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Assembly Line

This lesson demonstrates the power of mass production. Students work in teams to design, construct, test, and redesign an assembly line to manufacture a product as quickly and efficiently as possible to meet the quality control criteria.

- Assemble a project by hand 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.
- Test and redesign the assembly line process.
- Compare the difference between assembling a product individually versus with an assembly line.

Age Levels: 8-18

Time Required: 1.5 hours

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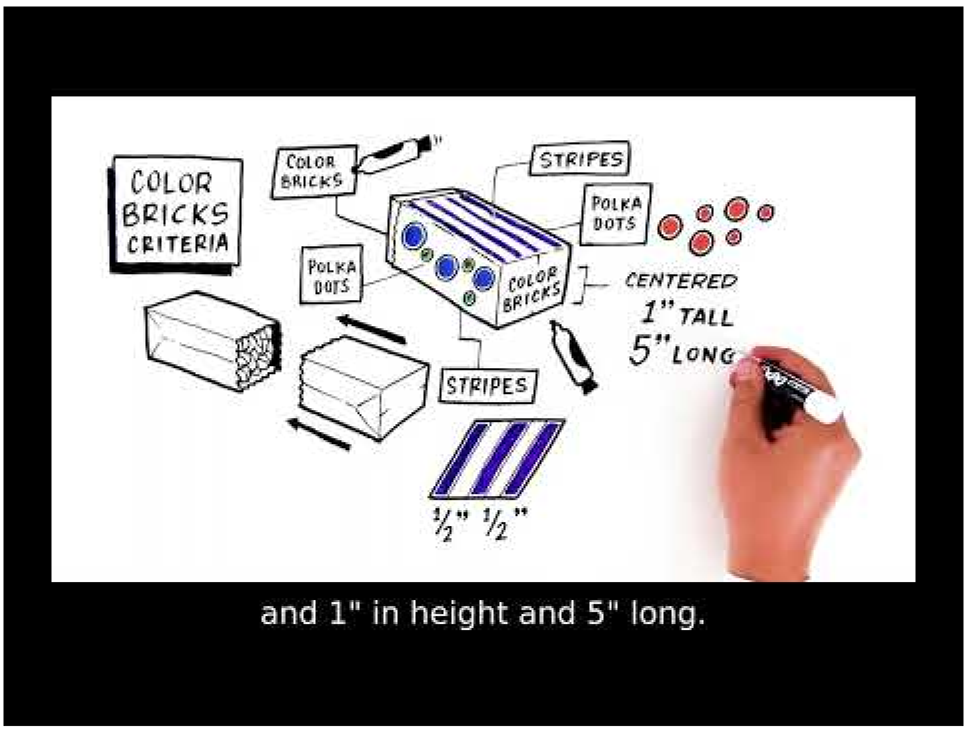
Lesson Plan Overview



Watch Video At: https://youtu.be/sjo_eB7nGrs

Lesson Plan Presentation

Download Presentation PDF
Download Presentation Powerpoint

Materials & Preparation

Activity 1 Build Materials (For each student)

Required Student Materials

- 2 brown paper bags
- 5 pieces of recycled paper 8”x 11”
- 1 full set of colored markers or crayons (be sure to include blue, green, red, orange, purple)
- 1 black marker
- 2 cups of different sizes or other objects that can be traced to make circles (i.e. compass)
- 1 ruler

Required Teacher Materials

- “Assemble one color brick” worksheet or write brick criteria on a shared board
- Sample Color Brick
- Stopwatch, phone or other timer

Dawna Schultz

Photo credit: Dawna Schultz

Activity 2 Build Materials (For each team)

Required Team Materials

- 30 brown paper bags (30 per team)
- Stack of recycled paper 8”x 11”
- 1 full set of markers or crayons (be sure to include blue, green, red, orange, purple)
- 1 black marker
- 2-4 sets of 2 cups of different sizes or other objects or that can be traced to make circles (i.e. compass)
- 4 Rulers
- 1 stop watch

Required Teacher Materials

Stopwatch, phone or other timer

Activity 2 Build Materials (For each team)

Stopwatch, phone or other timer

Testing Materials & Process

Materials

Stopwatch, phone or other timer

Process: Activity 1

- Start timer counting up, as you instruct students to begin building their brick.
- Record the name and time as each student completes their brick.

Process: Activity 2

- Set a countdown timer for 10 minutes.
- Record how many bricks each team completes.

Real World Applications

Working the Assembly Line

Did you ever wonder what it's like to work on an assembly line? Here's a peek into what it would be like to work on a car assembly line. (Video 3:48)

Watch Video At: https://youtu.be/6umIEl6Sv8A

Source: Jeff Gilbert, News Reporter YouTube Channel

1.7 Million LEGO Bricks an Hour!

Go inside a Swedish LEGO plant to learn how 1.7 million bricks are manufactured on an assembly line in just one hour. (Video 5:36)

Watch Video At: https://youtu.be/zrzKih5rqD0

Source: How It's Made YouTube Channel

Coca-Cola Assembly Line In Action!

Watch as Coca-Cola's holiday North Pole cans roll off the assembly line. (Video 1:21)

Watch Video At: https://youtu.be/nYKrnuz17jg

Source: The Coca-Cola Company YouTube Channel

Engineering Design Challenge

Design Challenge

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 (3 large – 1” circles & 3 medium – 1/2” circles scattered per side). One side must have 3 blue and 3 green circles. The other side must have 3 red and 3 orange circles.
- The top and bottom of the brick must have 4 vertical 1/2” purple stripes with 1/2” in between each stripe.
- Both sides of the brick must have “Color Bricks” written in black marker. Letters must be centered on the sides and 1” in height and 5” long.

Constraints

Use only the materials provided.

Activity Instructions & Procedures

Procedure

1. The first activity is done individually. For the second activity, break class into teams of 2-4
2. Hand out the Assemble One Color Brick and Assembly Line Design Challenge worksheets, as well as some sheets of paper for sketching designs.
3. Discuss the topics in the Background Concepts Section.
4. Review the Engineering Design Process, Design Challenge, Criteria, Constraints and Materials. If time allows, review "Real World Applications" prior to conducting the design challenge.
5. Before instructing students to start brainstorming and sketching their designs, ask them to consider the following:
   – How to keep quality control, while maintaining efficiency
   – What order or sequence do your steps need to be in to make the brick?
   – The number of people on your team and the number of tasks that need to be completed
   – The differences between assembling a product individually versus with an assembly line
6. Provide each student with their materials for activity 1. Then, provide each team with their materials for activity 2.
7. For Activity 1: Explain that students must build a brick as quickly as possible using the quality control criteria. For Activity 2: Explain that student teams must build an assembly line from everyday items. Using the assembly line students build as many blocks as possible within 10 minutes using the quality control criteria.
8. Announce the amount of time they have to design and build (1 hour recommended).
9. Use a timer or an on-line stopwatch (count down feature) to ensure you keep on time. (www.online-stopwatch.com/full-screen-stopwatch). Give students regular "time checks" so they stay on task. If they are struggling, ask questions that will lead them to a solution quicker.
10. Students meet and develop a plan for their assembly line. They agree on materials they will need, write/draw their plan, and present their plan to the class. Teams may trade unlimited materials with other teams to develop their ideal parts list.
11. Teams build their designs.
12. Test the assembly line designs by setting a countdown timer for 10 minutes and recording how many bricks each team completes.
13. Teams should document the number of bricks they completed.
14. As a class, discuss the student reflection questions.

15. For more content on the topic, see the “Real World Applications” and “Digging Deeper” sections.

Variations

- Change the size of the brick (use large brown grocery paper bags).
- Play some fun, fast music during the assembly line testing.
- Add more tasks, such as packaging bricks into a box to ship.
- Instead of seeing how many bricks each team makes in 10 minutes, tell students they have to make a certain number of bricks and see how long it takes each team.

Student Reflection (engineering notebook)

1. How long did it take you to make 1 color brick?
2. What was the easiest task and why?
3. What was the most challenging task and why?
4. Is there an easier and/or faster way to make the brick? If yes, describe

Time Modification

The lesson can be done in as little as 1 class period for older students. However, to help students from feeling rushed and to ensure student success (especially for younger students), split the lesson into two periods giving students more time to brainstorm, test ideas and finalize their design. Conduct the testing and debrief in the next class period.

Engineering Design Process

Watch Video At: https://youtu.be/rTcI8sslNjU

Background Concepts

History of the Assembly Line

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.

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Henry Ford created the Model T automobile in 1908. The car was simple so owners could fix it themselves. It was also sturdy and cheap. Soon, the Ford Motor Company started receiving so many orders for Model T's that they couldn't build them quickly enough. To speed up production, Ford changed the way the Model T was built. Instead of several groups of workers each building a complete car from the ground up, workers stayed in one spot and added parts to cars as they moved past them. Parts were delivered to the employees by conveyor belts. Ford even managed to time the delivery of a part so that it would get to a worker only when it was needed. By 1913, Ford had a complete assembly line functioning. This method of production was rapidly adopted by many industries when they discovered that mass production on assembly lines sped up manufacturing time and lowered costs.

Ford used an approach for his assembly line that we call just-in-time (JIT) manufacturing today. This approach lets manufacturers purchase and receive components just before they're needed on the assembly line. As a consequence, it relieves manufacturers of the cost and burden of housing and managing idle parts. The basic elements of JIT were developed by Toyota in the 1950's and were well-established in many Japanese factories by the early 1970's. JIT began to be adopted in the U.S. in the 1980's (General Electric was an early adopter), and is now widely accepted and used.

Vocabulary

- **Assembly Line**
  A manufacturing process where a product is assembled by adding parts in sequence.
- **Constraints**
  Limitations with material, time, size of team, etc.
- **Conveyor Belt**
  A belt moved by rollers which is used to transport objects from one place to another.
- **Criteria**
  Conditions that the design must satisfy like its overall size, etc.
- **Efficiency**
  The ability to avoid wasting materials, energy, efforts, money, and time in producing a product.
- **Engineers**
  Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering (see infographic).
- **Engineering Design Process**
  Process engineers use to solve problems.
- **Engineering Habits of Mind (EHM)**
  Six unique ways that engineers think.
- **Iteration**
  Test & redesign is one iteration. Repeat (multiple iterations).
- **Manufacturing**
  The use of people, machines and tools to turn raw goods into finished products.
- **Mass Production**
  The large scale manufacturing of a product.
- **Prototype**
  A working model of the solution to be tested.
- **Quality Control**
  A procedure or set of procedures intended to ensure that a manufactured product adheres to a defined set of quality criteria.

Dig Deeper

Internet Connections

- Crayola Factory Assembly Line: How Crayons are Made
- PBS American Experience Assembly Line

Recommended Reading

- Henry Ford and the Assembly Line (ISBN: 978-1584151739)
- The Assembly Line (ISBN: 978-0618484379)
- Lean Assembly: The Nuts and Bolts of Making Assembly Operations Flow (ISBN: 978-1563272639)

Writing Activity

Write an “explanatory essay” describing the steps of the assembly line process.

Curriculum Alignment

Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

National Science Education Standards Grades K-4 (ages 4 – 9)

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

Abilities to distinguish between natural objects and objects made by humans

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- History of science

National Science Education Standards Grades 5-8 (ages 10 – 14)

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- History of science

National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

Historical perspectives

Next Generation Science Standards Grades 3-5 (Ages 8-11)

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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 using a systematic process to determine how well they meet the criteria and constraints of the problem.

Standards for Technological Literacy – All Ages

Technology and Society

Standard 7: Students will develop an understanding of the influence of technology on history.

Design

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Related Engineering Fields and Degrees

There are many different types of engineering fields that involve designing products and processes. Here are just some of the related engineering fields.


Manufacturing Engineering


Industrial Engineering


Mechanical Engineering

Download the Engineering Fields Infographic: How will YOU change the world?

Student Worksheet

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 out 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

- The brick must be made up of 2 brown bags.
- The brick must be filled with 4 pieces of recycled paper (lightly crunched up and stuffed into one bag. The other bag will cover this bag and the crunched up paper.)
- The largest sides of the brick must be filled with polka dots. (3 large 1” diameter & 3 medium 0.5” circles scattered per side). One side must have 3 blue and 3 green circles. The other side must have 3 red and 3 orange circles.
- The top and bottom of the brick must have 4 vertical 0.5” purple stripes with 0.5” in between each stripe.
- Both sides of the brick must have **Color Bricks** written in black marker. Letters must be centered on the sides and 1” in height and 5” long.

Constraint

Use only the materials provided.

Reflection

1) How long did it take you to make 1 color brick?

2) What was the easiest task and why?

3) What was the most challenging task and why?

4) Is there an easier and/or faster way to make the brick? If yes, describe

Design Challenge

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 out 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! They will award the contract to the engineering team that can make the bricks the fastest while meeting the quality control constraints.

Design Challenge

Each team (approximately 8-10 per team) will design an assembly line process that will make as many “color bricks” in 10 minutes as possible and still meet all of the quality control constraints.

Criteria

- Each brick must be made up of 2 brown bags.
- Each brick must be filled with 4 pieces of recycled paper (crunched up and stuffed into one bag. The other bag will cover this bag and the crunched up paper.)
- The largest sides of the brick must be filled with polka dots. (3 large 1” diameter & 3 medium 0.5” circles scattered per side). One side must have 3 blue and 3 green circles. The other side must have 3 red and 3 orange circles.

- The top and bottom of the brick must have 4 vertical 0.5” purple stripes with 0.5” in between each stripe.
- Both sides of the brick must have **Color Bricks** written in black marker. Letters must be centered on the sides and 1” in height and 5” long.

Criteria

You must only use the materials provided.

Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a process for solving the challenge. You’ll need to determine what materials you want to use.

Draw your design below, and be sure to indicate the description and number of parts you plan to use.

Design Challenge

Brainstorm designs for your assembly line:

Team Chosen Assembly Line Design:

Construction Phase

Build your assembly line. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

Testing Phase

Each team will test their assembly line. If your design and process were unsuccessful, redesign and test again. Continue until you are happy with your solution. Be sure to watch the tests of the other teams and observe how their different designs worked.

Sketch your Final Design

Evaluation Phase

Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class.

1) Was the order of your assembly line tasks successful? If not, why?

2) Did you have enough people in your assembly line to have experts in one task? If not, how would it have changed your assembly line if you had more people?

3) Did your group meet the quality control criteria? If not, why?

4) If you had more time or different supplies what would you add, change, or do differently?

5) Was it hard to go fast and still meet the quality control criteria? What would it take to improve?

6) Did your team work together harmoniously and efficiently?

7) What are the benefits of the assembly-line method when compared to assembling a product individually?

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