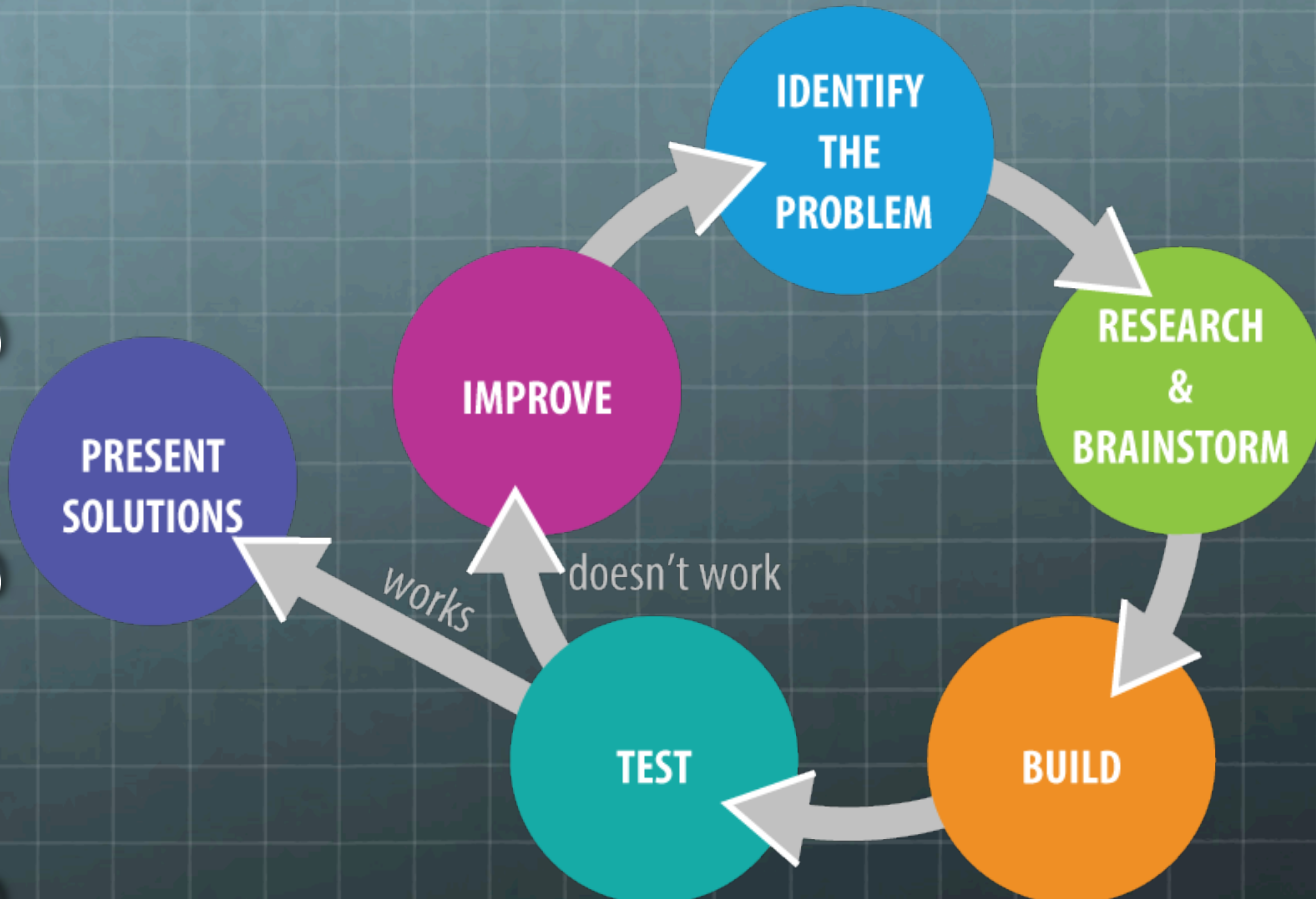
Engineering Design Process



The Engineering Design Process

What is the Engineering Design Process?

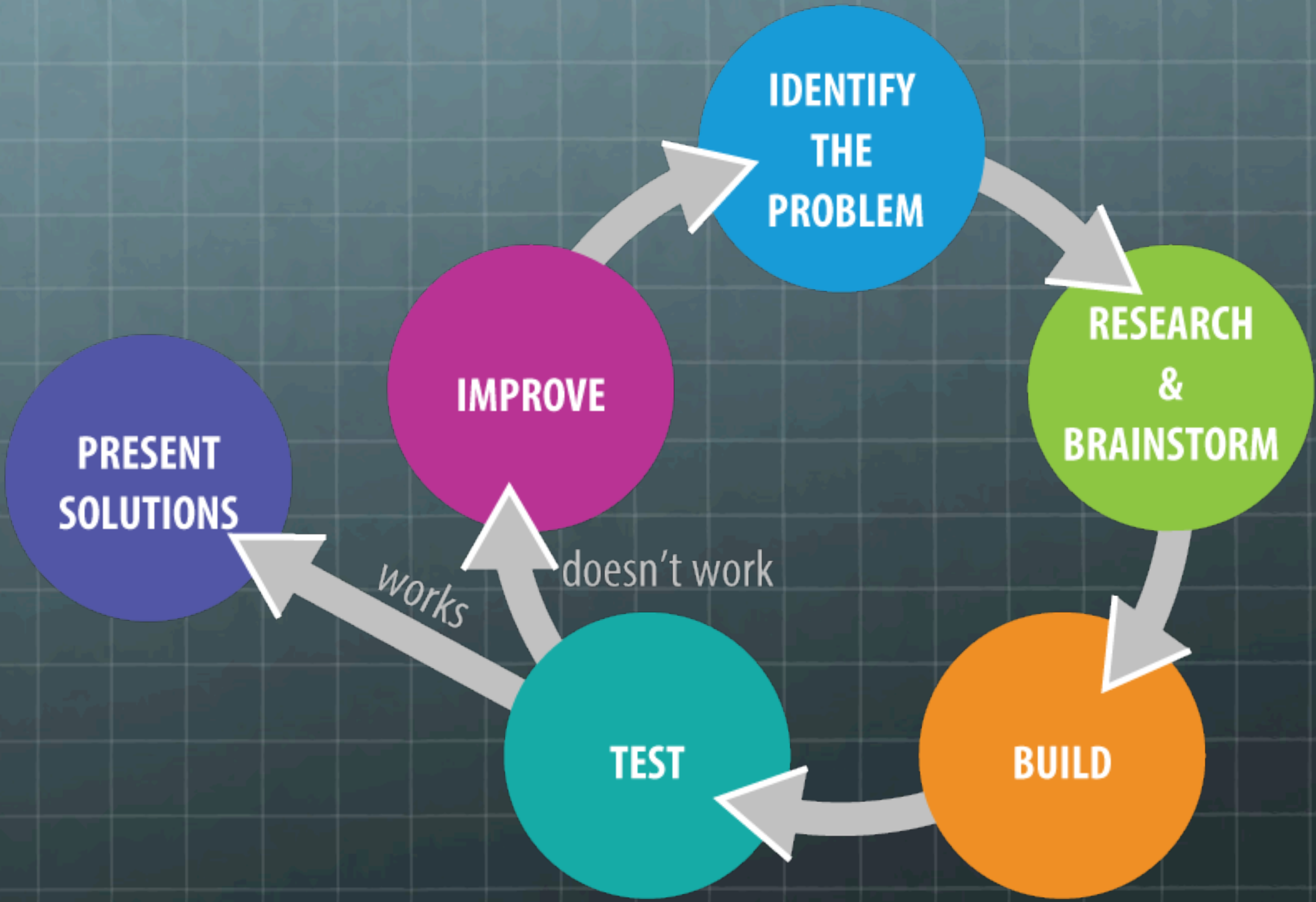
- The engineering design process is a creative planning process that leads to useful products and systems
- There are no perfect designs.
- The design process is never final; there are always multiple solutions to a problem.
- The design process is influenced by requirements called *criteria* and *constraints*.

Criteria and Constraints:

Criteria: identify the desired elements and features of a product or system and usually relate to their purpose or function.

Constraints: such as size and cost, establish the limits on a design.

Engineering Design Process



Step One:
Identify the Problem by Asking a Question

- Defining the problem is like conducting detective work.
- You must examine the evidence and form some conclusions.

Step Two: Plan & Brainstorm

- Brainstorming involves bringing a group of people together to generate many different ideas.

- All ideas are considered- None are criticized

Step Two:
Plan & Brainstorm

Research may require going to the library, using computer databases, writing letters, performing experiments, and asking questions.

Step Two: Plan & Brainstorm

Develop multiple ideas that will solve the problem and meet the requirements

Criteria:

- ✓ How will the solution actually work?
- ✓ What materials should I use?
- ✓ What should the product look like so that people will buy or use it?

Constraints:

- ✓ Will it be completed by the deadline?
- ✓ What size should it be?

Step Two:
Plan & Brainstorm

CHOOSE THE BEST IDEA

Decide on an idea that best meets the criteria, fits within the constraints, and has the least amount of negative characteristics.

- Choose the best idea by listing the strengths and weaknesses of each alternative.
- Decide which one would provide better performance and/or safety
- If you need to, compromise. Give up one desirable trait for another

Step Three: Create a Prototype

- Realistic drawings help you visualize what the solution will look like in real life.
- Build a prototype or model of your design based on your drawings. A prototype is a working model; it looks and functions just like the finished product.

Step Four: Test and Evaluate

Prototypes must be tested and important questions must be answered during the evaluation.

Possible Questions:

- **Is it safe for people and the environment?**
- **Is it comfortable?**
- **Is it affordable?**
- **Does it look good?**
- Will it last as long as it needs to?
- Does it meet the criteria and constraints?
- Does it work?

Step Five: Improve Design

- After studying all test data and evaluating design solutions, you may need to make changes.
- This is the time to improve the design before production starts

Step Six:
Share & Present Solutions

- Share your design ideas with others to prove the design is worthy of manufacturing.

Possible ways that you can share your solution:

Poster	Drawings	Charts
Prototypes	PowerPoints	Reports
Discussion	Magazine Articles	

INERTIA LANDER

WE CHALLENGE YOU TO…

…design and build a shock-absorbing system that will protect a pilot when he/she lands.

INERTIA LANDER

- In this lesson, students assume the role of NASA aerospace engineers, using the engineering design process to learn steps for designing, creating, and improving equipment.
- Students design and build a shock-absorbing system that protect a cotton ball “pilot” when they land. By doing so, they come to understand some of the challenges of inertia during landings.

INERTIA LANDER

- Students perform the following:
  - Design and build a shock-absorbing system out of a combination of materials.
  - Use test results to improve their design.

Vocabulary & Concepts

- **Potential and Kinetic Energy:** When the lander hits the surface, its motion (kinetic) energy is changed into stored (potential) energy, which gets stored in the shock absorbers.
- **Acceleration Due to Gravity:** The lander accelerates (speeds up) as it falls due to Earth's gravitational pull.

Vocabulary & Concepts

- Air Resistance: Even though there is no air on the moon, we need to consider that on Earth when testing our lander. Air exerts a force on the lander as it falls, slowing it down.
- Measurement: Students measure the various heights from which they drop the lander.

Materials

- 1 piece of Cardstock
- 1 small paper cup
- 3 index cards
- 1 cotton ball
- 8 plastic straws
- scissors
- tape

Function of Parts

- Cotton ball = Pilot
- Cardstock = Half for the platform to place the cabin, use the other half for other uses as needed
- Cup = Lander cabin
- Straws = Lander structure and/or Shock absorbers as needed
- Index Cards = Shock absorbers as needed

Brainstorm & Design

- What kind of shock absorber can we make from these materials to help soften a landing?
- How will we make sure the lander doesn't tip over as it falls through the air?
- What things other than shock absorbers do you need to think about to help protect the pilot?
- How will you position the pilot's cabin on the flat platform at the top of the lander?

Brainstorm & Design

- What types of materials will absorb the shock of an impact, or force of the crash?
- How many shock absorbers will your lander need to make a softer landing?
- How will you keep the pilot from falling out of the cabin?
- Remember, *brainstorm BEFORE* you build!

Build, Test, & Evaluate

1. Design a shock-absorbing system from the supplied materials, (think about how springs and cushions are used).

2. Only AFTER designing, may you begin constructing your lander.

3. Put your group's name & cohort on the platform.

Build, Test, & Evaluate

4. Attach your shock absorbers to the platform.
5. Finally, add a cabin for the pilot by taping the cup to the platform.
6. Put a pilot (the cotton ball) in the cup.
   - Nothing other than the cotton ball can be in the cup.
   - The cotton ball must remain in its original shape; it must not be changed in any way.
   - The cup has to stay open—no lids!

Build, Test, & Evaluate

- Ready to test?
  - Test the lander from different heights.
  - Begin by dropping your lander from a height of one foot (30 cm).
  - If successful, repeat the test by raising the lander one foot for every test.
- Evaluate & Redesign:
  - If the pilot bounces or falls out, figure out ways to improve your design.
  - Study any problems and redesign.

Assessment

- Each group will show the class their landers, explaining their design choices and how they solved the problems they encountered.

Be Ready to Discuss:

- What forces affected your lander as it fell?
- After testing, what changes did you make to your lander?
- How did testing help you improve your design?
- What did you learn from watching others test their landers?