Robot Arm Challenge
Real-World Application
Industrial Robots

- Robots that work in a manufacturing setting are known as, “industrial robots.”
- Industrial robots perform tasks such as sorting, welding, painting, product assembly, packaging, labeling, and quality inspection.
- Visit IEEE’s Robots website and check out some videos of Unimate the first industrial robot ever built.
Titan: Strongest Robot Arm in the World

Vist IEEE’s Robots website and check out some videos of Titan the world’s strongest robot arm in action.
The Design Challenge
You are a team of engineers all working together to follow the engineering design process to design a robot arm that meets the challenge criteria and constraints.
Defining the Challenge: Criteria & Constraints

Criteria:
- Arm length: minimum of 18"
- Pick up an empty Styrofoam cup 18” away
- Lift the cup to a height of at least 6”

Constraints:
- Use only the materials provided
- Create a solution in the time provided
Materials

Optional *(Table of Possibilities)*
- Binder clips
- Paper clips
- Brass fasteners
- Rubber bands
- Clothespins
- Popsicle sticks
- Wire
- Fishing Line
- String
- Tape
- Paper
- Short pencils

Required for each team
- Cardboard strips
- Cup (for testing)- may want to test multiple types of cups- plastic, styrofoam or paper or just test one.
Vocabulary

- **Engineers**: Inventors and problem solvers of the world. Twenty five major specialties are recognized in engineering (see infographic).
- **Engineering Habits of Mind (EHM)**: Six unique ways that engineers think.
- **Engineering Design Process**: Process engineers use to solve problems.
- **Criteria**: Conditions that the design must satisfy like its overall size, etc.
- **Constraints**: Limitations with material, time, size of team, etc.
- **Prototype**: A working model of your solution to be tested.
- **Iteration**: Test & redesign is one iteration. Repeat (multiple iterations).
- **Industrial Robot**: Perform tasks such as sorting, welding, painting, product assembly, packaging, labeling, and quality inspection.
- **Unimate**: First industrial robot ever built.
- **Titan**: The strongest robot arm in the world, with a payload capacity of over 1,000 kg (2,200 lb).
Engineering Design Process
Learn about the engineering design process (EDP). The process engineers use to solve problems.

Source: TeachEngineering YouTube Channel
Engineering Design Process

- Divide into teams of two (or more - up to 4 max)
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class
Productive Failure

The engineering design process involves failure: test, fail, redesign. Iterate again and again until you have the best possible solution.

It is important to document your iterations so they can keep track of each redesign. Use your engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.

It’s also important to showcase the fact that there can be multiple solutions to the same problem. There’s no one “right” solution.
Engineering Habits of Mind (EHM)

EHM is about how engineers think everyday. The core of the engineering mind is about making things that work and making things work better.

- **Systems thinking**: Seeing whole systems and parts and how they connect.
- **Problem-finding**: identifying and defining a problem.
- **Visualising**: manipulating materials and sketching- mental rehearsal of practical design solutions.
- **Improving**: Relentlessly trying to make things better by experimenting, designing, sketching, and prototyping.
- **Creative problem-solving**: generating ideas and solutions with others with many iterations.
- **Adapting**: Testing, analysing, reflecting, & rethinking.

Consider...

Before you get started brainstorming...consider the following...

- How can you control the movement of the arm from a distance?
- How might you use the fishing line?
- Consider the strength of the grip on the different types of cups
- Look at a trash grabber as one possible example
Engineering Fields
What is Engineering?

Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.

Source: TeachEngineering YouTube Channel
Related Engineering Fields

There are many different types of engineering fields that are involved with designing robot arms. Here are just some of the related engineering fields.

- **Mechanical Engineering**
- **Manufacturing Engineering**
- **Industrial Engineering**
- **Electrical Engineering**

Download the Engineering Fields Infographic

How will **YOU** change the world?
Greatest Engineering Achievements of 20th Century

- Electrification
- Automobile
- Airplane
- Water Supply and Distribution
- Electronics
- Radio and Television
- Agricultural Mechanization
- Computers
- Telephone
- Air Conditioning and Refrigeration

- Highways
- Spacecraft
- Internet
- Imaging
- Household Appliances
- Health Technologies
- Petroleum/Petrochemical Technologies
- Laser and Fiber Optics
- Nuclear Technologies
- High-performance Material

Source: [http://www.greatachievements.org/](http://www.greatachievements.org/)
Do you know any Engineers?

- How many engineers do you know? Your teammates? Your class?
- What do they do? What engineering degrees do they have?
- What items in your classroom and your school did engineers have a part in creating?

Check out the **NAE Grand Challenge for Engineering** to help you learn more about how engineers are making the world a better place:

- [NAE Grand Challenge for Engineering](#)
Reflect & Debrief
Reflection

- Which material was most critical to your robot arm design?
- How did working as a team help in the design process?
- What did you learn from the designs developed by other teams?
- How can you redesign it next time to make it even better?
For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE’s TryEngineering.org.

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