ASSEMBLY LINE CHALLENGE

Dear Fellow Educators,

We are excited to offer the Assembly Line Challenge as an opportunity for you to provide a hands-on engineering and design challenge to your students.

As part of this lesson plan, you will find the following resources:

- Teacher Reference Guide with Next Generation Science Standards alignment, lesson objectives, and manufacturing career connections.
- A student information sheet with directions, suggested materials, examples, and additional activities.
- Optional student worksheets with background information, simple machines notes and a rubric.
- Additional information about manufacturing careers.

A general overview of the Assembly Line Challenge is:

Students will design an assembly line machine (aka Chain Reaction or Rube Goldberg Machine) that uses at least 8 simple machines to accomplish a task that they have selected.

The student will design the assembly line machine with a simple blueprint that includes labels for the materials to be used and the type of machine for each step.

The student will manufacture their machine and modify its design as needed.

The student will create a video that (1) identifies the problem they are solving; (2) briefly explains the machines and process of the assembly line; (3) successfully demonstrates the entire machine.

The video should not be longer than 90 seconds. The assembly line should take at least 30 seconds.

The completed video can be submitted by: (1) using the QR Code to access an online form (https://www.jotform.com/conklin/Assembly_Line_Challenge_2020); or (2) post it to their social media account (Facebook, Instagram, or Twitter only) and use the hashtag: #pghmfgchallenge.

If you have any questions, please reach out.

Sincerely,

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Teacher Reference Guide

ASSEMBLY LINE CHALLENGE

Standards

NGSS HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

NGSS HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

NGSS HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social cultural, and environmental impacts.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Formulating, refining, and evaluating empirically testable questions and design problems using models. Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. Apply scientific ideas or principles to design parts of a system and the complete system. Evaluate competing design solutions based on design criteria.	Models of all kinds are important for testing solutions. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	Models can be used to represent systems and their interactions.

Objectives

The student will:

- Evaluate solutions to a complex real-world problem.
- Think critically about the importance of simple machines in everyday life.
- Use their knowledge of simple and complex machines to design and build an assembly line contraption (aka Rube Goldberg Machine or Chain Reaction Machine).

Manufacturing Career Connections

According to Deloitte and the Manufacturing Institute, more than 2 million manufacturing jobs across the United States could remain unfilled between 2018 and 2028 due to advanced technology skill requirements, misconceptions about manufacturing jobs, and the retirement of baby boomers. This shortage directly impacts the manufacturing industry in Pennsylvania, which is the eighth largest in the country and contributes $84 billion each year to the economy.

Manufacturers are looking for employees with basic skills in math, reading, and writing; technical skills in blueprint reading and mechanical reasoning; and career ready skills in critical thinking, problem solving, project management, teamwork, and communication.

High Priority Occupations for our region include:

Engineers (Mechanical and Electrical)
Electrical & Electronic Engineering Technicians*
Industrial Machinery Mechanics*
Maintenance & Repair Workers*
Assemblers*
CNC Machine Operators*
Machinists*
Welders*

*Require training, but not a 4-year degree

Student Information Sheet

ASSEMBLY LINE CHALLENGE

Directions

(OPTIONAL) **Research** the 6 simple machines.

Design an Assembly Line blueprint on paper that uses at least 8 simple machines to accomplish a task (you decide what that is). The drawing should include labels for ALL material to be used and each machine.

Manufacture your machine. **Modify** your design as needed. (Be sure to update your blueprint.)

Practice, **improve** and **add** ideas as you build!

Create a video that (1) introduces you and your school; (2) identifies the problem you are solving; (3) briefly explains the machines and process of the assembly line; and (4) successfully demonstrates the entire machine.

The video should not be longer than 90 seconds. The assembly line should take at least 30 seconds.

The completed video can be submitted by: (1) using the QR Code to access an online form; or (2) posting the video to your Social Media (Facebook, Instagram or Twitter only), include your school name, and use the hashtag: #pghmfgchallenge.

Examples

Free Apps to Explore

Rube Goldberg Machine Tricks

Google Play Store

iTunes Store

Cube Cut: Making Your Future

Google Play Store

iTunes Store

Materials

Most materials are appropriate for this activity. Here are some suggestions:

Recycled Materials

Cardboard
Plastic Containers
Cups
Paper Towel or Toilet Paper Tubes
Cans
Foil

Rolling or Falling Items

Balls
Marbles
Dominoes
Toy Cars
Wheeled toys
Blocks
Batteries
Legos

Ramp Items

Cardboard
Books
PVC Pipe
Toy Train or Car Tracks
Index Cards
Skewer Sticks (or sticks from the woods!)

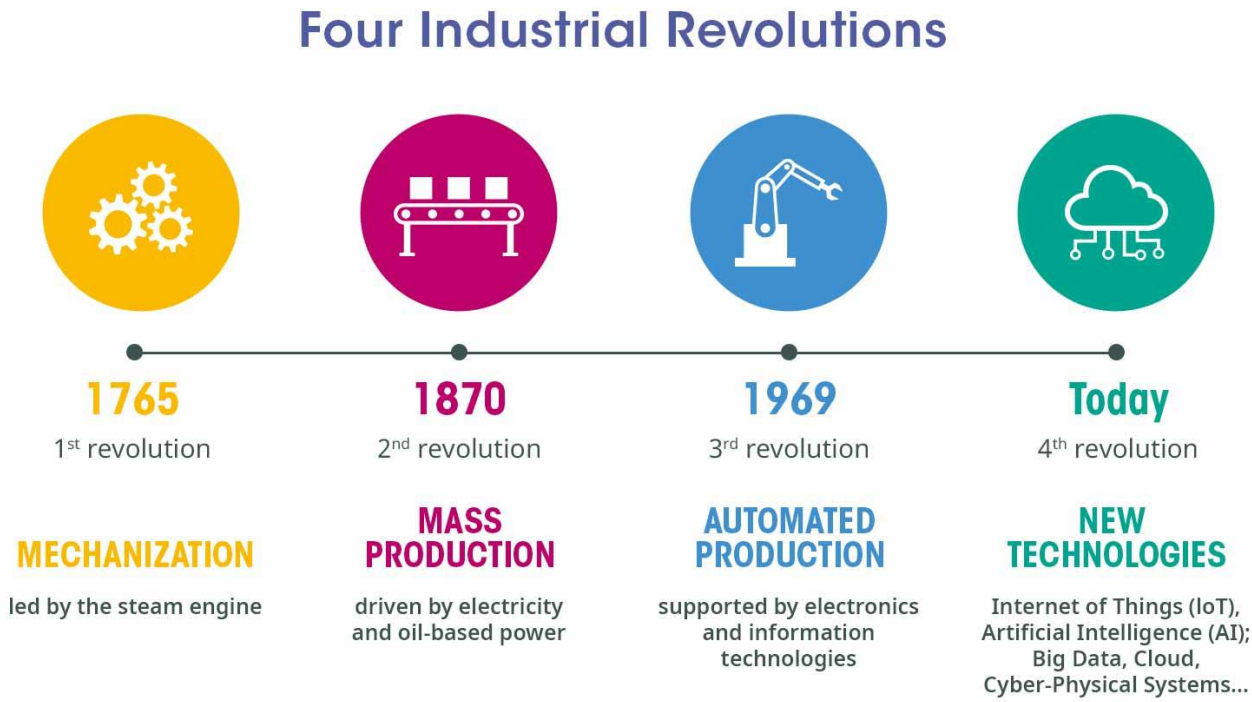
Household Materials

Tape
Paper
Hangers
String
Craft Sticks
Playing Cards
Cereal Boxes
Balloons
Straws
String
Rubber bands
Old Toys
Plastic Silverware
Scrap Wood

Background Information

Assembly Line

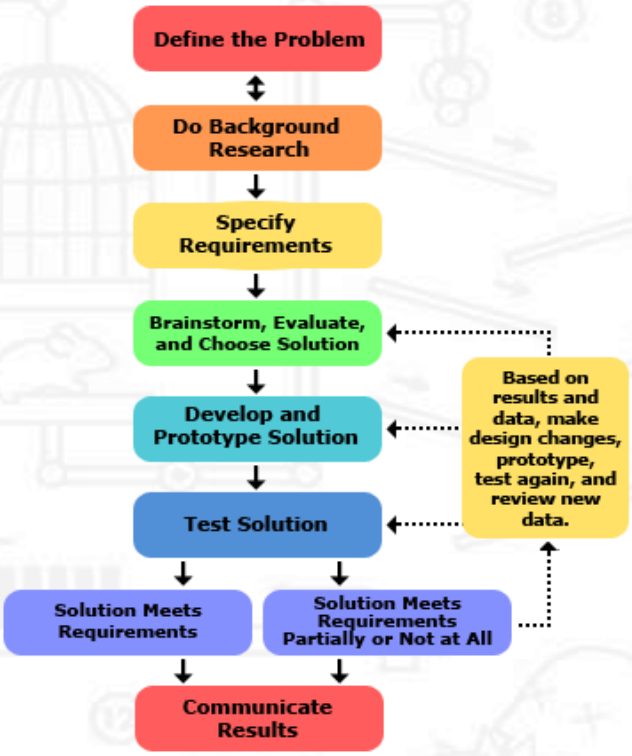
The assembly line was first implemented in manufacturing over 100 years ago. Permitting industry to mass produce products, it saved time and money. Henry Ford is noted as the first to use a moving assembly line for mass production of an entire car. His innovation reduced the time it took to manufacture a car from more than 12 hours to two hours and 30 minutes. The invention of the assembly line is referred to as the 2nd Industrial Revolution.



Sources: https://www.visiativ-industry.ch/industrie-4-0/

Engineering Process

Engineers follow a simple process when designing a solution to a problem. Start with asking, "What is the problem I am trying to solve and who am I solving it for?" Once this has been identified, collect information (research and prior knowledge) about existing solutions to avoid mistakes and learn about best practices. Determine specific requirements (aka what will define success when the problem is solved) and brainstorm solutions. Begin developing and testing the solution, making sure it meets the requirements you have set. Once the problem has been solved, it is important to clearly communicate the results.



Simple Machine Notes

Explain what a simple machine is:

Define the following terms <u>related to simple machines</u>:

- Mechanical advantage

- Input force / Effort

- Output force

- Resistance force(s)

- Motion

- Efficiency

Fill out the following chart:

Type of Machine	**Explanation:** Why is it considered a machine? (Use the terms mechanical advantage, input/output force, motion, and efficiency when possible and appropriate.)	**Examples:** Find at least 3 photos that show different, everyday examples of this type of machine.
Incline Plane		
Wheel and Axle		
Lever (Include explanation and examples for all three types of levers)		
Pulleys (Include explanation and examples for all three types of pulleys)		
Wedge		
Screw		

Assembly Line Rubric

Criteria	Points & Comments
Design: Clear, detailed drawing of final assembly line machine with labels for ALL material used. Each machine is labeled. Drawing is clear, easy to read, and understand.	/20
Assembly Line Machine: Contains at least 8 simple machines to solve the problem; is 30 seconds or more in length (from first machine to completed task/problem)	/20
Video Presentation: Introduces yourself and your school; identifies the problem you will be solving; briefly explains the machines and process of the assembly line; successfully demonstrates the entire machine; is no longer than 90 seconds.	/10
Total Points	/50