The Maker’s Journey:
Precision in Production

Assembly Line Challenge

Introduction:

The Assembly Line activity gives students a window into one of the most transformative ideas in engineering: how organizing people, tools, and tasks can dramatically improve how things get made. While students often think of engineering as designing or building a single object, modern engineering and manufacturing depends just as much on designing the *systems* that produce those objects reliably, safely, and efficiently. This activity helps students experience that shift firsthand.

In this lesson, students explore how breaking a complex build into smaller, repeatable steps can increase speed, reduce errors, and improve overall quality. They see how communication, role clarity, and workflow design affect output—exactly the same challenges real manufacturing teams face. When students test different layouts, adjust their process, or troubleshoot bottlenecks, they’re practicing the same iterative thinking used in factories, labs, and engineering firms today.

Overview:

In this hands-on engineering challenge, students simulate an assembly line to build cardboard crank, pivot, and guide components that will be used in the next lesson to construct linkage systems. Students must plan workflow, assign roles, manage quality control, and improve efficiency while working under time constraints. This activity emphasizes systems thinking, teamwork, and iterative improvement.

Learning Objectives:

By the end of the lesson, students will be able to:

1. Explain how an assembly line works and why task sequencing matters.
2. Collaborate effectively by assigning roles and following a defined process.
3. Build components that meet given specifications and quality standards.
4. Reflect on how efficiency, accuracy, and communication affect production outcomes.

Materials:

- Precision in Production Assembly Line Slideshow
- Quality Control Checklist Handout (Pring ahead of time, one for each group)
- Task Cards Handouts (Print ahead of time, one set of all 3 for each group)
  - Crank Assembly cards
  - Guide Assembly cards
  - Pivot Assembly cards
- Precision in Production Box of materials (1 box for each 4-5 student team)

- 1 sheet (or bag) of 25 1" circles
- 2 sheets (or bags) of 10 2" ovals
- 5 3" cardboard circles
- 1 3" Chipboard circle *(hole making template)*
- 1 4" cardboard square *(scrap for poking holes in circles)*
- 1 bag of 35 wood dowels
- 1 nail
- 1 ruler
- 1 bottle of glue
- 2 paper cups
- 2 paintbrushes
- 1 roll of tape

Scissors needed but not included in kit

Extra materials: *If any teams are short dowels or other parts, there are extras in the Part 2: Linkage boxes.*

Outline:

1. Ask students:
   - How are products like toys or bicycles made quickly and consistently?
   - Why don't factories have one person build everything?

2. Introduce the concept of an assembly line (example script below)

   Today you're going to operate like process engineers. Your goal isn't just to build a product — it's to design a production system that can build it accurately, repeatedly, and at scale.

   In engineering, the design of the object is only half the challenge. The other half is figuring out how to manufacture it efficiently. That means reducing variability, minimizing bottlenecks, and creating a workflow where each step adds value without introducing errors.

In small groups, you will create a plan to complete each discrete operation in the production of component parts. You are essentially creating an assembly line. Instead of one person working on one component from start to finish, you will divide up the many tasks, so each group member focusses on just one or two.

As you work, pay attention to where delays occur, where mistakes cluster, and which steps determine your overall pace. Engineers call these the constraints or rate-limiting steps in a system. Identifying and improving them is a core part of industrial engineering.

By the end of the activity, you should be able to discuss how workflow design, communication protocols, and standardization influence production outcomes — and why modern manufacturing depends on continuous improvement, not just clever designs.

3. Organize students into their teams and follow the Assembly Line Challenge Slideshow to introduce the Assembly Line activity

4. Planning and Role Assignment:
   Before assembly begins, groups take 10 minutes to:
   - Review task cards for cranks, pivots, and guides.
   - Decide the order to complete the tasks.
   - Assign roles.
   - Select a student to serve as Quality Control Officer who will move to another group once the assemble starts.

   Teacher Tip: Encourage students to think about steps that can happen at the same time and which cannot.

5. Assembly Challenge

   Use the classroom clock, stopwatches, or an online timer for recording assembly times for each group. Once a group says they are done they cannot make any more changes to the components. Allow Quality Control Officers time to inspect the components and add up any penalty time before reporting results to the whole class.

6. Reflections & Discussions
   - What slowed your group down?
   - Where did mistakes happen, and why?
   - How did planning help (or not help)?
   - What would you change if you could run the assembly line again?

- Encourage students to treat mistakes as data, not failures—this mirrors real engineering processes.

The big idea: engineering isn't only about building something once. It's about designing a system that can build it accurately, efficiently, and repeatedly. What your students practiced today is the foundation of modern manufacturing and industrial engineering.

Students may notice that small changes — reorganizing their layout, clarifying communication, standardizing motions — had a big impact on performance. That's exactly how continuous improvement works in real factories. Engineers don't just design products; they constantly refine the processes that make those products.

Vocabulary

Assembly line: A system where a product is built step by step, with each person or station responsible for one specific task before passing the part to the next step.

Quality control: The process of checking parts or products to make sure they meet the required rules and standards before they are considered finished.

Efficiency: How quickly and smoothly work is done while using the least amount of time, effort, and materials.

Inspection: A careful check of a part or product to see if it was built correctly and follows all the rules.

Workflow: The order in which tasks are completed and how materials move from one step to the next in a process.

NGSS Standards Reference Table

NGSS Code	Standard Description	Lesson Connection
MS-ETS1-1	Define criteria and constraints for a design problem.	Students identify materials, time limits, and quality requirements for their assembly line.
MS-ETS1-2	Evaluate competing design solutions using a systematic process.	Groups compare assembly strategies and reflect on efficiency and accuracy.
MS-ETS1-3	Analyze data from tests to identify best characteristics for a new solution.	Students analyze build times and inspection results to improve their process.
MS-ETS1-4	Develop a model for iterative testing and modification of a design.	Students test, modify, and optimize their assembly line process based on results and feedback.
ETS1.A	Defining and delimiting engineering problems.	Students clarify the challenge, constraints, and desired outcomes before starting.
ETS1.B	Developing possible solutions.	Groups brainstorm and assign roles to develop an efficient workflow.
ETS1.C	Optimizing the design solution.	Students reflect and iterate to optimize their assembly process.
SEP	Science & Engineering Practices: Planning, Analyzing, Explaining, Arguing from Evidence	Students plan, carry out, analyze, explain, and defend their assembly strategies and outcomes.
CCC	Crosscutting Concepts: Systems, Structure & Function, Cause & Effect	Students treat the assembly line as a system and observe how process changes affect outcomes.