

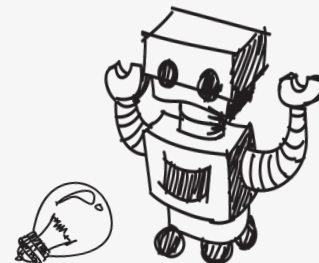
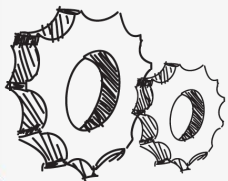


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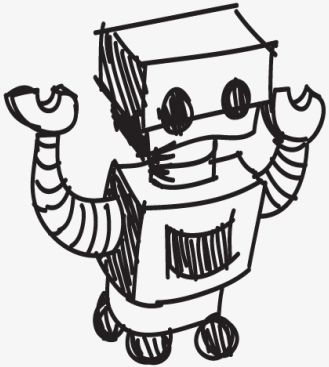
TRYEngineering



Keysight Lesson #3: AI & Machine Learning Sorter

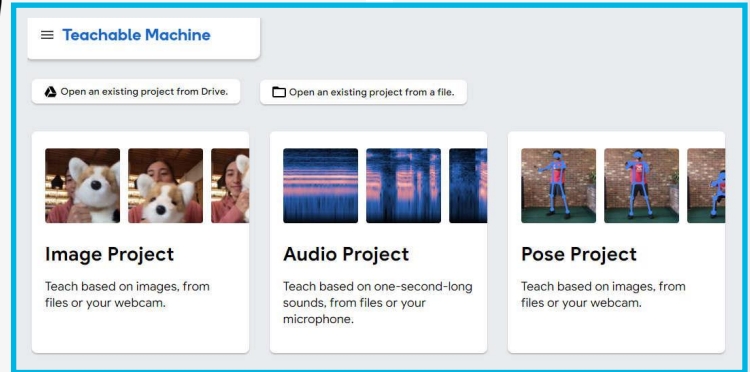


The Design Challenge



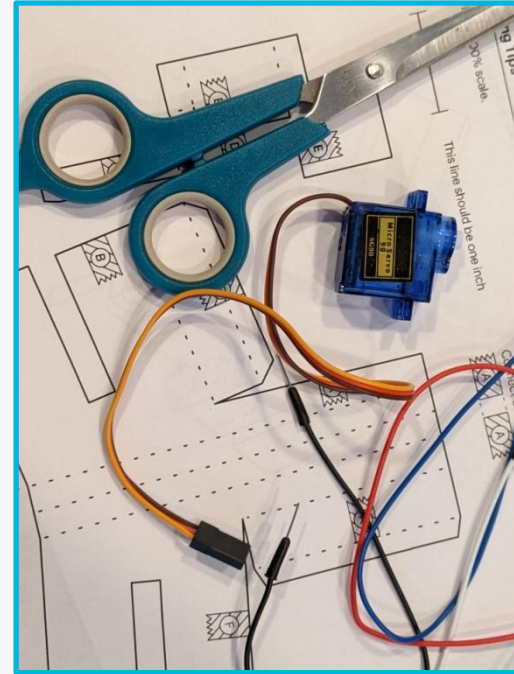
Exploring AI

For the first activity, you will use machine learning and the **Teachable Machine from Google** to train your computer to distinguish between items. This platform allows you to test how machine learning works and see how to increase the odds of having the machine make correct choices. You'll explore predictive image matching as well as machine learning techniques to improve the accuracy of your computer system.



The Design Challenge

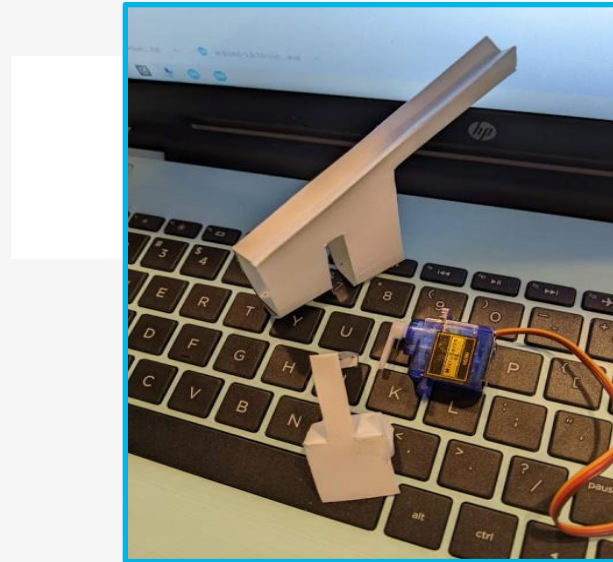
You have been given the challenge of working as part of a team of engineers use machine learning to train your computer to distinguish between two different types of dry cereal and then accurately sort the two into separate cups via a simple device attached to an Arduino. You'll then re-engineer the device to improve how efficient it works.



Defining the Challenge: Criteria

Criteria

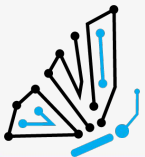
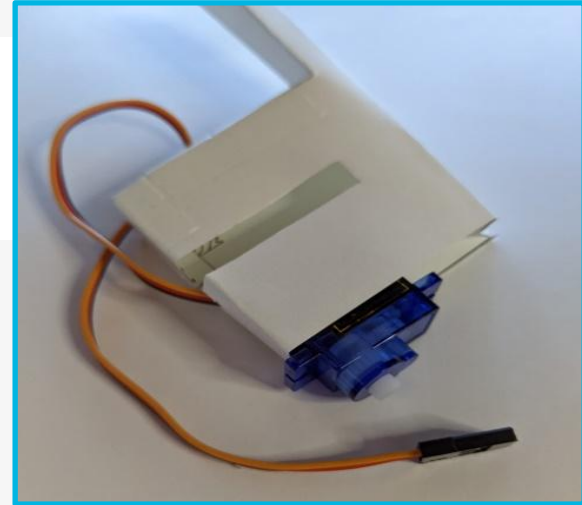
- ▶ The computer must be well trained or it will make errors.
- ▶ Cereal must be sorted correctly every time.
- ▶ Students can alter the design or the code if they have ideas for improvement.



Defining the Challenge: Constraints

Constraints

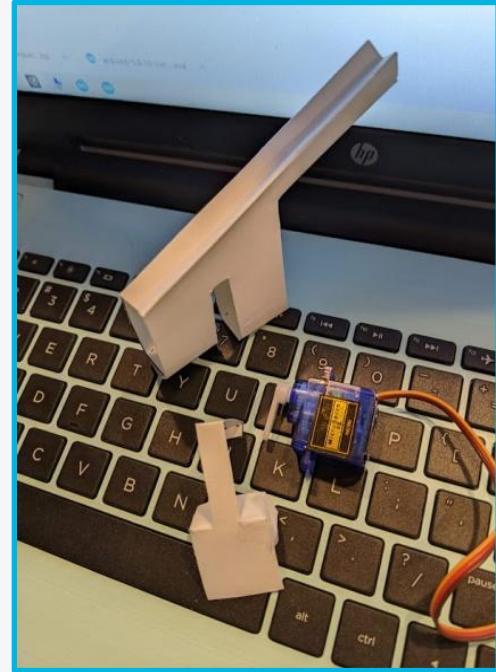
- ▶ Time
- ▶ Materials
- ▶ Teamwork



Materials

Required

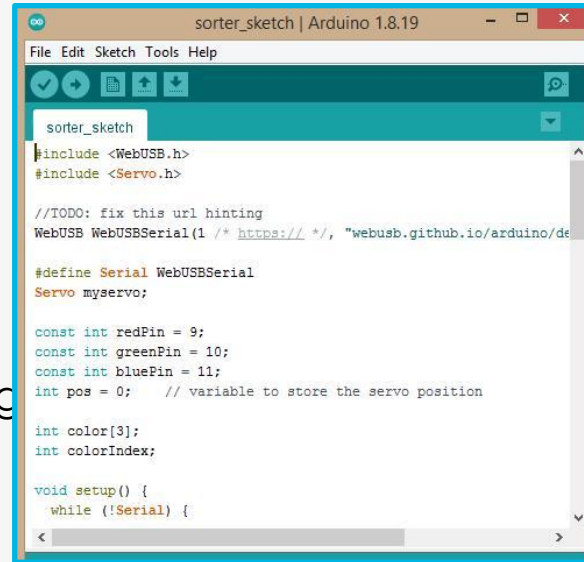
- Computer (shared by two students)
- Cardboard Template
- Scotch Tape
- Scissors
- Ruler
- Googly Eyes
- Arduino Leonardo
- Micro Servo (SG90)
- Five jumper wires (Male to Male)
- Two paper cups
- Two different types of dry cereal



Consider...

Before you get started...brainstorm and consider the following...

- ▶ Understand the Challenge
- ▶ How to approach the machine learning aspect of the challenge
- ▶ Problem solving
- ▶ Troubleshooting errors in sorting



```
sorter_sketch | Arduino 1.8.19
File Edit Sketch Tools Help
sorter_sketch
#include <WebUSB.h>
#include <Servo.h>

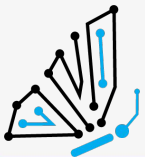
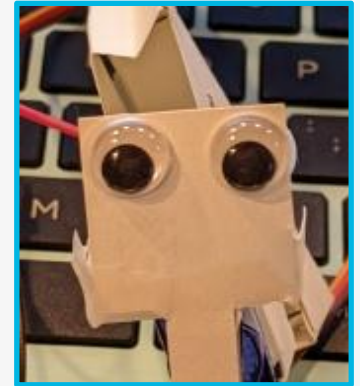
//TODO: fix this url hinting
WebUSB WebUSBSerial(1 /* https:// */, "webusb.github.io/arduino/de

#define Serial WebUSBSerial
Servo myservo;

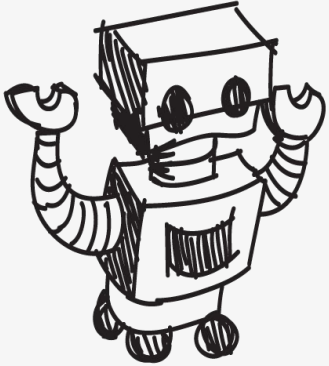
const int redPin = 9;
const int greenPin = 10;
const int bluePin = 11;
int pos = 0; // variable to store the servo position

int color[3];
int colorIndex;

void setup() {
  while (!Serial) {
```



Engineering Design Process



The Engineering Design Process



Learn about the engineering design process (EDP). The process engineers use to solve problems.
(Video 1:47)



Source: TeachEngineering YouTube Channel <http://www.youtube.com/watch?v=b0ISWaNoz-c>

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

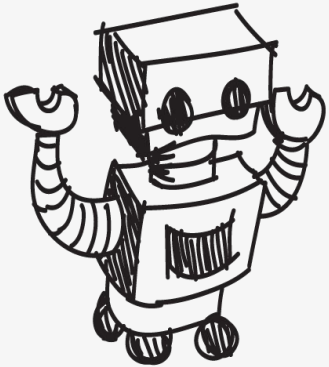


Productive Failure

- 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.



Vocabulary

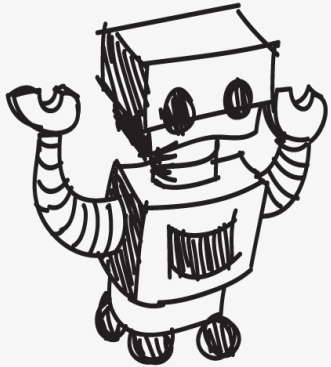


Vocabulary

- ▶ 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.
- ▶ 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)
- ▶ Artificial Intelligence: aims to imitate human or “natural” intelligence by use of modern algorithms and datasets that imitate human learning.
- ▶ Machine Learning: the use of algorithms used to support intelligent strategies for pattern recognition.



Background Knowledge



What is AI?

Artificial Intelligence (AI) seeks to replicate human or “natural” intelligence using advanced algorithms and datasets that mimic human learning processes. It's like teaching computers to think, learn, and make decisions!

1. **Search Engines:** AI helps search engines by recommending websites to users based on individual requests, and tracks how well the suggested sites meet the users' needs.
2. **Music Apps:** Music streaming services also use AI algorithms to determine which song a subscriber might want to hear next. AI works behind the scenes to suggest songs you might like. It learns from your favorite tunes and creates playlists just for you.
3. **Self-Driving Cars:** Self-driving cars require AI algorithms to interpret the motion of other vehicles from real-time cameras, to read and understand road signs, and to make choices regarding steering, speed, and safety



What are some other application of AI?

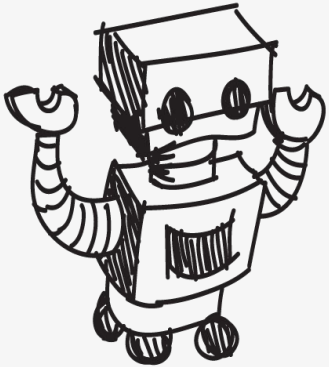
What is Machine Learning?

Machine Learning (ML) is a widespread and influential variety of AI which enables machines to perform complex tasks without specific instructions or programming. This goal is achieved using statistical optimization, which sometimes incorporates **feedback from the environment** in which an algorithm operates, and is inspired by the immersive way that humans and other animals are able to learn.

- **Image recognition** and searching for similar images (e.g. Google Lens) are successful arenas for supervised ML. Applications of image recognition include facial or eye recognition in a security system, quality assurance in manufacturing settings, and automated diagnosis from medical scans.
- **Computer vision** is used to inform autonomous vehicles about their surroundings, to perform face tagging online, and to automate military combat including missile guidance.



Dig Deeper



Dig Deeper Challenge

- ▶ Do you think that the development of artificial intelligence puts humanity at risk?
- ▶ Are there certain applications you think should be in accessible to “intelligent machines?” Consider warfare, weather forecasting, remote surgeries --- can/should all of these be managed by intelligent machines?
- ▶ Where do you think machine learning can have the greatest impact to help society? Harm society?
- ▶ Do you think that machines and humans should have separate access to the internet?

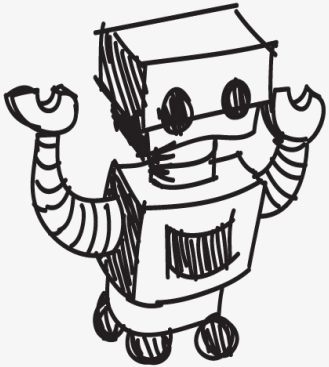


Online Resources

- ▶ What is Machine Learning?
(<https://www.ibm.com/cloud/learn/machine-learning>)
- ▶ Artificial Intelligence
(<https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-artificial-intelligence>)
- ▶ Teachable Machine
(<https://teachablemachine.withgoogle.com/>)
- ▶ MathWorks Machine Learning Videos
(<https://www.mathworks.com/videos/series/introduction-to-machine-learning.html>)



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.

(Video 3:43)



Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvaGmVo>

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Related Engineering Fields

There are many different types of engineering fields that are involved with communication methods and equipment. And as is true with most industries, engineers of different disciplines often work together in teams to create or improve a product or process. Some of the prominent degrees leading to a career in artificial intelligence include:

- ▶ [Computer Engineering](#)
- ▶ [Software Development](#)
- ▶ [Electrical Engineering](#)
- ▶ [Computer Science](#)

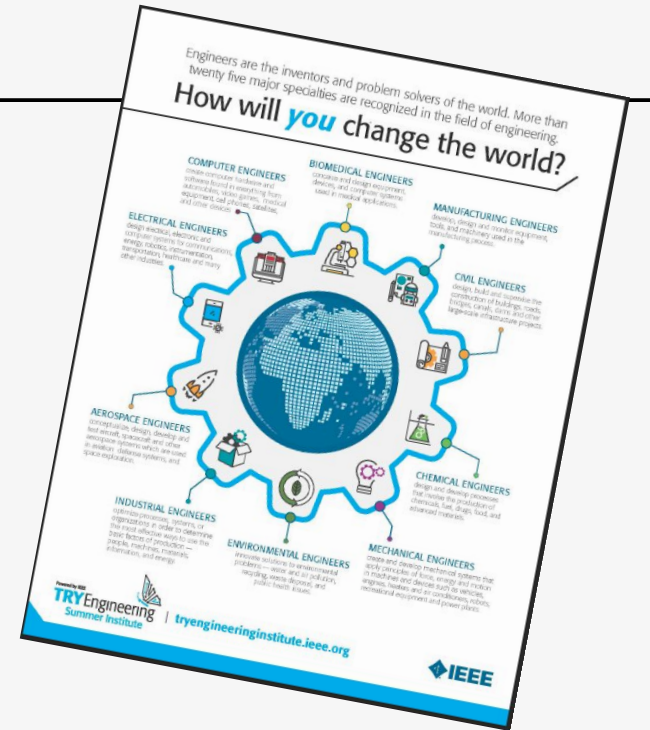
Details on these and others are available at www.tryengineering.org.



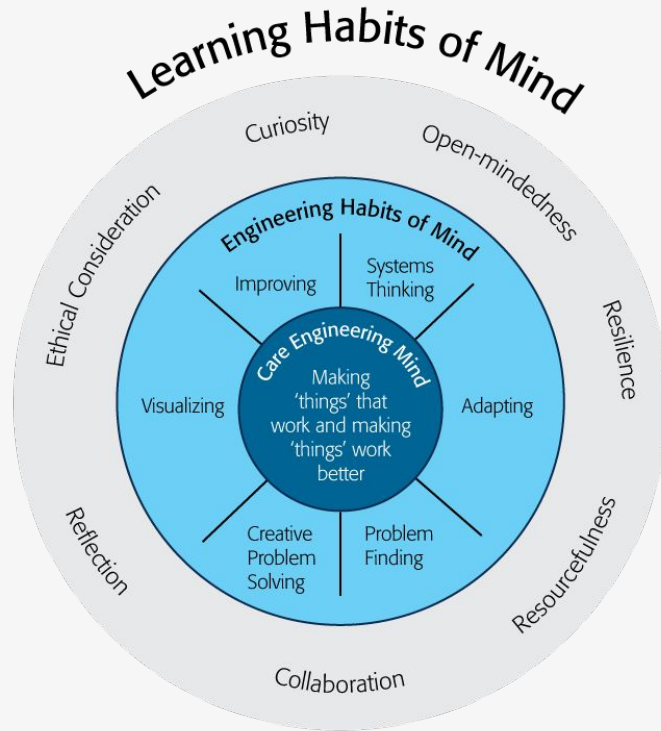
Related Engineering Fields

- Download the Engineering Fields Infographic How will **YOU** change the world?

Engineers are the inventors and problem solvers of the world! More than twenty five major specialties are recognized in the field of engineering. **Engineers make the world a better place!**



Engineering Habits of Mind



Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

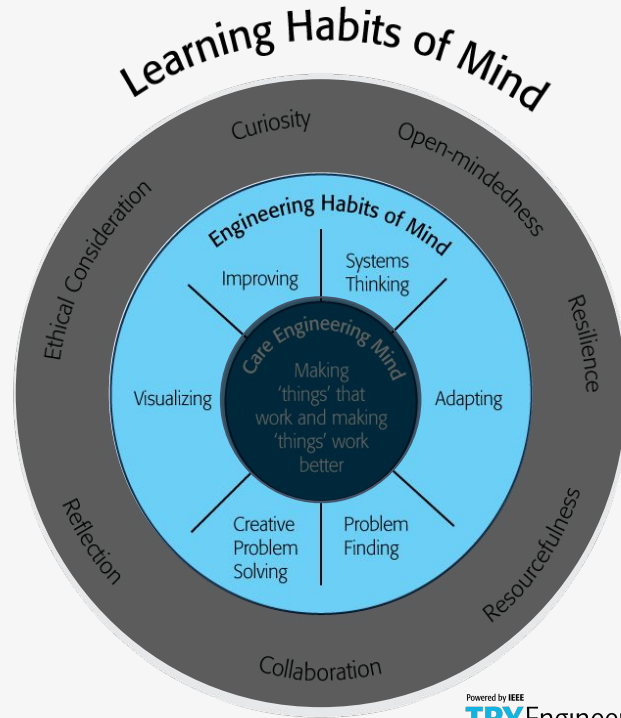
Source:

<https://online-journals.org/index.php/i-jep/article/view/5366>



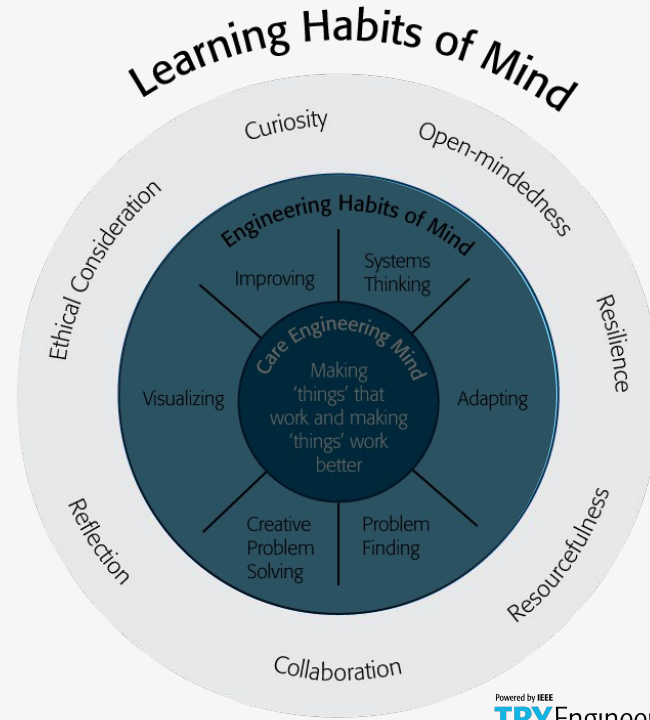
Engineering Habits of Mind Checklist

- ❑ Systems thinking
- ❑ Problem-finding
- ❑ Visualising
- ❑ Improving
- ❑ Creative problem-solving
- ❑ Adapting



Learning Habits of Mind Checklist

- ❑ Open-mindedness
- ❑ Resilience
- ❑ Resourcefulness
- ❑ Collaboration
- ❑ Reflection
- ❑ Ethical Consideration
- ❑ Curiosity



Greatest Engineering Achievements of the 20th Century



Greatest Engineering Achievements OF THE 20TH CENTURY

Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration

11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

LinkEngineering



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

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Learn more about how engineers make the world a better place



The banner features the NAE logo (three interlocking puzzle pieces) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" with "NATIONAL ACADEMY OF ENGINEERING" in smaller text below. Navigation buttons for "Challenges", "News", and "Community" are in green rounded rectangles. The main visual is a green puzzle piece with a nuclear fusion symbol, set against a background of glowing green lines and dots radiating from a central point. Below the puzzle piece, the text "Provide energy from fusion" is displayed, followed by a paragraph: "Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way." A row of ten diamond-shaped icons represents various engineering fields: a smartphone, VR, a gear, a classical building, a water drop, a nuclear symbol, CO2, a brain, a laptop, a padlock, and a microscope.

NAE GRAND CHALLENGES FOR ENGINEERING
NATIONAL ACADEMY OF ENGINEERING

Challenges News Community

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.



For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE's [TryEngineering.org](https://www.tryengineering.org)

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