 - Why is education so important to obtaining a job in Manufacturing?

Activity Sheet 1: Agree & Disagree Statements

Complete the Agree & Disagree Statement table below, first by yourself, and then with your partner.

Statement	My thoughts are similar to (or different from) those in the lesson
<p>Manufacturing is very high tech requiring high tech solutions and a highly skilled and qualified work force.</p> <p><input type="checkbox"/> agree <input type="checkbox"/> disagree <input type="checkbox"/> it depends on <input type="checkbox"/> not sure</p> <p>My thoughts:</p>	
<p>Everything you touch has been manufactured. Manufacturing means to make, fabricate or process raw materials into a finished product that meet a customer's expectations or specifications.</p> <p><input type="checkbox"/> agree <input type="checkbox"/> disagree <input type="checkbox"/> it depends on <input type="checkbox"/> not sure</p> <p>My thoughts:</p>	
<p>The manufacturing marketplace has changed drastically since the Industrial Age.</p> <p><input type="checkbox"/> agree <input type="checkbox"/> disagree <input type="checkbox"/> it depends on <input type="checkbox"/> not sure</p> <p>My thoughts:</p>	

When I think of manufacturing, it looks like this:



☐ agree ☐ disagree
☐ it depends on ☐ not sure

My thoughts:

When I think of manufacturing, it looks like this:



☐ agree ☐ disagree
☐ it depends on ☐ not sure

My thoughts:

Activity Sheet 2: Then and Now: Cell phones

Look at the two photographs below, and answer the following questions:

- What are the two images in the photographs?
- What similarities and differences can you observe?
- What are the most significant differences between the 1987 cell phone and the 2012 cell phone?
- Why do you think these changes were made?
- What factors have influenced these changes?

1987



2012



Activity Sheet 3: Manufacturing Card Sort

Craft Production

Goods are manufactured by hand with or without the aid of tools. Skilled laborers make what people need. Hand methods were laborious and costly.

Adolescents were apprenticed to a master craftsman, and refined their skills over a period of years in exchange for low wages. By the time their training was complete, they were well-equipped to set up in trade for themselves, earning their living with the skill that could be traded directly within the community, often for goods and services.



The Industrial Revolution

The shift, at different times in different countries, from a traditional agriculturally-based economy to one based on the mechanized production of manufactured goods in large-scale enterprises.

Machines took the place of hand production methods and increased productivity. There was a high demand for metal parts used in machinery. This led to the development of several machine tools for cutting metal parts.

Consumers benefited from falling prices for clothing and household articles such as cast iron cooking utensils. Ordinary working people found increased opportunities for employment in the new mills and factories, but these were often under strict working conditions with long hours of labor dominated by a pace set by machines



Assembly Line

Henry Ford experimented with workers staying in one place, doing the same job over and over. Ford introduced a moving assembly line for his car manufacturers to streamline the factory process.

In this process, the motion of workers is minimal. All parts or assemblies are handled either by conveyors or motorized vehicles such as fork lifts, or gravity, with no manual trucking. Heavy lifting is done by machines and each worker typically performs one simple operation.



Green Manufacturing

Companies begin to address sustainability and tackle environmental issues on the plant floor

Engineers develop manufacturing processes that reduce pollution and waste by minimizing natural resource use, recycling and reusing what was considered waste, and reducing emissions.

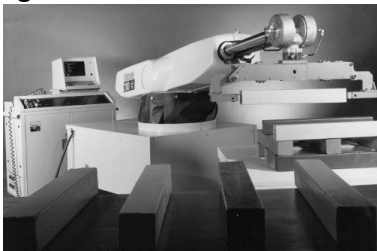
Manufacturers are exploring solutions that help buildings, cars, airplanes, trucks and trains get more performance from less fuel.



Industrial Robot

The first generation of industrial robots were installed in a permanent position and carried out simple tasks and routines. Later generations can be programmed to carry out specific actions over and over again while others are more flexible having to identify objects before performing a task.

Robots are designed to perform tasks that humans found dangerous or boring and can perform with consistent speed and precision. For example, a robot might twist the caps onto jars coming down an assembly line. These machines work alongside humans to perform an increasing number of manufacturing tasks.



Rapid Prototyping (3-D Printing)

A process of making a three-dimensional object of virtually any shape from a digital model.

Humans use a computer-aided design program to develop an idea. A 3-D printer is then used to manufacture that idea printing the 3-D model, prototype, or part out of resin.

Manufacturers are able to cut out processes such as injection molding, resin tooling, mold making and soft tooling. All of this will go into shortening their time to market and reduce costs.

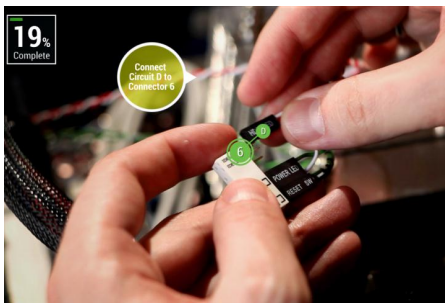


Augmented Reality

Workers have the flexibility of being hands-free using wearable devices to overlay instructions as they work.

Augmented reality pulls together real-time data, schematics, work orders and resources with the mobile functionality of smartphones and tablets.

Pointing a camera to factory on-site piece of equipment can match it to the digital map of the plant and verify it is in its designated location, not only freeing the staff from cumbersome paper layout plans but also providing the operators with virtual reality contextual information.



Activity Sheet 4: Question Cards

In what ways have the use of materials in manufacturing changed over time?

How have manufacturing processes changed over time? Consider the role of humans.

What factors influence changes in manufacturing?

Activity Sheet 5: Autonomous Cars

Read the case study about driverless cars below. Use the information to help you create a definition of “advanced manufacturing.” Consider improvements to products, processes, materials, and efficiencies. The first one has been done for you.

Advanced manufacturers are developing complex systems that allow cars to drive themselves. Driverless technology could significantly reduce the number of people killed in car accidents, over a million worldwide each year.

In a world without crashes, cars wouldn’t need tons of reinforced steel, excessive airbags, and other features that make them so heavy. Lighter cars would be more efficient on the road and better for the environment. Data received from self-driving cars already on the road shows that they are safer and smoother when steering themselves than when a human takes the wheel, improving accuracy on the roads. These cars use high precision tools and methods such as radar, GPS, LIDAR, and computer vision to sense their surroundings. Highly-skilled engineers work together to test and refine materials and techniques so these driverless cars could actually be on the road for consumers.

But, would you ride in a car traveling at full speed where there is no driver? In addition to the technological aspects of designing and manufacturing driverless cars, manufacturers must also consider potential customer and cultural resistance. Innovative advanced manufacturing businesses in the United States continue to inform the public about the progress of these vehicles and showcase them at conventions and tradeshow.

What is Advanced Manufacturing?	It Says	I say
	Advanced manufacturers are developing complex systems that allow cars to drive themselves.	Advanced manufacturing is the use of innovative technology to improve products or processes.
	Driverless technology could significantly reduce the number of people killed in car accidents, over a million worldwide each year.	
	In a world without crashes, cars wouldn’t need tons of reinforced steel, excessive airbags, and other features that make them so heavy. Lighter cars would be more efficient on the road and better for the environment.	
	Data received from self-driving cars already on the road shows that they are safer and smoother when steering themselves than when a human takes the	

	wheel, improving accuracy on the roads.	
	These cars use high precision tools and methods such as radar, GPS, LIDAR, and computer vision to sense their surroundings.	
	Highly skilled engineers work together to test and refine materials and techniques so these driverless cars will soon be on the road for the every day consumer.	
	Innovative advanced manufacturing businesses in the United States must consider potential customer resistance while informing the public about the progress of these vehicles and showcasing them at conventions and tradeshow.	
My definition of Advanced Manufacturing . . .		

Activity Sheet 5: Autonomous Cars Teacher Key

What is Advanced Manufacturing?	It Says	I say
	Advanced manufacturers are developing complex systems that allow cars to drive themselves.	Advanced manufacturing is the use of innovative technology to improve products or processes.
	Driverless technology could significantly reduce the number of people killed in car accidents, over a million worldwide each year.	Advanced manufacturing improves existing or creates entirely new materials, products, and processes via the use of science and engineering.
	In a world without crashes, cars wouldn't need tons of reinforced steel, excessive airbags, and other features that make them so heavy. Lighter cars would be more efficient on the road and better for the environment.	Advanced manufacturing improves existing or creates entirely new materials, products, and processes via the use of science and engineering.
	Data received from self-driving cars already on the road shows that they are safer and smoother when steering themselves than when a human takes the wheel, improving accuracy on the roads.	Advanced manufacturing improves existing or creates entirely new materials, products, and processes via the use of science and engineering.
	These cars use high precision tools and methods such as radar, GPS, LIDAR, and computer vision to sense their surroundings.	Advanced manufacturing improves existing or creates entirely new information technologies and high precision tools.
	Highly skilled engineers work together to test and refine materials and techniques so these driverless cars will soon be on the road for the everyday consumer.	Advanced manufacturing employs a highly-skilled work force.
	Innovative advanced manufacturing businesses in the United States continue to inform the public about the progress of these vehicles and showcase them at conventions and tradeshows.	Advanced manufacturing is led by innovative businesses that communicate exciting developments in consumer processes and products.

My definition of Advanced Manufacturing . . .

Advanced manufacturing is the use of innovative technology to improve products or processes. Advanced manufacturing improves existing or creates entirely new materials, products, and processes via the use of science, engineering, and information technologies; high-precision tools and methods; a high-performance workforce; and innovative business or organizational models.

Car Interior Images

1965 Mustang Convertible



© S.E. Schwartz/Mustang Dreams

1978 AMC Gremlin



Freely licensed media file

1983 Accord



Freely licensed media file

1995 Mustang GT



Freely licensed media file

2004 Ford Taurus



Cargarus.com

2010 Ford Taurus



Freely licensed media file

Manufacturing Summarizer

3 examples of what advanced manufacturing is

- _____
- _____
- _____

2 examples of how it has changed

- _____
- _____

1 example of what it looks like today

- _____

Example of Career Card - Additional Cards are provided with Counselor Resources

Electrical Engineer

What is an Electrical Engineer?

Electrical engineers design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems, and power generation equipment. They evaluate sub-system electrical configurations and performance specifications to meet guidelines, based on existing system architecture. Electrical Engineers provide engineering analyses for concurrent engineering and R&D concept/design iterations through detailed electrical equipment design, performance requirements definition, design specifications, concept options down-selecting and bills of materials. They provide support analyses to develop electrical equipment design concepts into prototype definitions, and identify and develop testing needs to validate viability and functionality of alternative design concepts.

How could you become an Electrical Engineer?

Electrical Engineer- Bachelor's degree

In addition to a bachelor's degree, this position requires:

- Strong computer skills, including MS Access, Excel, Word, PowerPoint
- In-depth knowledge of engineering economics
- An understanding of systems modeling tools, such as Arena simulation
- Strong analytical and organizational skills
- Oral, written, and problem solving communication skills

Electrical and electronics engineers must have a bachelor's degree. Employers also value practical experience, so participation in cooperative engineering programs, in which students earn academic credit for structured work experience, is valuable as well.

It may be helpful to have the degrees, certificates and/or coursework listed below.

Physics

Algebra

Drafting

Electronics engineering

Electrical engineering technology

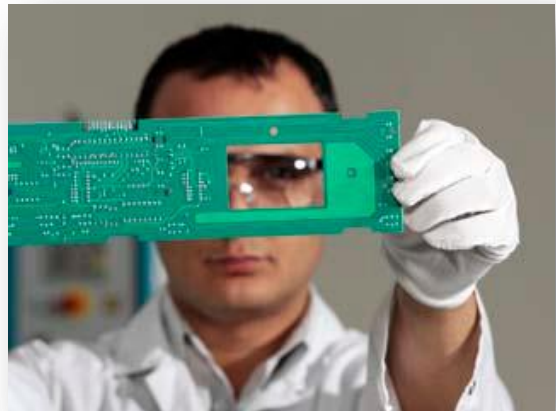
Digital systems design

Salary Range:

\$56,490-\$136,690

Job Outlook

Employment of electrical and electronics engineers is projected to grow 4 percent from 2012 to 2022. Job growth is expected because of electrical and electronics engineers' versatility in developing and applying emerging technologies.



Augmented Reality Marker



This AR target image is of grains from an Oregon sand dune and was taken by a test version of the Mars Hand Lens Imager (MAHLI) for the Curiosity rover. The view is about 1 inch or 2.5cm across.

Credit : NASA/JPLCaltech/Malin Space Science Systems.

Augmented Reality

Augmented reality pulls together real-time data, schematics, work orders and resources with the mobile functionality of smartphones and tablets.

Augmented reality superimposes graphics, audio, and other sensory enhancements over a real-world environment in real time. This is different from virtual reality, which creates a completely immersive, computer-generated environment. AR overlays onto the natural world as it exists.



Augmented Reality Map on iPhone



Real time information is digitally overlaid on to a physical object. In this image, vehicle statistics and repair instructions are overlaid on the engine for a mechanic to reference.

Try it!



Download the application Spacecraft 3D on a Smart Device; open the application, and then point it at the marker image to the left.

Additive Manufacturing

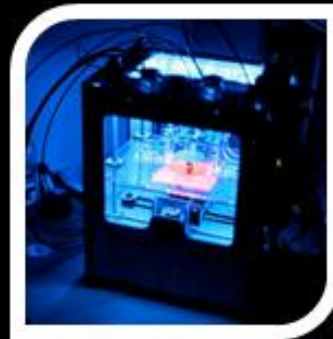
Manufacturing uses rapid prototyping, also known as 3-D printing to test out new designs with cheaper materials before going into production. Rapid prototyping enables designers and engineers to quickly see, touch, and test versions of individual components without having to make changes to production tooling.



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it out!



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3D printing or additive manufacturing is a process of making a three-dimensional solid object of virtually any shape from a digital model.



The CandyFab granular printing system uses heated air and granulated sugar to produce food-grade art.



An example of 3D printed limited edition jewelry. This necklace is made of glass fiber-filled dyed nylon.