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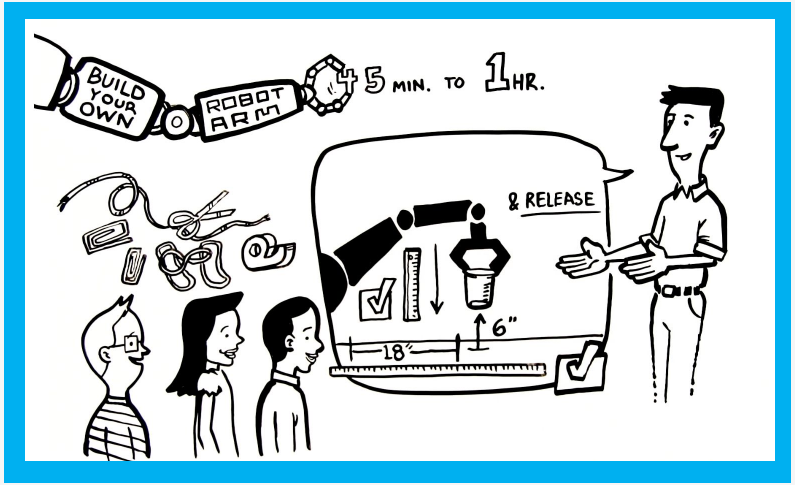
TRY Engineering

Lesson Plan:

Build Your Own Robot Arm



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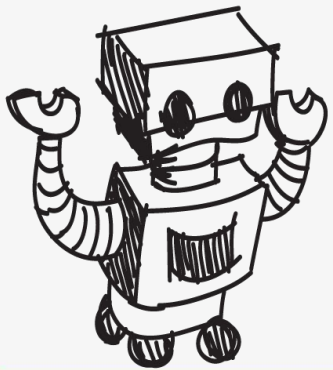
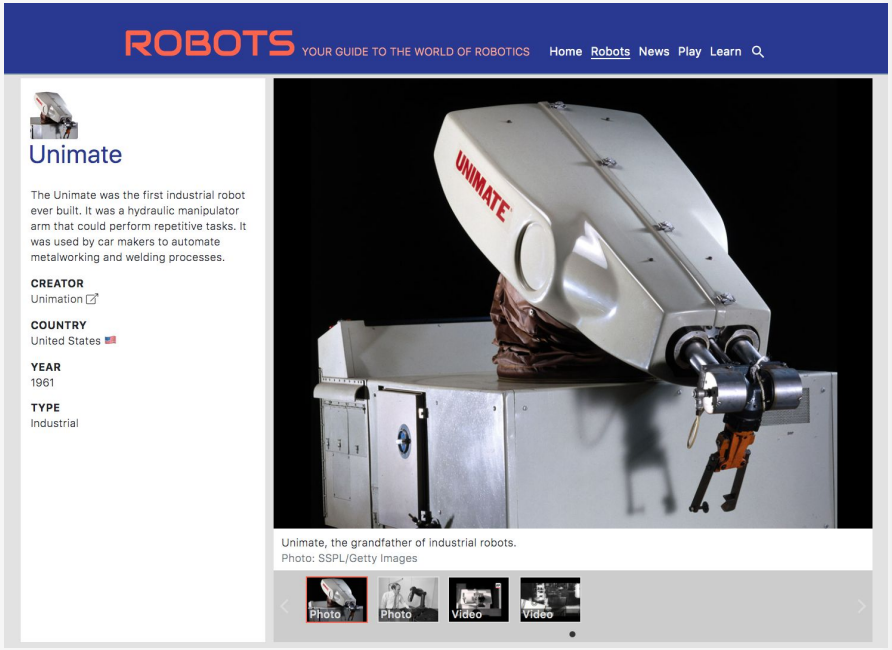
Real-World Application



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.



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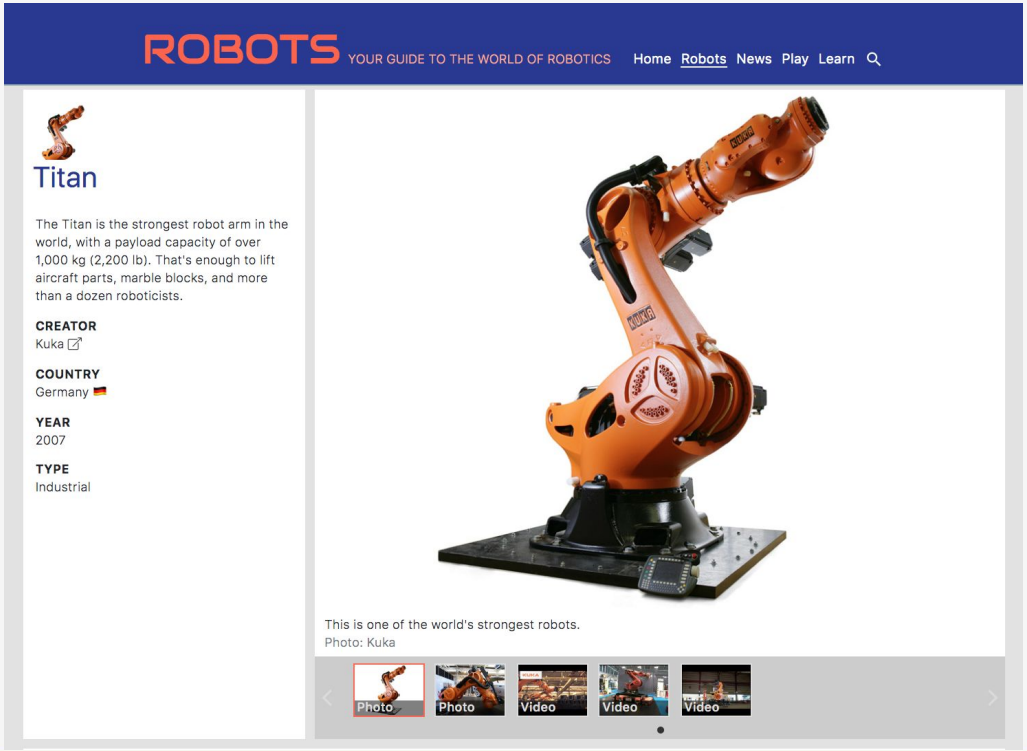
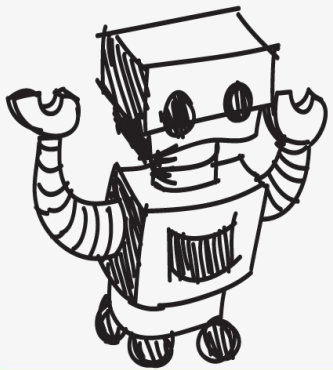
Titan: Strongest Robot Arm in the World



Visit [IEEE's Robots website](#) and check out some videos of Titan the world's strongest robot arm in action

The Design Challenge

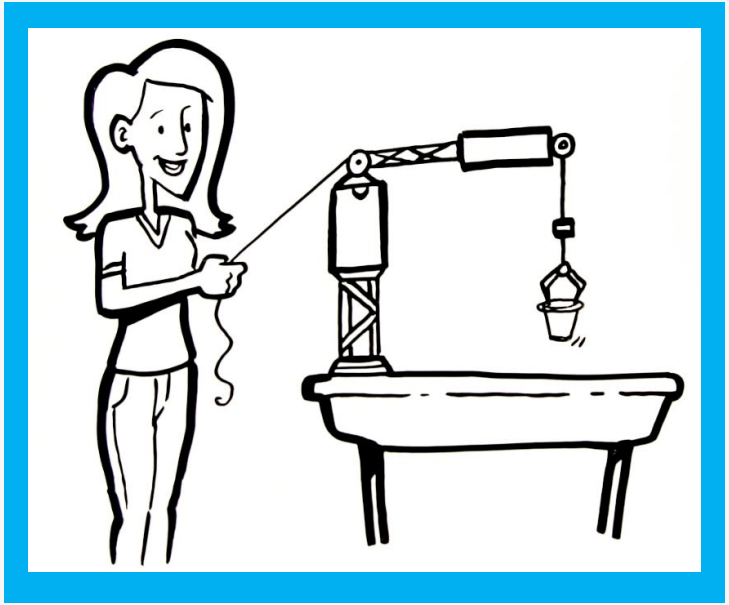


The Design Challenge

- You are a team of engineers all working together, using the engineering design process, to design a robot arm that meets the challenge's criteria and constraints.

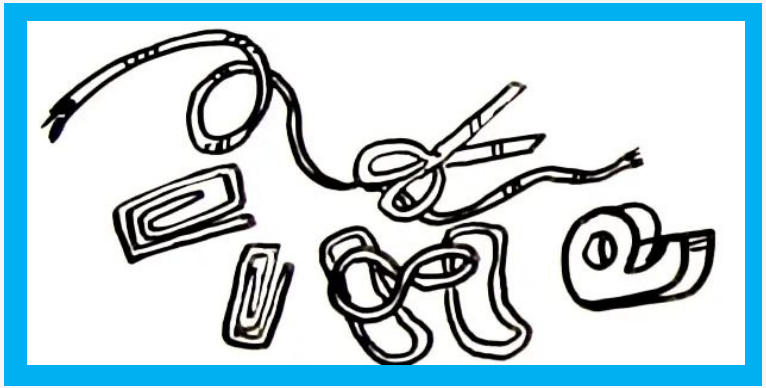
Defining the Challenge: Criteria & Constraints

- 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
  - Design a solution in the time provided



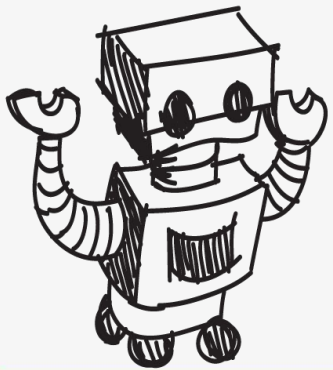
Materials

- 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.



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

Dig Deeper



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 the solution to be tested.

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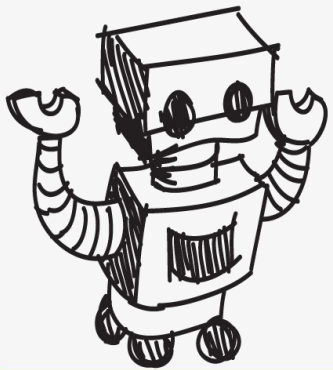
Vocabulary

- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Industrial Robot: Performs 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



The 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 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 productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.

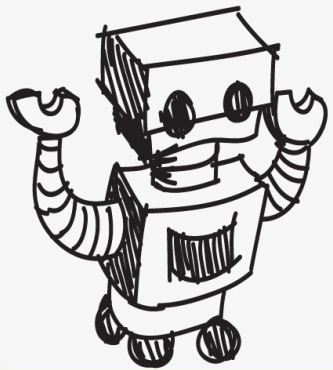
- It's also important to showcase the fact that there can be multiple solutions to the same problem. There's no one "right" solution.

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?

Source: TeachEngineering YouTube Channel

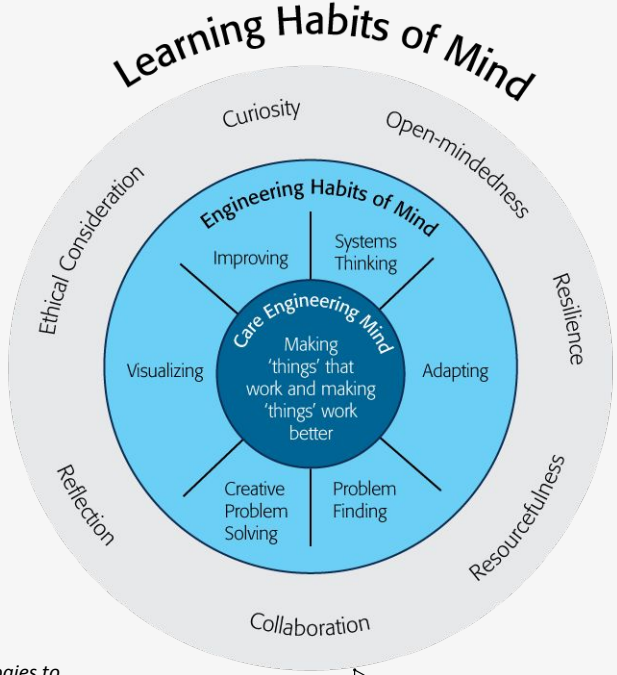
Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.

Related Engineering Fields

- There are many different types of engineering fields that involve 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?

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 them 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



Source: B. Lucas and J. Hanson, Thinking Like an Engineer: Using Engineering Habits of Mind and Signature Pedagogies to Redesign Engineering Education. (International Journal of Engineering Pedagogy, Vol 6, No. 2 (2016): https://online-journals.org/index.php/i-jep/article/view/5366)

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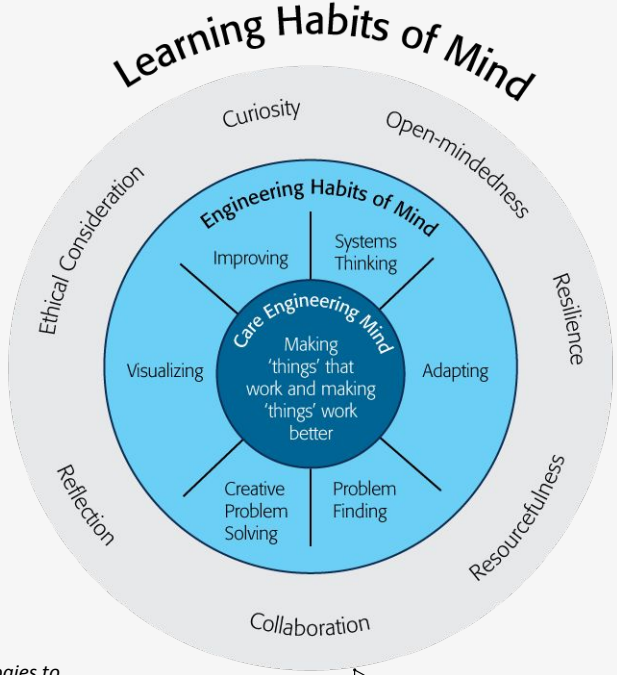
Engineering Habits of Mind (EHM)

- Improving: Persistently 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



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Greatest Engineering Achievements of 20th Century

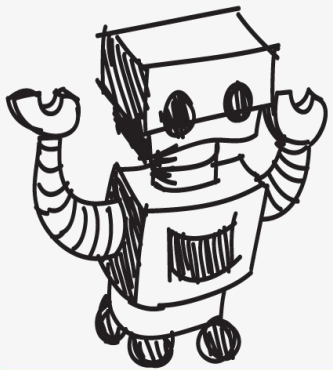
- Electrification
- Automobile
- Airplane
- Water Supply and Distribution
- Electronics
- Radio and Television
- Agricultural Mechanization
- Computers
- Telephone
- Air Conditioning and Refrigeration
- Highways
- Spacecraft
- Internet
- Imaging
- Household Appliances
- Health Technologies
- Petroleum/Petrochemical Technologies
- Laser and Fiber Optics
- Nuclear Technologies
- High-performance Material

Source: http://www.greatachievements.org/

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 help design?
- Check out the NAE Grand Challenges for Engineering to help you learn more about how engineers make the world a better place:
  - NAE Grand Challenge for Engineering

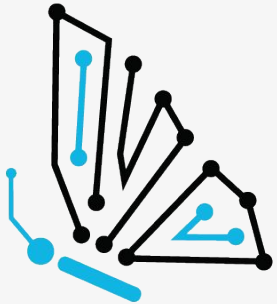
Reflect & Debrief



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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