KEYS TO CONNECT

CAREER ACTIVITY

The Assembly Line

OBJECTIVES

Students will be able to:

- Assemble a product individually that meets the quality control criteria.
- Design an assembly line process to assemble a product as quickly and efficiently as possible meeting the quality control criteria.
- Construct an assembly line.
- Test and redesign the assembly line process.
- Compare between assembling a product individually and assembling a product using an assembly line.

OVERVIEW

The origins of the assembly line can be traced back to miners during medieval times who used bucket elevators, to the shipbuilders of the fourteenth century who created moving lines of parts. By the 1900's, the assembly line was used by many industries (shipbuilding, canning, milling, meat-packing, etc.), but was most successful in the automobile industry. Henry Ford created the Model T automobile in 1908. The car was not complicated, allowing owners to fix it themselves. Popularity of the Model T skyrocketed causing Ford Motor Company to receive so many orders that they needed to change how they manufactured the vehicle. To decrease production time, Ford changed the way the Model T was built and created the beginnings of the vehicle manufacturing assembly line we know today. Rather than having the same workers build a complete car from start to finish, workers would be responsible for one specific element of the production process. This was made possible through the usage of conveyor belts. As assembly lines have become more technologically advanced, more manufacturing plants are used as the core of production.

Toyota has also contributed to the manufacturing history by initiating the Just in Time (JIT) system that has become known worldwide. The JIT system was based on years of continuous improvements to make vehicles ordered by customers in the most efficient way. It means that Toyota will only manufacture "what is needed, when it is needed, and in the amount needed." In addition to the Just In Time system, "jidoka" (which can be loosely translated as "automation with a human touch") is a key component of the Toyota Production System. When a problem occurs, the equipment stops immediately, preventing defective products from being produced; and the Just in Time system, in which each process produces only what is needed for the next

process in a continuous flow. These two philosophies come together with the Toyota Production System to move towards elimination of waste using the most efficient methods.

In this activity, students will work individually to assemble a product and then work in teams to design, construct, test, and redesign an assembly line process whose product must meet specific quality control criteria. This the core focus of Juan Carlos Liberato; a Final Assembly Engineer at Toyota. Juan is a highly skilled professional who plans, directs, and coordinates activities in departments across Toyota on a global level.

INQUIRY QUESTIONS

1. What are some of the most significant strengths and weaknesses of an assembly line?
2. What would be the benefits of adding robotics or automated machines to an assembly line?
3. Can you discuss the most important parts of an assembly line?

NEXT GENERATION SCIENCE STANDARDS

Next Generation Science Standards Grades 3–5 (Ages 8–11) Engineering Design:

3–5–ETS1–3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Next Generation Science Standards Grades 6–8 (Ages 11–14) Engineering Design Students who demonstrate understanding can:

MS–ETS1–2 Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

BACKGROUND

The first prototype of what we call the modern-day assembly line can be traced back to the meat processing industry. In both Cincinnati and Chicago, meat production in the 19th century used overhead trolleys to move meat from worker to worker. The trolleys were connected with a pulley system (a type of simple machine) to move the meat to be processed past workers at a steady pace. This formed what is the first assembly line. Stationary workers concentrated on one task and performed it at a pace dictated by the machine, thereby minimizing unnecessary movement and dramatically increasing productivity.

Using this example, Henry Ford designed an assembly line that began operation in 1913. This innovation reduced manufacturing time for magneto flywheels from 20 minutes to 5 minutes. Because this worked so well, Ford replicated this for other parts of the Model T. Ford's accomplishments forced both his competitors and his parts suppliers to imitate his technique. As the assembly line spread through American industry, it brought dramatic productivity gains and changed the way in which the organization of work was structured.

KEY VOCABULARY

- Engineering
- Assembly line
- Efficiency
- Data
- Prototype
- Mass Production

MATERIALS

Student Materials

- 2 brown paper bags
- 5 sheets of paper *(letter-sized, or whatever size you have)*
- 1 full set of colored markers or crayons
- 1 black marker
- Cups or other objects that can be traced to make circles (i.e. compass)—all must be the same size

Team Materials

- 20 brown paper bags (20 per team)
- Stack of paper *(letter-sized, or whatever size you have)*
- 1 full set of markers or crayons
- 1 black marker
- Cups or other objects or what can be traced to make circles (i.e. compass)—all must be the same size
- 1 stopwatch

TEACHER PREPARATION

- Print **Student Capture Sheet #1:** Build One Color Brick
- Print **Student Capture Sheet #2:** Team Challenge, Build Multiple Color Bricks Assembly Line Challenge
- Prepare the classroom where space is clear and there is room for movement

PROCEDURE

Engage: *What is an assembly line?*

Begin the lesson by engaging students' curiosity by showing the What is an Assembly Line? video. To get students thinking about the concept of an assembly line, introduce students to the *See, Think, Wonder* thinking routine that they can use to consider their own understanding.

See: *What do you see happening in the video? How does an assembly line increase production?*

Think: *What connections can you make to prior knowledge? What are you learning?*

Wonder: *What questions come to mind as you watch?*

Explore: *Creating Your Own Color Block*

***Either pass out materials individually to students or have on a designated table*

1. Share with students the background knowledge of an assembly line to continue the conversation from the engage section.
2. Give students **Student Capture Sheet #1:** Build One Color Brick.
3. Explain that students must build a brick as quickly as possible using the quality control criteria.
4. Give students 30 minutes to complete the challenge.
5. Once students have completed the challenge, bring students back to together. Here are a few questions for students to reflect on:
    - What was the easiest task and why?
    - Where did you feel challenged?
    - Is there an easier way to make the brick?
    - How would you make more than one brick?
6. Ask students to write down their thoughts on a piece of paper or as a class discussion.

Experiment: *Team Challenge, Create an Assembly Line*

1. As you close out the individual building, tell students that they will be divided into groups of 4.
2. Divide students into groups of 4 and pass out to student teams **Student Capture Sheet #2:** Team Challenge, Build Multiple Color Bricks Assembly Line Challenge.
3. Give students time to develop a plan for their assembly line and gather their materials.
4. Put 15 minutes on a timer and let the teams build their bricks!
5. Teams should record how many bricks they were able to build in 15 minutes.
6. Bring the class back together and record on the board how many bricks each team was able to build. What was the average? Minimum and Maximum?
7. Give students a few minutes to reflect and write down their thoughts on the activity.

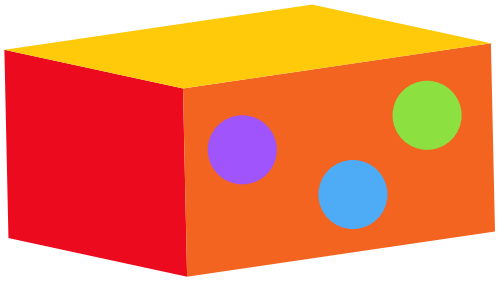
Extend

1. Watch the Toyota Career Video, featuring Juan Carlos Liberato.
2. Ask students how the activity they completed is connected to the work that Juan does every day.
3. Encourage students to share Juan's story and the team challenge they participated in with family members.
4. How would they alter the activity to try with family or friends?

BUILD ONE COLOR BRICK

Scenario

A local toy company is calling on engineering teams to implement time saving methods to help them meet the demands of manufacturing their most popular product—"color bricks." This toddler toy is made of recycled brown bags and has been hugely popular. They are constantly selling out! The toy company needs to place an order for one million color bricks in just 3 days!



Assemble One Color Brick

See how fast you can assemble one color brick and still meet the criteria.

Criteria

- Brick must be made from 2 brown bags. One bag must be filled with 4 pieces of lightly crunched up recycled paper. The other bag will cover this bag.
- The largest sides of the brick must be filled with polka dots. One side must have 3 colored circles and the other side must have 3 different colored circles.
- Both sides of the brick must have Color Bricks written in black marker. Letters must be centered on the sides and one inch in height and five inches long.

Constraint

- Use only the materials provided.

Remember: Before you begin, create your plan

Start your timer when you begin making your brick. Record your time below.

How long did it take you to make your brick? _____

TEAM CHALLENGE, BUILD MULTIPLE COLOR BRICKS ASSEMBLY LINE CHALLENGE

Scenario

You are a team of engineers working to help a local toy company implement time savings methods to manufacture "color bricks." Each member of your team will design and construct their own brick as quickly as possible. Then, the team will work together to design an assembly line to manufacture bricks as quickly and efficiently as possible.

Criteria for Quality Control

- Brick must be made from 2 brown bags. One bag must be filled with 4 pieces of lightly crunched up recycled paper. The other bag will cover this bag.
- The largest sides of the brick must be filled with polka dots. One side must have 3 colored circles and the other side must have 3 different colored circles.
- Both sides of the brick must have "Color Bricks" written in black marker. Letters must be centered on the sides and one inch in height and five inches long.

Constraint

- Use only the materials provided.

Start your conversation by observing the time it took each of your teammates to make one brick. What was the average time? _____

Create a plan, what will your assembly line look like? Station 1, Station 2, etc.

How many bricks were you able to build in 15 minutes? _____