

**CLASSROOM ACTIVITY**

Sustainable Innovation

OBJECTIVES

Students will:

- **Identify** characteristics of community sustainability.
- **Research and evaluate** potential risks and opportunities for autonomous vehicles in their community.
- **Create** a design proposal that outlines how to sustainably integrate autonomous vehicles into their community.
- **Assess** another design proposal and apply constructive critiques in order to optimize their own design.

OVERARCHING QUESTION

How can autonomous vehicles contribute to sustainable communities?

ACTIVITY SUMMARY

After researching the potential of autonomous vehicles, students will explore the opportunities and risks that these vehicles present for their community's sustainability through the lens of mechanical engineering. They will then collaborate to create a design proposal for the sustainable integration of autonomous vehicles into their community.

MATERIALS

- Devices with internet access, at least enough for half the class
- *Designing Solutions Handout*, one per student
- Device with the ability to project video, one for the instructor

CHALLENGE

1. Full-Class Brainstorm: Write *sustainable communities* on the board and ask students to brainstorm and share any characteristics or examples that come to mind. Record the students' brainstorming on the board as they share.
2. After a few minutes have passed, explain that a community's sustainability can be assessed based on three components: economic growth, social progress, and environmental protection. When these three components are present, a community is sustainable because its needs can be met and maintained indefinitely, without compromising future generations.
3. Challenge students to look over the sustainability characteristics that they just brainstormed and consider: Do any of these characteristics *not* fit into one of these three sustainability categories? Invite students to share any that may not fit and decide together if it is a true attribute of sustainability.

4. Then write *autonomous vehicles* on the board. Invite students to turn to a peer and discuss: Based on the components of sustainability and anything you already know about autonomous vehicles, do you think artificial intelligence-guided autonomous vehicles could contribute to a sustainable community? Call on a few students to share their initial thoughts.
5. Then tell the class that today they will be challenged to develop a plan for the sustainable integration of autonomous vehicles into their community as they take on the role of several different careers. Distribute one *Designing Solutions Handout* to each student, and elaborate on the challenge by reading aloud the bullets listed under *Step 1: Define the Challenge*.
6. Explain that students will complete this challenge in small groups of three or four. For Step 1, they will be taking on the role of mechanical engineers. Tell the class that mechanical engineering is a branch of engineering that applies a range of science and math principals to design, produce, and operate machinery. Explain that one of the first steps mechanical engineers take when approaching a problem is to analyze the situation to see how a mechanical device could be of help. Then show the Mechanical Engineer Career Profile Video available at <https://stemcareerscoalition.org/careers-portal> and ask students to listen for some of the other responsibilities of mechanical engineers.
7. After answering any questions, prepare student groups to perform research to better understand the challenge.
 - Write the following websites on the board:
 - eia.gov/outlooks/aeo/pdf/AV.pdf
 - nhtsa.gov/technology-innovation/automated-vehicles-safety
 - Explain that groups will have about 15 minutes to use these websites to gain a better idea of the current state and future potential of autonomous vehicles. Encourage students to divide the research responsibilities and begin with the websites on the board. If applicable, they may also use a town or city website to research their community's transportation system—though this may not be available in smaller communities where such a system does not exist.

DESIGN

1. Bring the class back together and explain that it's time to develop a solution to the challenge. Call on a student to read the handout's *Step 2: Create a Design* section aloud.
2. Explain that as groups develop their design proposals, each group member will look at the challenge through the eyes of a community scientist in one of the following careers. Read the careers below to the class and give groups a moment to decide who will assume each role. Before students begin, also instruct them to visit <https://stemcareerscoalition.org/careers-portal> and watch the Career Profile Video associated with their career in order to understand it more fully.
 - **Renewable Energy Engineer:** You strive to develop methods for producing energy from renewable or sustainable sources.
 - **AI Researcher:** You explore how AI systems can help people with their daily tasks.
 - **Electro-Mechanical Engineer:** You are responsible for designing, creating, testing, and evaluating autonomous vehicles in order to ensure customers can use them.
 - **Design Engineer:** You research and develop ideas for new autonomous systems and you help develop them.

3. Tell the class that they will have about 20–25 minutes to complete the *Design* portion of their handouts. Quickly recap and encourage students to:
 - Watch their Career Profile Video and then approach the challenge from the perspective of their chosen career as they brainstorm possible design proposals.
 - Use their research on autonomous vehicles and their background knowledge on their community to consider risks and opportunities *and* decide how their community could benefit from sustainable vehicles.
 - Use a separate piece of paper to outline a proposal that answers the questions provided on the handout.
 - Be ready to share, explain, and justify their proposal!

SOLVE

1. When there are about 10 minutes left in the class period, pair student groups together. Explain that an important part of the engineering design process is the process of optimization, in which solutions are assessed and improved upon.
2. Instruct each group to share their proposal with each other. As they do, they should:
 - Listen carefully to the other team's proposal and focus especially on how their plan could enhance the community's economic growth, social progress, and/or environmental protection.
 - Ask questions and provide suggestions on how to improve their plan's sustainability from the viewpoint of their selected career.

Remind students that critiques should be rooted in research and/or background knowledge of their community. The goal of providing feedback is to help one another create an even stronger design proposal!

3. Go on to explain that once both proposals have been shared, groups should complete the *Step 3: Analyze Solutions* portion of the handouts and optimize their design proposal. If time permits, they may edit their proposal in order to include these sustainability optimizations.

STANDARDS

Next Generation Science Standards

- Earth and Human Activity:
 - HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Engineering Design:
 - ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

ITEEA Standards for Technological Literacy

- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology. In order to recognize the changes in society caused by the use of technology, students should learn that:
 - I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
- Standard 5. Students will develop an understanding of the effects of technology on the environment. In order to discern the effects of technology on the environment, students should learn that:
 - L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.
- Standard 8. Students will develop an understanding of the attributes of design. In order to realize the attributes of design, students should learn that:
 - J. The design needs to be continually checked and critiqued, and the ideas of the design must be redesigned and improved.

Step 1: Define the CHALLENGE

Your challenge is to:

1. Explain the current state of autonomous vehicles.
2. Identify the potential of autonomous vehicles.
3. Describe your community's current transportation system.
4. Develop a sustainable plan for introducing autonomous vehicles into your community.

Jot your research notes below:

Step 2: Create a DESIGN

Overview: Work with your group to develop a design proposal that outlines how to integrate autonomous vehicles into your community in a way that enhances your community's sustainability in terms of economic growth, social progress, and/or environmental protection.

Be sure to consider personal autonomous vehicles as well as shared-use autonomous vehicles (such as public transit, ride sharing, and/or taxis).

Requirements: Your proposal must include:

1. **Risks and Opportunities:** How could autonomous vehicles potentially harm *and* benefit your community?
2. **Objectives:** What do you hope to ultimately achieve over the next ten years?
3. **Action Plan:** An outline (at least three steps) that succinctly explains how you will reach your objectives.

Jot notes below and then complete your design proposal in a format of your choice on a separate piece of paper.

Step 3: Analyze SOLUTIONS

Think about the feedback your design proposal received, and consider how you could improve your plan's sustainability. Then work as a group to describe at least two optimizations below: