

UNIVERSITY TRANSPORTATION CENTER FOR

RAILWAY SAFETY

Day 4

FULL STEAM AHEAD:
THE FINAL FREIGHT CHALLENGE



UTRio Grande Valley

Housekeeping Rules

Safety and **respect** is our priority, please adhere to the following rules so that we can have a fun and engaging experience.



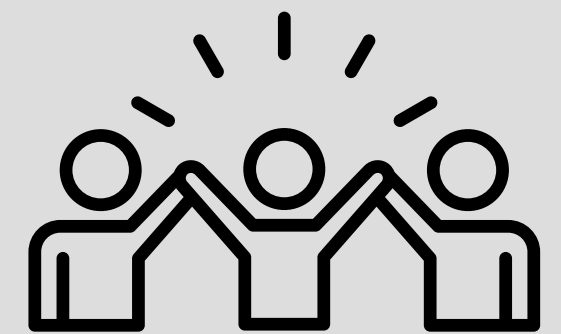
Must wear
designated shirt
every day.



Restroom only
when
accompanied by
an adult.



Use of electronic
devices is only for
instructional purposes.



Be active,
engaged, and
participate in your
group.

High Bay Tour!

Preparation Guidelines:

- Make sure to wear closed-toed shoes.
- No shorts allowed! Only long pants are permitted.
- Don't hesitate to ask questions!

High Bay Tour!

Questions:

- How many of you are aware of what you plan to study in college?
- How many of you have an interest in pursuing a career in the STEM field?
- Are you familiar with the roles and responsibilities of engineers?

Winning Contract

- Instructors will choose a winning team that excels in the challenge, showcases effective teamwork, and exhibits perseverance in the face of minor setbacks.
- The victorious team will go on to compete against the winners from other weeks on **Friday, June 26, 2026**.
- **Time:** 8:00 AM – 12:00 PM



Conductor Award

- Instructors will select one exceptional student for recognition.
- This student will have the opportunity to return and compete, even if their team does not win.
- One conductor award for each level (elementary, middle, and high school) will be presented during the ceremony on June 26 at 6 PM.

Today's Agenda

1. High Bay Tour
2. Work as a team
3. Train Science
4. Newton's 3rd Law
5. Forklift: Wheel and axel assembly challenge
6. Closing Discussion



Team Building Activity

Good Listener: Practice listening

Instructions

- Form two lines and stand facing your partner.
- Place a cup (or any object) on the ground between the two of you.
- Pay close attention as the instructor calls out various body parts, such as: Head, Shoulders, Knees, or Toes.
- Each time a body part is mentioned, touch it as swiftly as you can.
- When the instructor shouts "Cup!", promptly grab the cup.
- The student who seizes the cup first wins that round.
- Successful participants will advance to compete against other winners.

Examples



Laughtercise. (2020, October 19). Team building activities for employees – Grab the cup! [Video]. YouTube. <https://www.youtube.com/watch?v=4ccTaGjQecI>



Corporate Games. (2023, August 4). Corporate games, Fun Friday, team building games, inclusion, office games [Video]. YouTube. <https://www.youtube.com/watch?v=WhKJAOAGbr4>

Reflection Questions

- What happened when you lost focus?
- How did paying attention help you do well?
- How did you show good sportsmanship during the activity?
- Why is listening an important skill for engineers and train workers?
- How can quick reactions help keep people safe near train tracks?

Railway Systems

Review of Locomotive Science

Cargo Container Types



Dry Container

(Box Containers)

Carry clothes, toys, books, tools and things that don't need to be cold.



Hopper

Carry grains, wheat, or gravel. Has a bottom hatch that opens and closes.



Tank

Carry liquids like milk, oil or chemicals, think of it like a soda on wheels!

Business Classifications

Class 1

- Major national freight railroads
- Operate across multiple states and even internationally
- Move massive volumes of cargo
- **Longest & Fastest**

Class 2

- **Regional railroads**
- Operate within a specific region
- Connect rural or mid-sized areas to Class 1
- Handle medium-distance freight

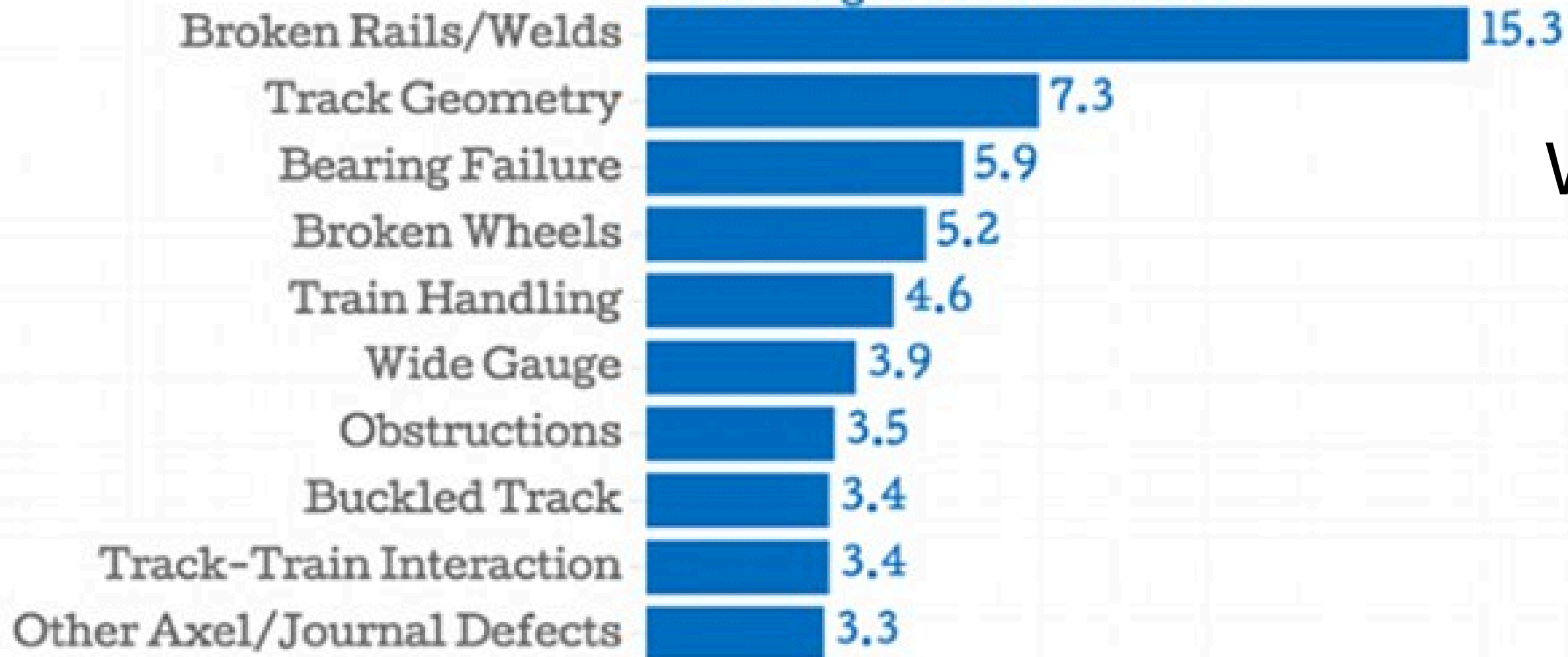
Class 3

- **Short line & local railroads**
- Often within cities or short rural stretches
- Serve vital role moving goods to and from Class 1 or Class 2 railroads

What Factors Can Lead To A Train's Failure?

Causes Of Main Line Train Derailments

Percentage of Derailments



Made with Chartbuilder

© Federal Railroad Administration

Data: Federal Railroad Administration

What is the main reason
trains go off the tracks
according to this
information?

Credit: Zolfagharifard, E. (2015, May 13)

Causes of Main Line Train Derailments.
Note. Reproduced from data published by the Federal Railroad Administration.
Chart created using Chartbuilder.

How Do Engineers Work To Prevent Derailments?

Key Components

- Inspections
- Sensors
- Signals
- Maintenance
- Emergency Systems



Why are signals and sensors important?

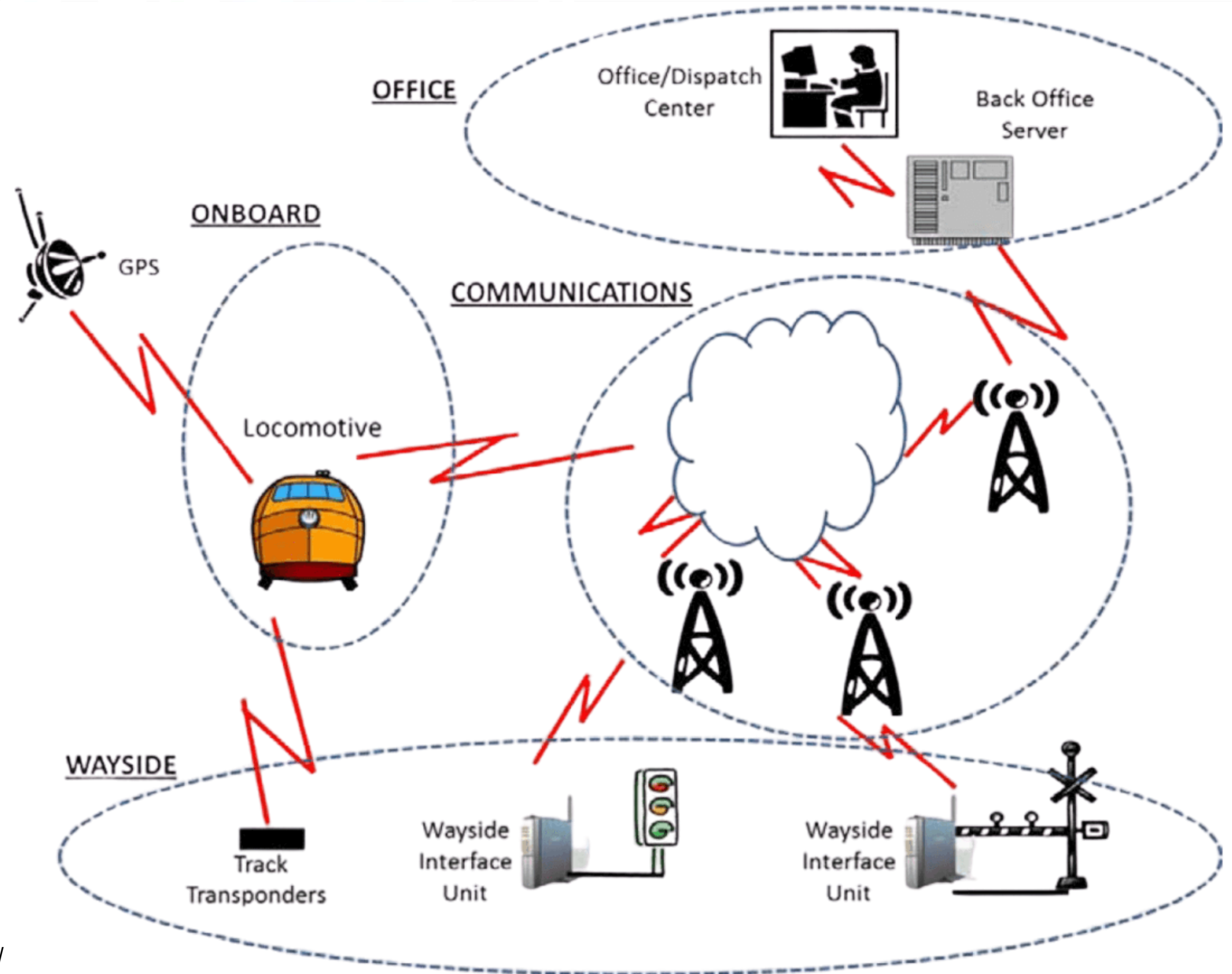
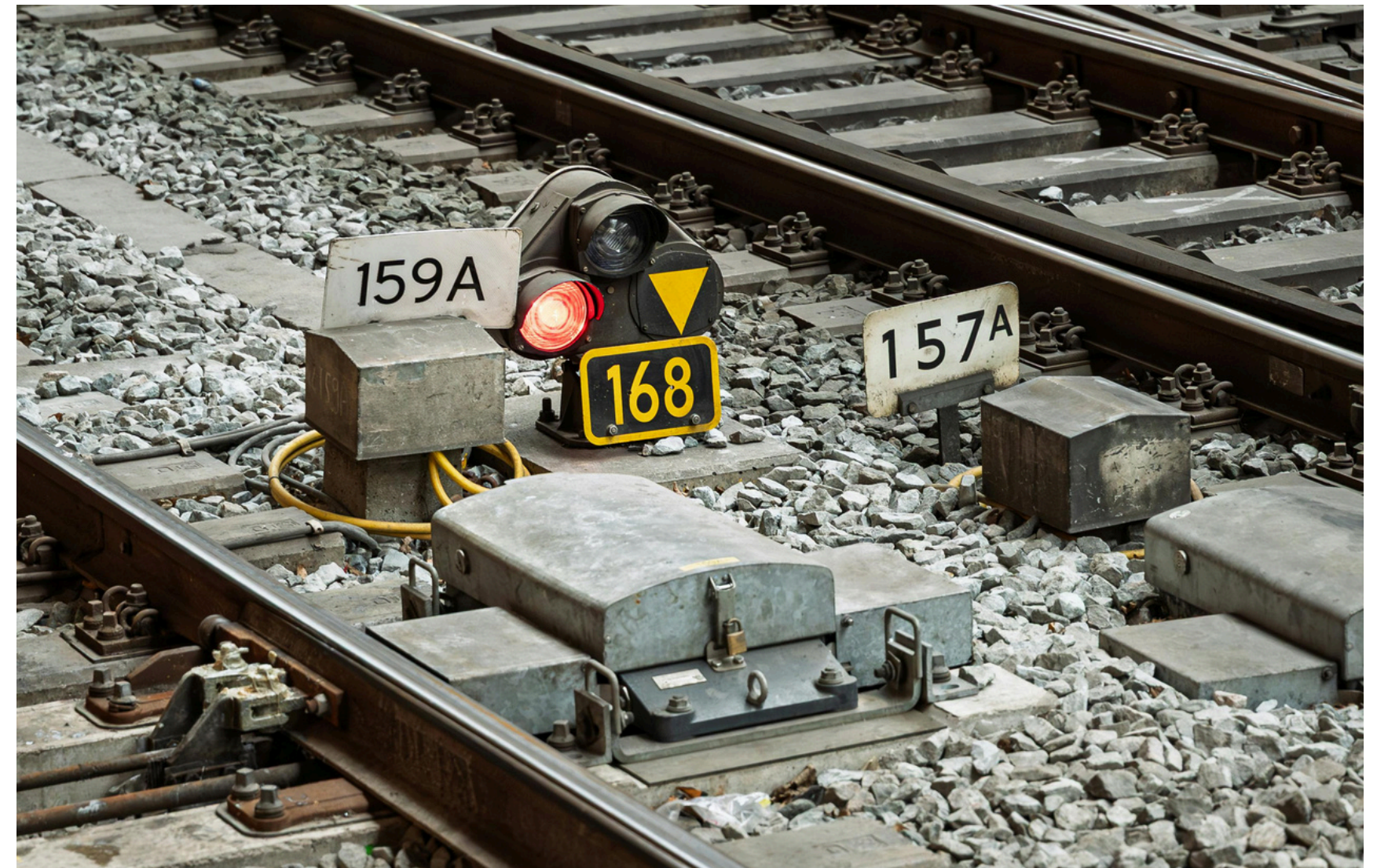


Image: Rutgers Center for Advanced Infrastructure and Transportation (CAIT).
(2019). Positive Train Control (PTC) technology illustration. <https://cait.rutgers.edu/>

Signals And Sensors Are Utilized To:

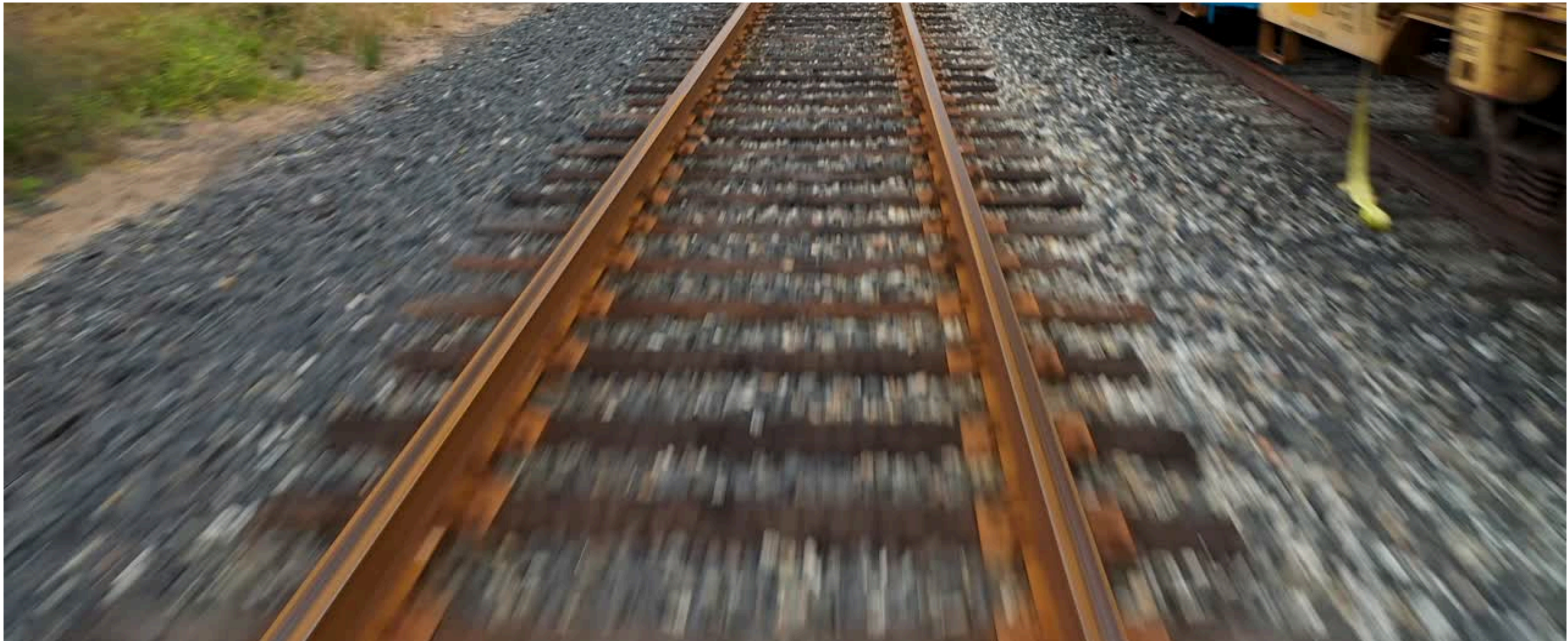
- Identify objects
- Halt movement
- Prevent collisions
- Transport cargo safely



Trackside Theory

Engineering Principles in Action

How Do Trains Propel Themselves Forward?



Newton's 3rd Law

01

In the video, what happened to the objects when a force was used on them? How is this like when a train starts to move?

02

When a train pushes against the tracks what is the opposite reaction?

03

How could this law be connected to safety systems like sensors or emergency brakes?

How do trains
move forward?



LearnFree. (2022, October 19). Action and reaction: Newton's third law (updated) [Video]. YouTube. <https://www.youtube.com/watch?v=mO1qtmFee-k>

Balloon Racer Activity



- Students will learn about Newton's Third Law by making racers powered by balloons.
- They will see how action and reaction forces work, just like in trains when they speed up and slow down, especially with sensors.

Materials



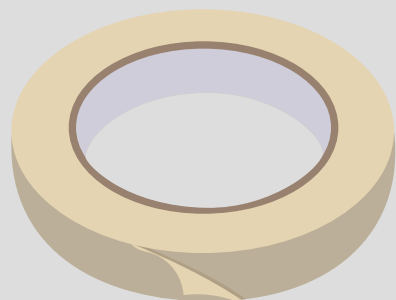
1 balloon



1 straw



String



Tape



2 chairs to
anchor string

Reaction:
Balloon accelerating upwards



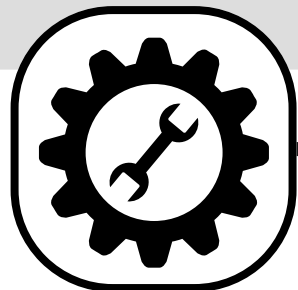
Action:
Air accelerating downwards

Animated image: Te Awamutu Space Centre. Balloon rocket activity. <https://www.spacecentre.nz/resources/rockets/>

Experiment Steps

Build

- Thread the straw onto the string.
- Tape the balloon to the straw
- Inflate the balloon (don't tie it), hold it shut and get ready.



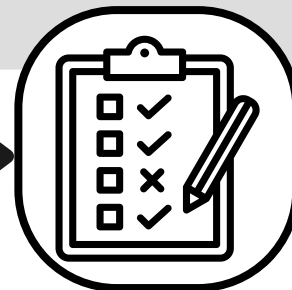
Test Run

Let go of the balloon and watch the racer fly forward.



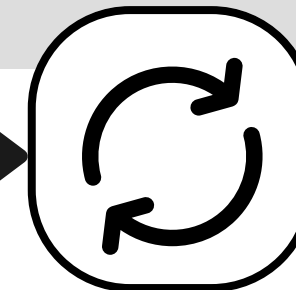
Evaluate

Make observations



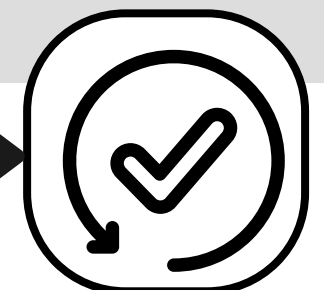
Modify

Complete 2-3 runs, adjust your design or launch method.



Final Run

After 2-3 attempts, each team does a final run for the class.



Questions to Consider

- What action took place?
- What was the resulting reaction?
- How does this relate to a train using its wheels to propel along the tracks?
- When a sensor indicates that the train should stop, what reaction occurs?

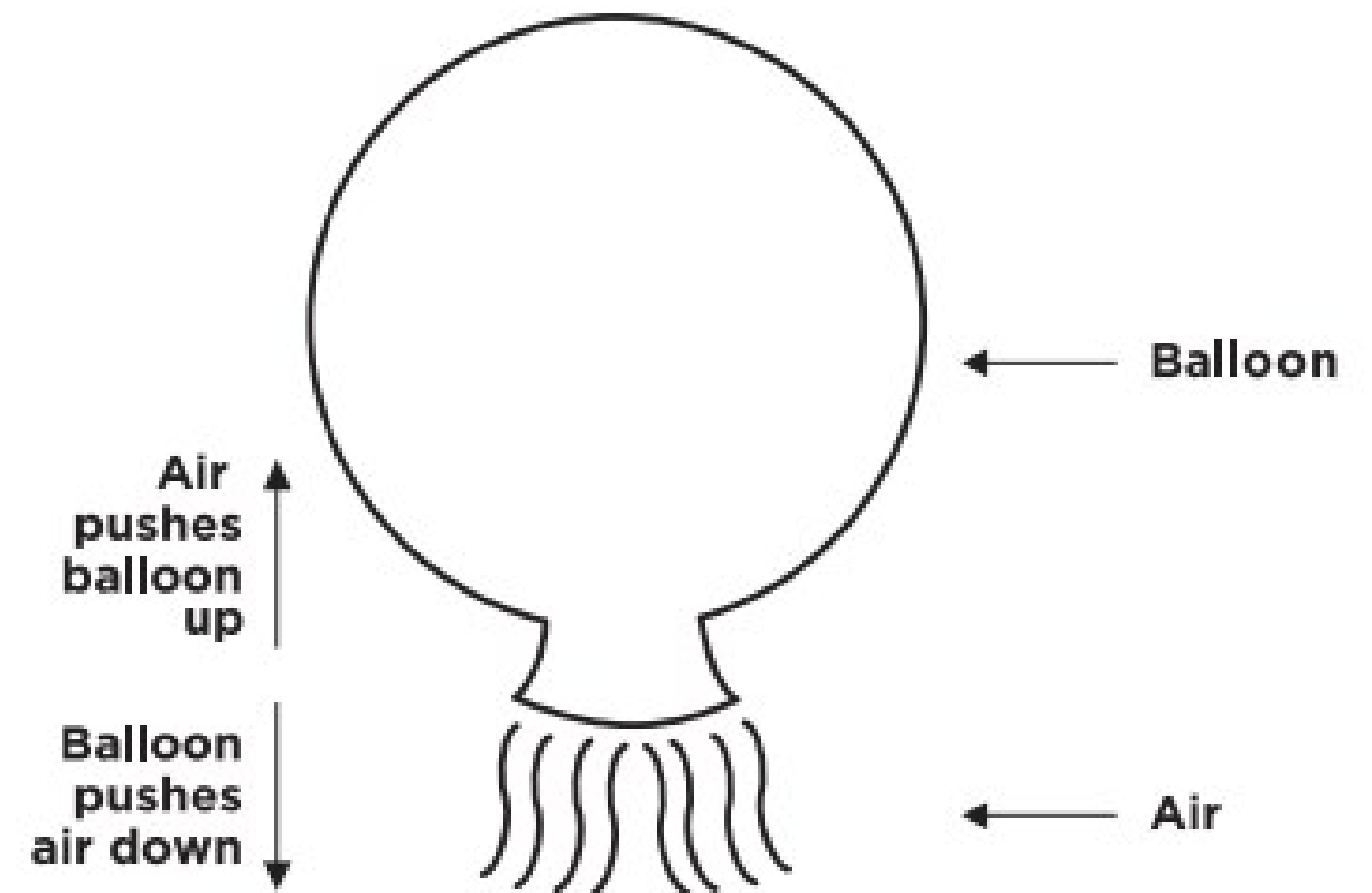


Image: Science World. Pop Bottle Rocket, Part I: Action and Reaction.
<https://www.scienceworld.ca/resource/pop-bottle-rocket-part-i-action-and-reaction/>

From Balloons to Robots:



- What causes a balloon to move?
- What enables a train to move?
- What drives a robot to move?

How Can Our Robot Emulate The Functions Of A Train?

- Balloon-air pushes backward
- Train-wheels push against tracks
- Robot-wheels push against floor

**All are examples of
Newton's 3rd Law**



Animated image: Te Awamutu Space Centre. Balloon rocket activity. <https://www.spacecentre.nz/resources/rockets/>

Stop and Think

01

What do you know about railroad crossings in rural areas?

02

Have you ever seen train tracks without lights or gates? What did you do?

03

Why might people ignore warning signs at train tracks? What could happen if they do?

Stop and Think

01



USDOTNHTSA. (2016). The Long Mile [Video]. YouTube. https://www.youtube.com/watch?v=G35Qu7H92_U

Stop and Think

01

What was the video trying to say?

02

How could sensors or advanced technology have helped stop what happened?

03

How can you help others see the dangers of rural train crossings?

Signals and Systems

Driving Base with Forklift

Scenario

Challenge: Rural Tracks Alert!

Welcome to a quiet rural community where freight trains pass through open farmland. There's no fancy technology, just basic barriers and watchful eyes. This is a **passive** railroad crossing.

Your engineering team has been hired to design a safety system for a passive rural grade crossing where cars, tractors, animals, and even people sometimes cross the tracks.



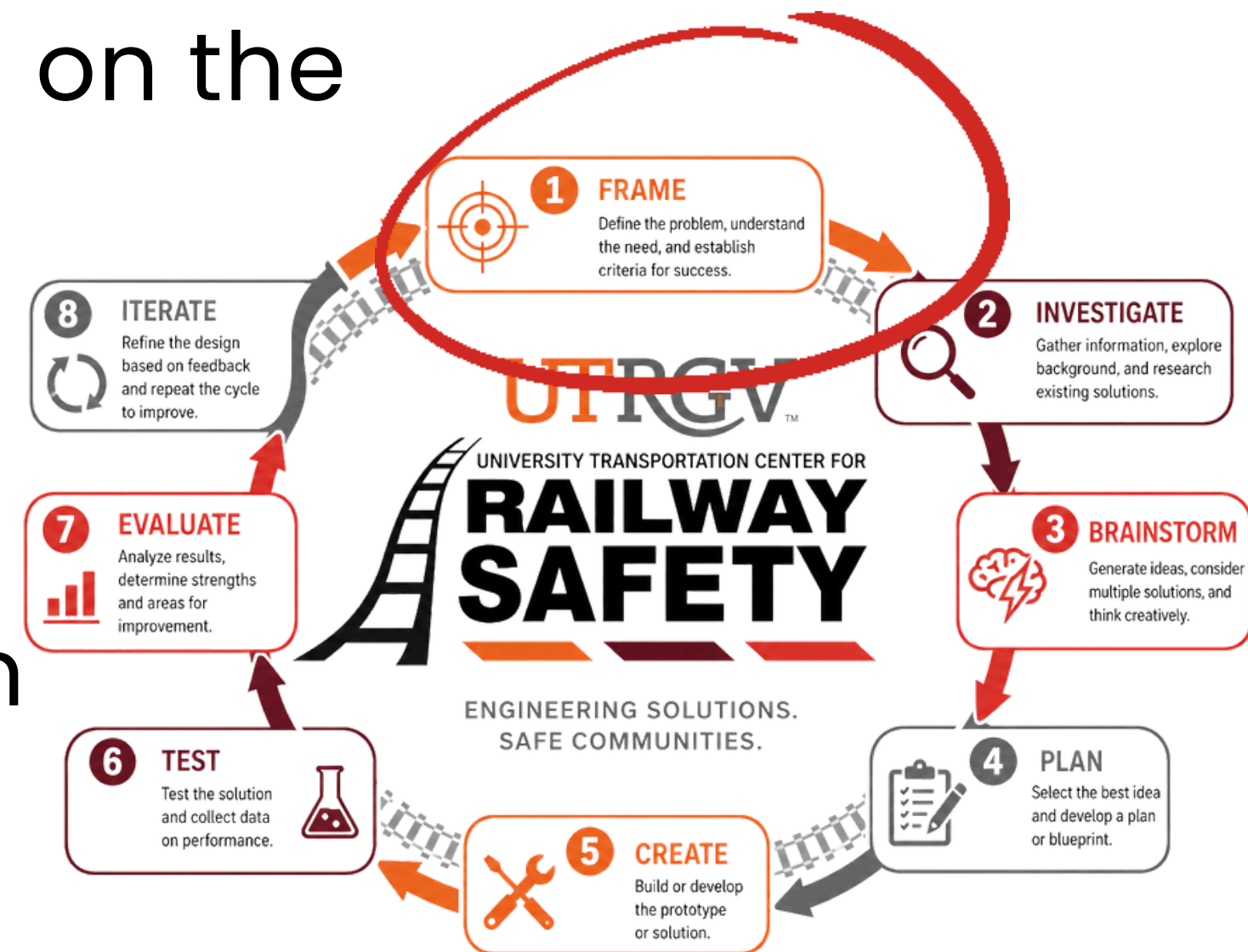
OpenAI. (2026, July 1). Engineering Design Cycle [AI-generated image]. ChatGPT (GPT-5.5). <https://chat.openai.com/>

Final Freight Mission

A wheel and axle has been discovered on the tracks after a derailment.

Your team must:

1. Travel through the tracks
2. Detect a crossing
3. Stop safely. Sound a warning alarm
4. Pick up the wheel and axle
5. Deliver it to the repair station
6. Continue and park at the depo



OpenAI. (2026, July 1). Engineering Design Cycle [AI-generated image]. ChatGPT (GPT-5.5). <https://chat.openai.com/>

Engineering Roles

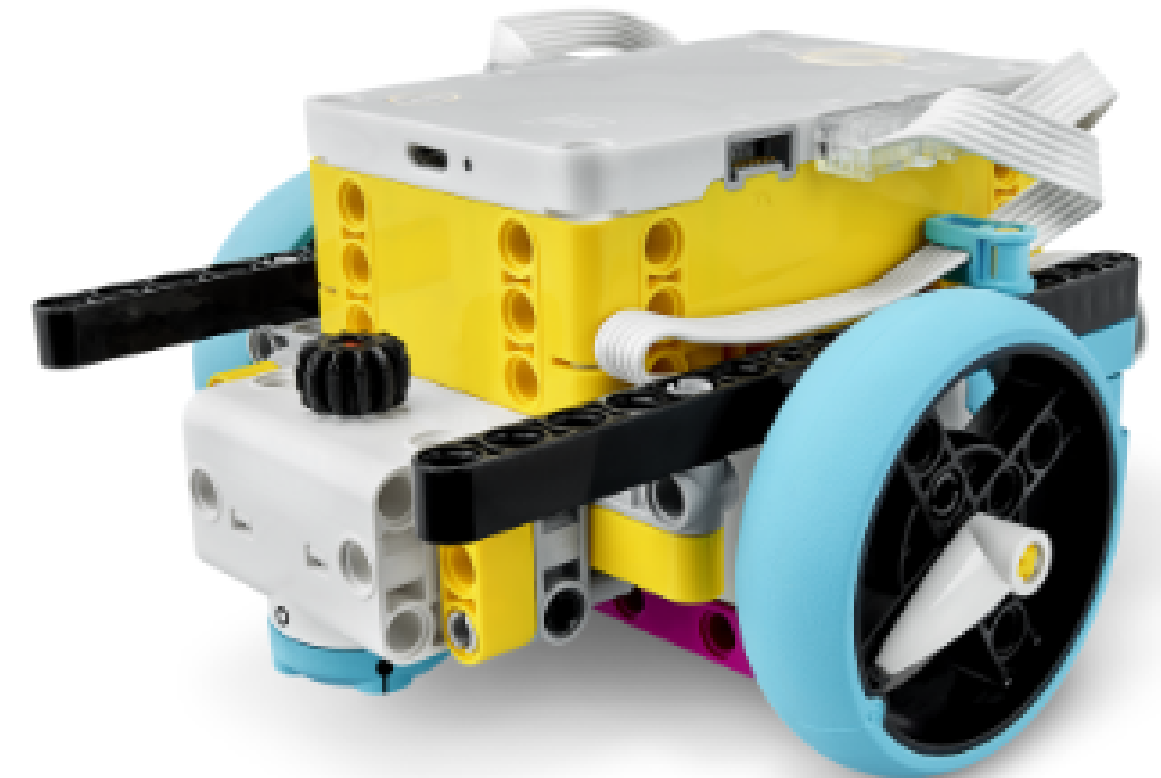
- Lead Engineer (Coordinator)
- Systems Engineer (Design)
- Mechanical Engineer (Parts)
- Mechatronics Engineer (Builder)





Driving Base 1

 34 steps



Note. Screenshot captured by the author from the LEGO® Education SPIKE™ Prime app. Copyright © LEGO Education. Used for educational purposes.

Build the driving base and practice your coding.



Grades 6-8

STEAM, Computer Science, Coding

Word Blocks

Life Hacks

Is there anything in your life that could benefit from a hack? What if that hack could help you see data? Or train your body, plan your...



Grades 6-8

STEAM, Engineering, Computer Science

Word Blocks

Competition Ready

Ready to expand your robotics skills? This unit also includes a guided FIRST® LEGO® League mission!

Note. Screenshot captured by the author from the LEGO® Education SPIKE™ Prime app. Copyright © LEGO Education. Used for educational purposes.

02

Training Camp 2: Playing with Objects

Controlling Movements Using the Distance Sensor

START

🕒 30-45 min.

> MORE

Note. Screenshot captured by the author from the LEGO® Education SPIKETM Prime app. Copyright © LEGO Education. Used for educational purposes.

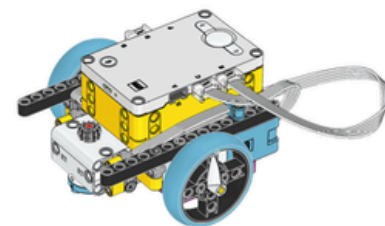
Put your driving base back together and build the forklift part **without sensors**, because we won't use them for our competition.

Building instructions

Driving Base 2



Driving Base



34 steps

Tools and Accessories



40 steps

Note. Screenshot captured by the author from the LEGO® Education SPIKE™ Prime app. Copyright © LEGO Education. Used for educational purposes.

Innovation Depot

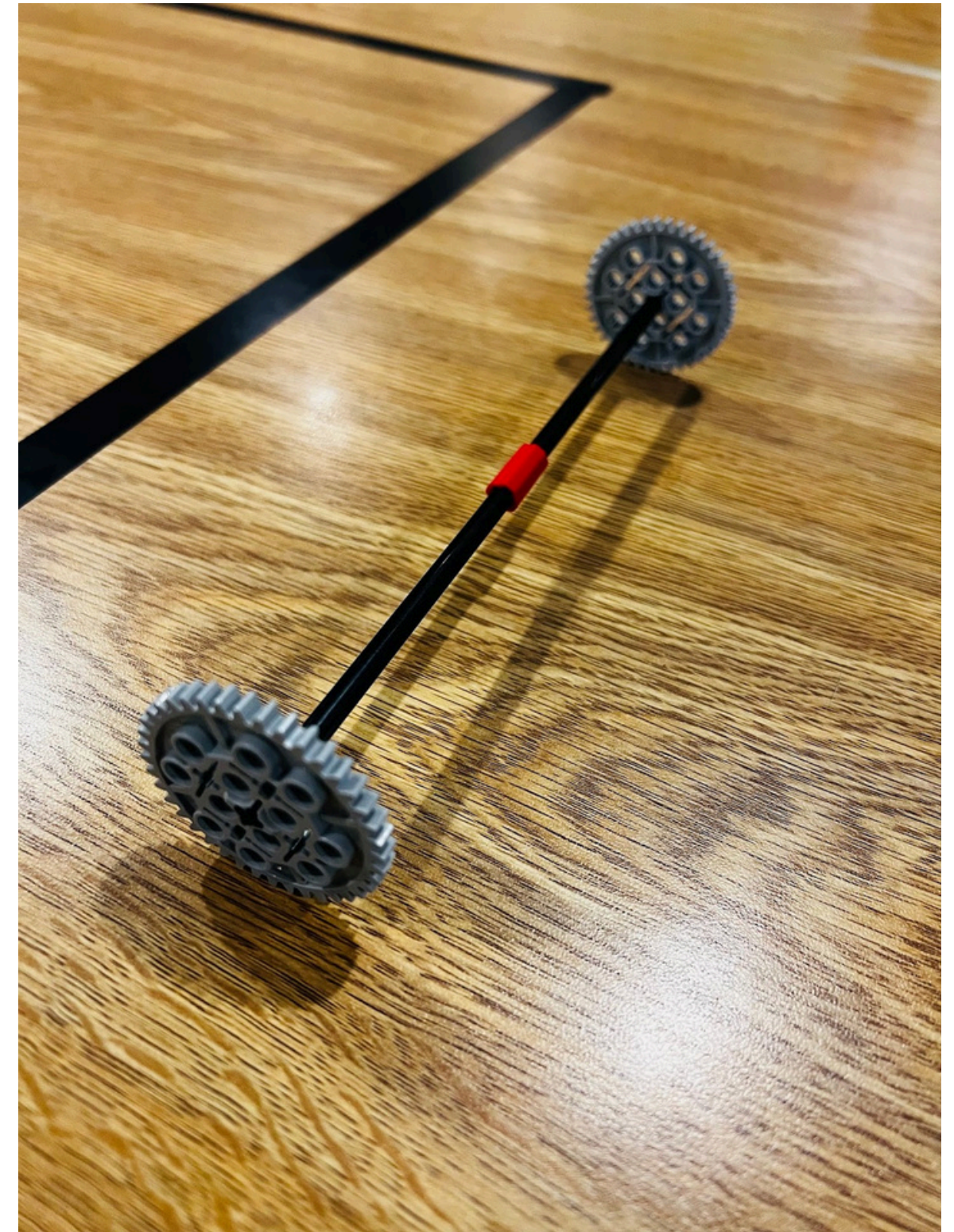
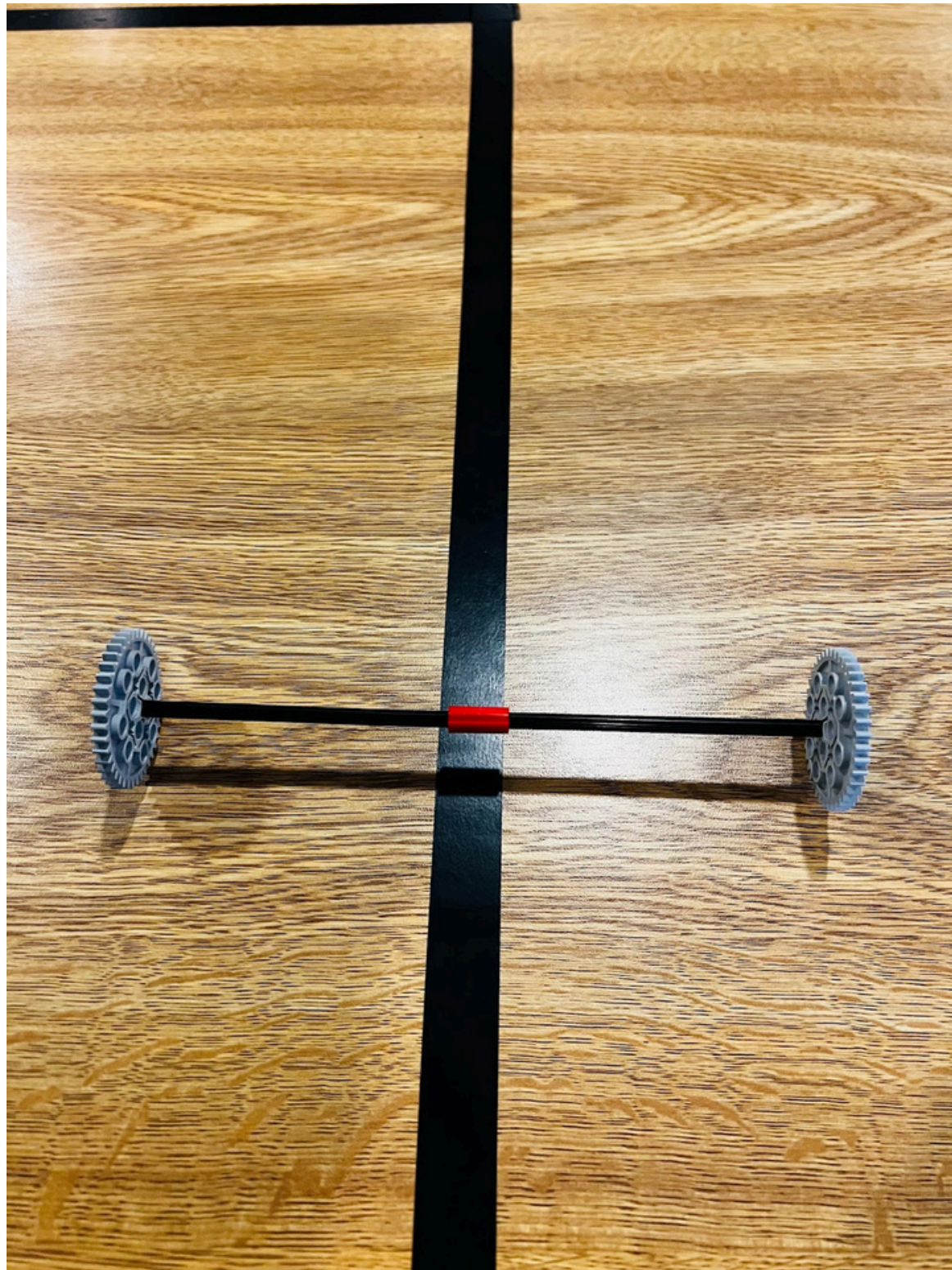
Engineering Design Challenge

Using the Medium Motor to Create a Functional Forklift

We will utilize the medium motor to lift a “wheel and axle” and deposit it at a specific drop-off area on the board or floor. Once you have completed the task, be sure to park your robot at the designated finish line.



Wheel and Axle

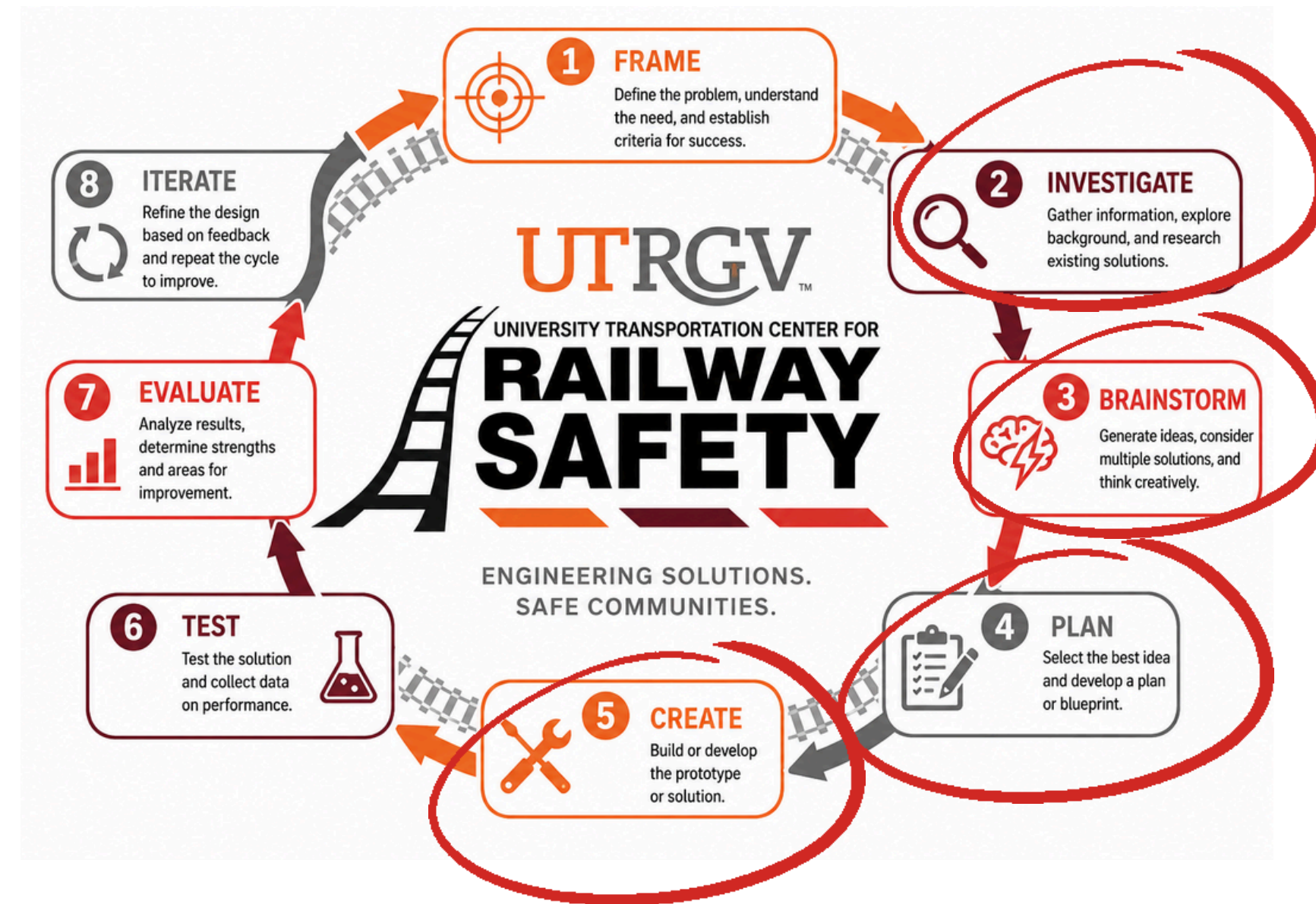


Students testing their engineering prototypes during the summer camp.
Note. Photograph by UTCRS Staff, used with permission.

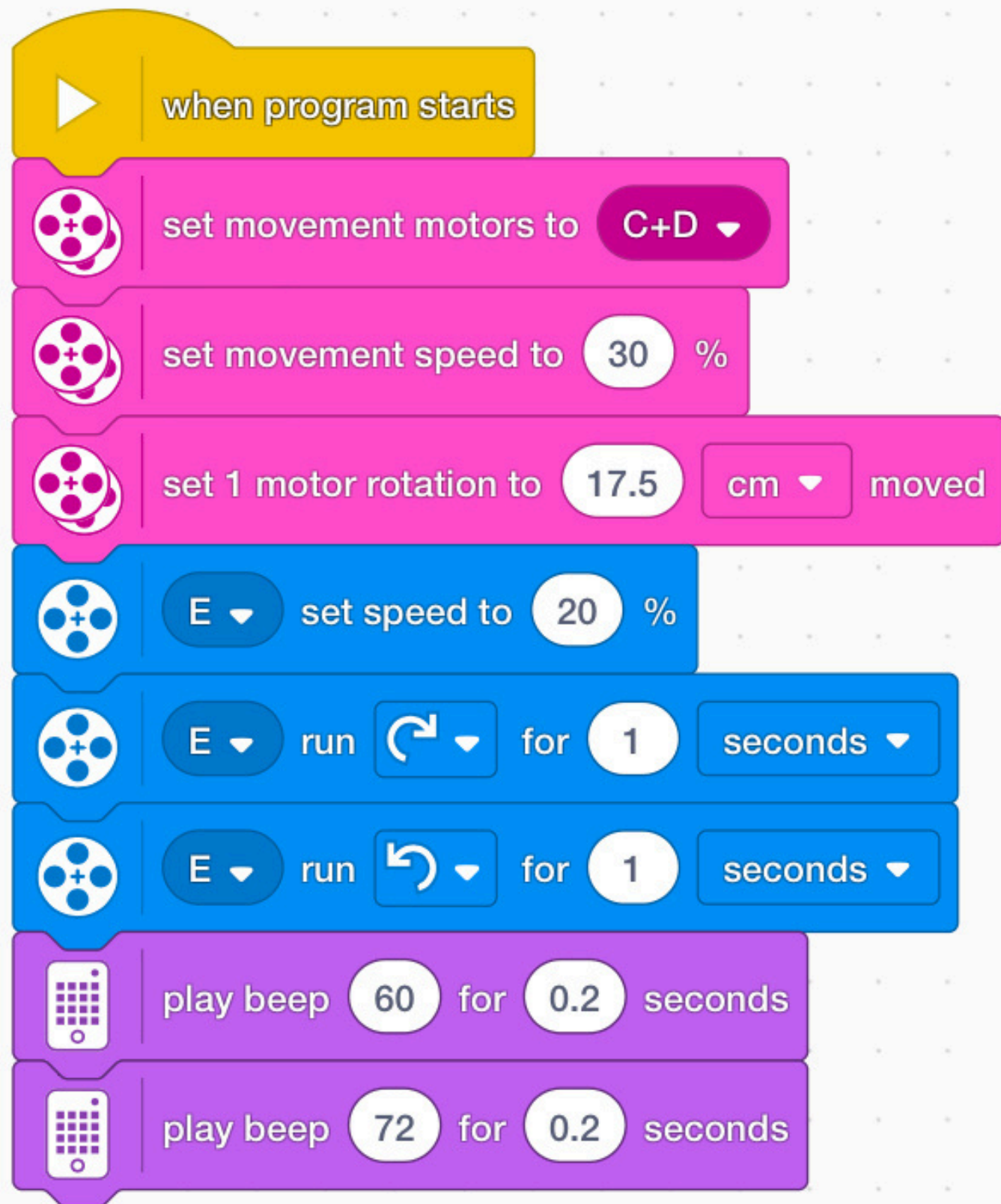
Task

Students will use a LEGO Spike Prime train to find an object on the tracks and move it to a safe place.

14:53:93



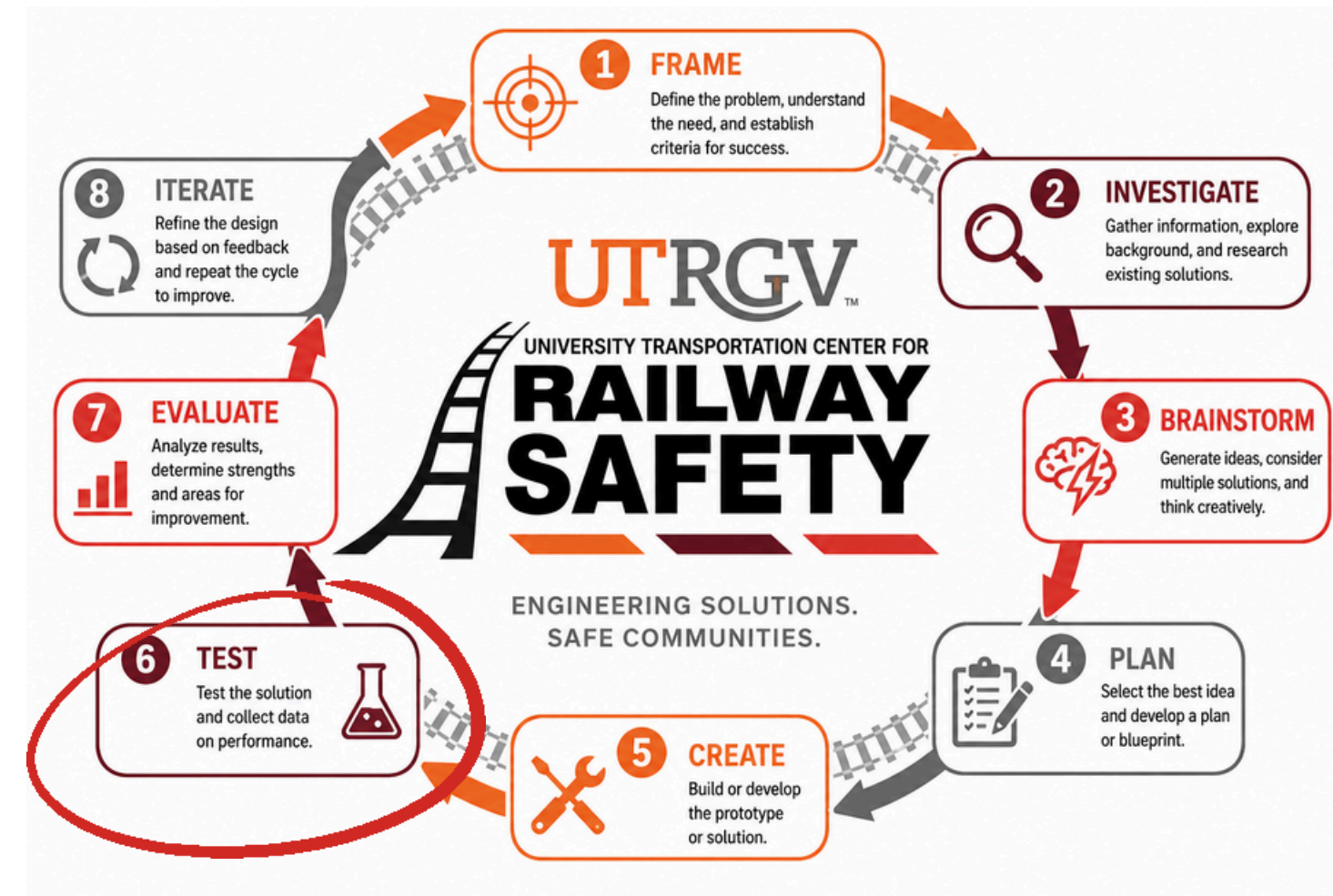
OpenAI. (2026, July 1). Engineering Design Cycle [AI-generated image]. ChatGPT (GPT-5.5). <https://chat.openai.com/>



Let's read the code like we would read a paragraph.

Note. Screenshot captured by the author from the LEGO® Education SPIKE™ Prime app. Copyright © LEGO Education. Used for educational purposes.

Test Time!



OpenAI. (2026, July 1). Engineering Design Cycle [AI-generated image]. ChatGPT (GPT-5.5). <https://chat.openai.com/>

Reflection Questions

- What makes communication important for engineers and conductors working on trains?
- How important was reaction time in your success during the activity?
- In what ways do engineers and conductors use technology and teamwork to ensure the safety of passengers and trains?



Final Stop

Debrief, Clean Up, and Departure

Exit Ticket: How do sensors help keep trains and people safe?

Selected!

And the
contract is
awarded to....

Apples/UTRGV		0123
Inc.	Date: _____	
Pay to the order of: _____	\$	
For: <u>Winning Contract</u>		
012345678 3210 02468		

Note. Adapted from a table created by the University of Texas Center for Railroad Safety staff. Used with permission.



Questions for Train Safety

- How does your design use sensors to stop accidents?
- How does the type of cargo change how fast or carefully the train should go?
- What would happen if train companies didn't work together well?



Final Stop

Debrief, Clean Up, and Departure

Exit Ticket: How does your robot system show what trains need to do to safely deliver cargo and keep rural crossings safe?



**Clean up and
ensure all LEGO
pieces are
accounted for.**

Group Winners

You are invited to return on
June 26, 8:00 -12:00 to compete for the
Grand Champion challenge activity!

You will be competing against the other
weekly elementary winners.

Good Luck and see you there!!!



Invitation to the Closing Ceremony

Everyone is warmly invited to join us for the closing ceremony

Date: June 26, 2026

Location: UTRGV Student Union Auditorium

Time: 6:00 PM – 7:15 PM

Bring your family and capture
wonderful memories with photos.

We look forward to seeing you there!



Note. Photograph by UTCRS
Staff, used with permission.



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