

# Transportation Engineering & Design Activities

Grades 5 to 12

**Design Streets for Everyone**



**Curb Design: Create an  
Enjoyable Downtown**

**Design an App for Safer  
School Zones**



**STRIDE**

Southeastern Transportation Research,  
Innovation, Development and Education Center

<https://www.transportation.institute.ufl.edu/>

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## STRIDE Center

The STRIDE Center is the 2016 USDOT Region 4 (Southeast) University Transportation Center (UTC) housed at the University of Florida Transportation Institute (UFTI). Our mission is to develop novel strategies for Reducing Congestion. The Center has nine partners, representing seven states in the Southeastern U.S. The UFTI and its partners in the STRIDE Center are recognized leaders at state, regional, national, and international levels. The STRIDE Center is focused on assembling and integrating research projects throughout the region in a way that maximizes contributions to solving current and future transportation problems as well as strengthening expertise and developing new technologies. For more information see <https://stride.ce.ufl.edu/>.

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### UNIVERSITY OF FLORIDA

The University of Florida is a public university located in Gainesville, FL. Ranked #5 nationally among public universities by the U.S. News & World Report, UF has over 10,000 students enrolled in 10 engineering departments. The University of Florida Transportation Institute (UFTI) housed in the Herbert Wertheim College of Engineering, aims to advance transportation, disseminate research results, and provide educational opportunities related to transportation. The STRIDE Center is housed at UFTI.



### THE CITADEL

The Citadel, The Military College of South Carolina, is a public college located in Charleston, SC. It is ranked #1 public college in the south for 12 consecutive years among colleges offering up to a master's degree. The Citadel School of Engineering offers undergraduate degrees in civil, computer, construction, electrical, and mechanical engineering that can be taken as a full-time cadet or a transfer student in a traditional college/civilian setting during the afternoon and evening.

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## Overview

This booklet includes three different activities related to transportation engineering. Students will think outside the box to solve real-life transportation challenges while using the engineering design process.

### Educators

The activities are designed to be adaptable for a wide range of ages, time periods, and group sizes including the following:

- Grades 5th to 12th
- 1 to 3 hours
- Individuals, pairs, small groups

### Use in the Classroom and Beyond

- afterschool programs
- summer camps
- STEM events
- homeschool programs
- and more!

## Next Generation Science Standards

### Middle School

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

### High School

- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-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.

# What is Transportation Engineering?

Transportation Engineers plan, design, build, operate, and maintain **safe** and **efficient** transportation infrastructure and systems for the **movement of people and goods**. They work on problems related to:

- Traffic
- Public Health & Safety
- Self-Driving Cars
- Logistics
- Airports, Ports, Railways
- New Technology (e.g., automated vehicles)
- Emissions and Energy Efficiency
- Infrastructure Operations
- Infrastructure Maintenance
- Data and Communication (e.g., apps, GPS)
- Equitable Transportation Systems and Planning

## Transportation Careers

There are many different careers related to transportation. Below are just some of the many options in the transportation sector:

- **Types of Engineers:** Civil, Traffic, Transportation, Computer, Safety, Robotics, Materials, Environmental, Mechanical, Industrial, Systems, Aerospace
- Planner
- Software Developer
- Logistician
- Transportation Manager
- Designer of infrastructure and technology
- Intelligent Transportation Systems Engineer
- Inventor of new devices and products
- Communications and Marketing Specialist
- Data Analyst
- Behavioral Scientist
- Economist
- Policy Analyst



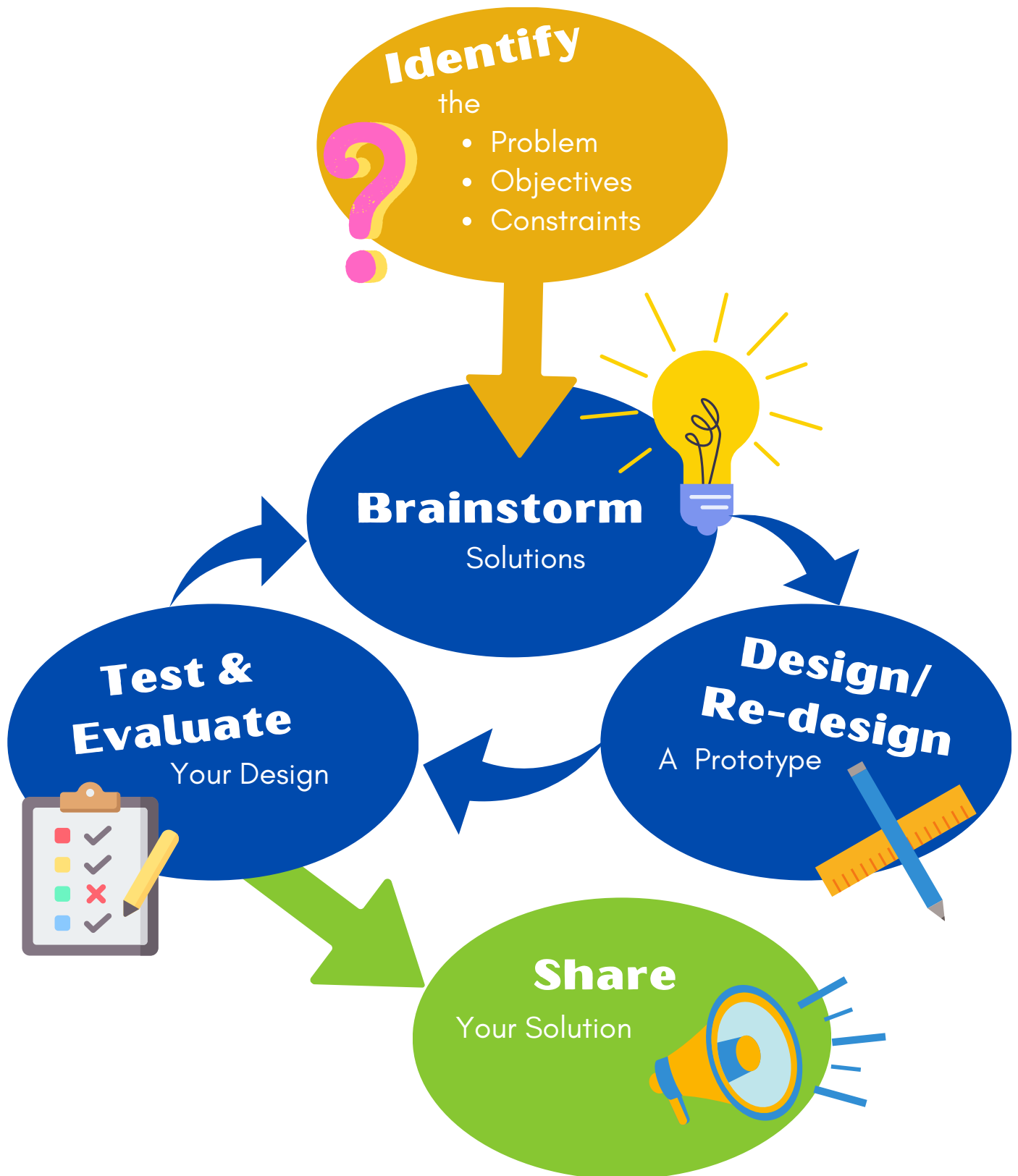
### Your Future In Transportation

<https://youtu.be/YkT4UZL-tpo>

A 5½ minute video about transportation careers produced by The National Academies of Sciences, Engineering, and Medicine.

# What is the Engineering Design Process?

The engineering design process is a series of steps that engineers follow to **create a solution to a problem.**



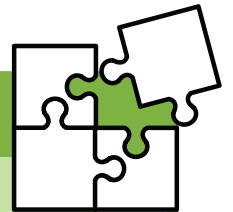
# Activity 1

## Design Streets for Everyone

Transportation engineers design streets to ensure the safe and efficient movement of people and goods. Not all streets, however, are designed with the needs of all users in mind. **Complete Streets** are designed to work for everyone including drivers, pedestrians, bicyclists, and transit users of all ages and abilities. In this activity, you will redesign a street using Complete Streets principles.

In this activity, you will learn how to

- Use the engineering design process to solve a real-world problem.
- Illustrate an existing street you know well.
- Evaluate the street based on the needs of many different users.
- Redesign the street using Complete Streets principles.
- Apply the design challenge to real-world examples.



### Steps

1. Learn about Complete Streets.
2. Sketch a street.
3. Evaluate your street.
4. Redesign your street.
5. Evaluate your new Complete Street design.



Image Source: City of Vancouver, Canada  
Complete Streets Policy Framework, 2017

# Design Streets for Everyone

## Step 1: Learn about Complete Streets

### What is a Complete Street?

A street designed and operated for **all people** regardless of age, ability, or mode of transportation.

### 2-Min Video

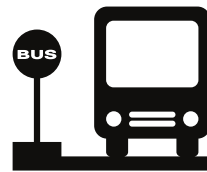
Introduction to Complete Streets from the Ontario Professional Planners Institute.

<https://youtu.be/sc-GKNeclbg>

What do each of these users need to travel safely?



Car driver



Bus rider



Pedestrian



Person with disabilities



Bicyclist

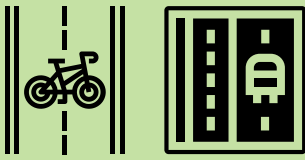


Person pushing a stroller



# Step 1: Learn about Complete Streets

## What are the ways we can design a Complete Street?



**Special lanes** such as bike and bus lanes can improve safety.



**Bus shelters** provide spaces for riders to sit and be protected from the sun and rain.



**Crosswalks, walk signals, and lighting** improve the safety for pedestrians.



**Ramps, tactile pavement, and audio alerts at crosswalks** improve the safety for persons with disabilities.



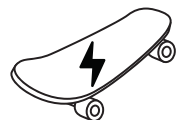
**Speed bumps, roundabouts, and bump outs** slow traffic down.



**Seating, trees, and trash cans** create inviting and more environmentally friendly spaces.

### Making room for new users

Where is the safest place for electric scooters, skateboards, electric skateboards, and other forms of micromobility to travel?



## Step 2: Sketch Your Street

1. Select a street that you are very familiar with and have walked and driven on many times.
2. Sketch what this street looks like to you. If you are able to visit the street and draw it in-person, make sure you are on the sidewalk and in a safe location. If you cannot visit the street or take pictures that you can use to do this activity, you can draw it from memory or use Google Streetview to look at the street.
3. In your drawing, include as much detail as possible.
  - Sketch one block (from one intersection to the next).
  - Show where the sidewalk is (if there is one).
  - Show what is on the sidewalk including benches, trees, bike racks, trash cans, parking meters, etc.
  - Sketch all lanes of traffic. How many lanes are there? Are there bike or bus lanes?
  - Draw any crosswalks. Are there walk signals? Are there blinking lights to stop traffic for pedestrians?
  - Show where the parking is. Are there parking spots designated for persons with disabilities? Are there loading zones?
  - Show any features that assist persons with disabilities.
  - Show where the bus stops are (if there are any) and if there are shelters.
  - Label areas that you think are unsafe or problematic for any users.

### Who uses your street?

Check off each of the different users that you have observed on your street.

- Cars
- Buses
- Streetcar
- Delivery Trucks
- Taxi/Rideshare
- Motorcycles / Scooters
- Bikes
- Stand-up electric scooters
- Skateboards
- Pedestrians



Try drawing your street to **scale**:  
Examples  
1-inch = 10 feet  
1-inch = 25 feet  
1-inch = 50 feet

## Step 2: Sketch Your Street

Use this space or a larger sheet of paper to sketch your street.

## Step 3: Evaluate Your Current Street

Complete Streets Evaluation	Score (1-10)
<b>Sidewalks:</b> are on both sides of the street, width is comfortable for passing and walking with someone, raised or separated from the road, free from obstacles	
<b>Safe Crossings:</b> clearly marked crosswalks, lights to stop traffic for crossing, median for pedestrians to stop in the middle of large streets, crosswalks are frequent	
<b>Facilities for People with Disabilities:</b> ramps at corners, smooth and even pavement, accessible pedestrian walk signals (with audible messages or vibrating surfaces), tactile pavement (e.g., bumps at corner for visually impaired)	
<b>Public Transit Facilities:</b> public transit services are present, separate lanes for buses, bus stops, clean seating and shelter at bus stops	
<b>Bicycle Facilities:</b> protected bike lanes, bike racks, bikeshare stations	
<b>Car Facilities:</b> one lane of traffic in each direction, speed bumps, roundabouts, and bump outs to slow traffic, separation between the driving lane and sidewalks	
<b>Amenities:</b> trees, rain gardens, benches, art or other features to make the space inviting	
<b>Your Assessment:</b> Does this street feel safe to you? Is it safe for an 8 year old to cross the street or ride a bike without an adult?	
<p style="text-align: right;"><b>TOTAL POINTS (out of 80 points)</b></p> <p style="text-align: right;">Your TOTAL POINTS <math>\div</math> 80 <math>\times</math> 100 = <input type="text"/> %</p>	

## Step 4: Redesign Your Street

### Your Challenge

The city transportation department wants to improve the safety of its streets. It has hired you to come up with a new design. Now that you have evaluated your street and learned about Complete Streets concepts, redesign your street using as many Complete Streets design features as you can **within the existing space** (e.g. you can't remove buildings to make more space). Use this space or a larger sheet of paper to sketch your street.

## Step 5: Evaluate the NEW Complete Street

Complete Streets Evaluation	Score (1-10)
<b>Sidewalks:</b> are on both sides of the street, width is comfortable for passing and walking with someone, raised or separated from the road, free from obstacles	
<b>Safe Crossings:</b> clearly marked crosswalks, lights to stop traffic for crossing, median for pedestrians to stop in the middle of large streets, crosswalks are frequent	
<b>Facilities for People with Disabilities:</b> ramps at corners, smooth and even pavement, accessible pedestrian walk signals (with audible messages or vibrating surfaces), tactile pavement (e.g., bumps at corner for visually impaired)	
<b>Public Transit Facilities:</b> public transit services are present, separate lanes for buses, bus stops, clean seating and shelter at bus stops	
<b>Bicycle Facilities:</b> protected bike lanes, bike racks, bikeshare stations	
<b>Car Facilities:</b> one lane of traffic in each direction, speed bumps, roundabouts, and bump outs to slow traffic, separation between the driving lane and sidewalks	
<b>Amenities:</b> trees, rain gardens, benches, art or other features to make the space inviting	
<b>Your Assessment:</b> Does this street feel safe to you? Is it safe for an 8 year old to cross the street or ride a bike without an adult?	
<b>TOTAL POINTS (out of 80 points)</b> Your <b>TOTAL POINTS</b> ÷ 80 × 100 = <input type="text"/> %	

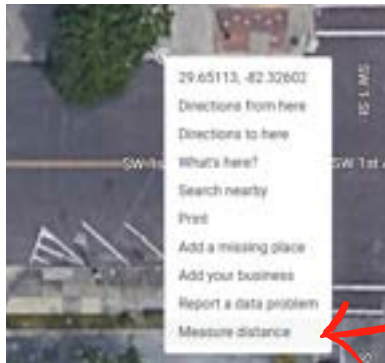
How did your score change?



# Design Streets for Everyone

## Computer Version

### Step 1: Sketch Your Street

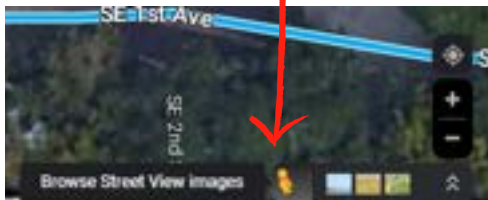


- Use **Google Maps** to measure the length of your street, the width of the street and sidewalk, and the number of lanes. Right click on a point and select "Measure Distance" from the pop-up menu. Then click on the second point to measure the distance of the line.

If you have access to the internet, try designing your street online.

- Use **Google Street View** to look for features like benches, lighting, crosswalks, ramps, etc.

Drag the yellow person in the bottom right to the street you want to look at.



Move down the street to identify features.

- Use **Streetmix.net** to sketch your street.

- Put the name of your street at the top.
- Make the street the same width as it is in real-life.
- Drag and drop the features that are on the street.



### Step 4: Redesign Your Street

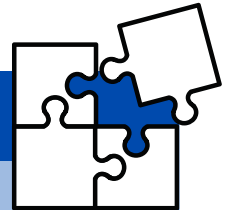
- Use **Streetmix.net** to create a new design for your street. Do not change the width of the space between the buildings. Save your street with another name.

# Activity 2

## Curb Design: Create an Enjoyable Downtown

Downtown areas can become very congested with people, cars, buses, bikes, and e-scooters due to limited space. Managing the space so that people are able to get around easily, but also enjoy their downtown experience can be a challenge. In this activity, you will learn how to create a livable downtown by designing a curb management plan for a busy street.

In this activity, you will learn how to



- Use the engineering design process to solve a real-world problem.
- Critically evaluate how well the design solution meets the needs of many different users.
- Determine how to use a limited space efficiently while reducing congestion.

### Steps

1. Learn about curb spaces.
2. Design your curb management plan.
3. Create a revenue plan.
4. Develop a marketing plan to get your plan selected.
5. Evaluate and vote on a plan.



The **curb space** is the space next to the curb typically used for parking.



# Curb Design

## Create an Enjoyable Downtown

### Step 1: Learn About Curb Spaces

The curb space is a valuable piece of land and many people want to use it for different reasons. They also may need the space during different times or days. Below are examples of ways the space can be designed to meet their needs.

#### 1-Min Video

An introduction to curb spaces and livable communities by the STRIDE Center.

[https://youtu.be/iArZZ\\_qmwoc](https://youtu.be/iArZZ_qmwoc)

Function	Design Feature
<b>Mobility</b> Move people and goods	sidewalks, bus lanes, car lanes, bike/scooter lanes
<b>Access for People</b> Help people arrive at their destination	bus stop, bus shelter, bike parking, bikeshare, passenger loading
<b>Access for Commerce</b> Spaces for delivery	loading zones, emergency vehicle access
<b>Activation</b> Spaces for people to socialize	food trucks, parklets, benches, events
<b>Greening</b> Improve the environment	trees, planters, rain gardens
<b>Storage</b> Provide storage for vehicles or equipment	car parking, electric vehicle charging, construction



# Who Uses the Curb Space?

## Delivery Truck Driver

In order to make deliveries, I need to be able to park near my customers for up to 10 minutes during the work day. When I double park or block traffic, I get tickets.



## Bus Driver

To make it easier for my passengers to get on and off the bus, I need to be able to pull up to the curb. My riders like having safe, shaded places to sit while waiting for the bus.



## Driver with a Disability

When I go downtown, I look for places where I can park that are close to my destination and have wheelchair accessible ramps.



## Store Owner

I would like my customers to be able to easily get to my store. Many of my customers live nearby and either bicycle or walk.



## Taxi/Rideshare Driver

This area is a very popular place for me to pick up and drop off customers at night when people are going out to dinner. Sometimes I can't pull up to the sidewalk to pick up my customers.



## Customer

I like to park near the restaurant where I meet up with a friend for lunch.



## Food Truck Owner

I would like to provide lunchtime service but I need a place where I can park every day and have tables on the sidewalk.



# Step 2: Design Your Curb Space - EXAMPLE

Follow each of the steps below to create your curb management plan on the following page. Here is an example of what a plan could look like for a road that has three lanes (one curb lane and two lanes for moving vehicles).

#1 SELECT A FUNCTION FROM THE BOXES BELOW. THEN, SHADE THE PARKING SPACE WITH THE COLOR RELATING TO THE FUNCTION

#2 DECIDE WHO CAN USE THIS LANE OF TRAFFIC FROM THE **MOBILITY** BOX BELOW. YOU CAN HAVE MORE THAN ONE USER.

#3 DESCRIBE HOW THIS SPACE WILL BE USED. (WHAT IS HAPPENING HERE?)

## Functions & Colors

Access for People  
Orange

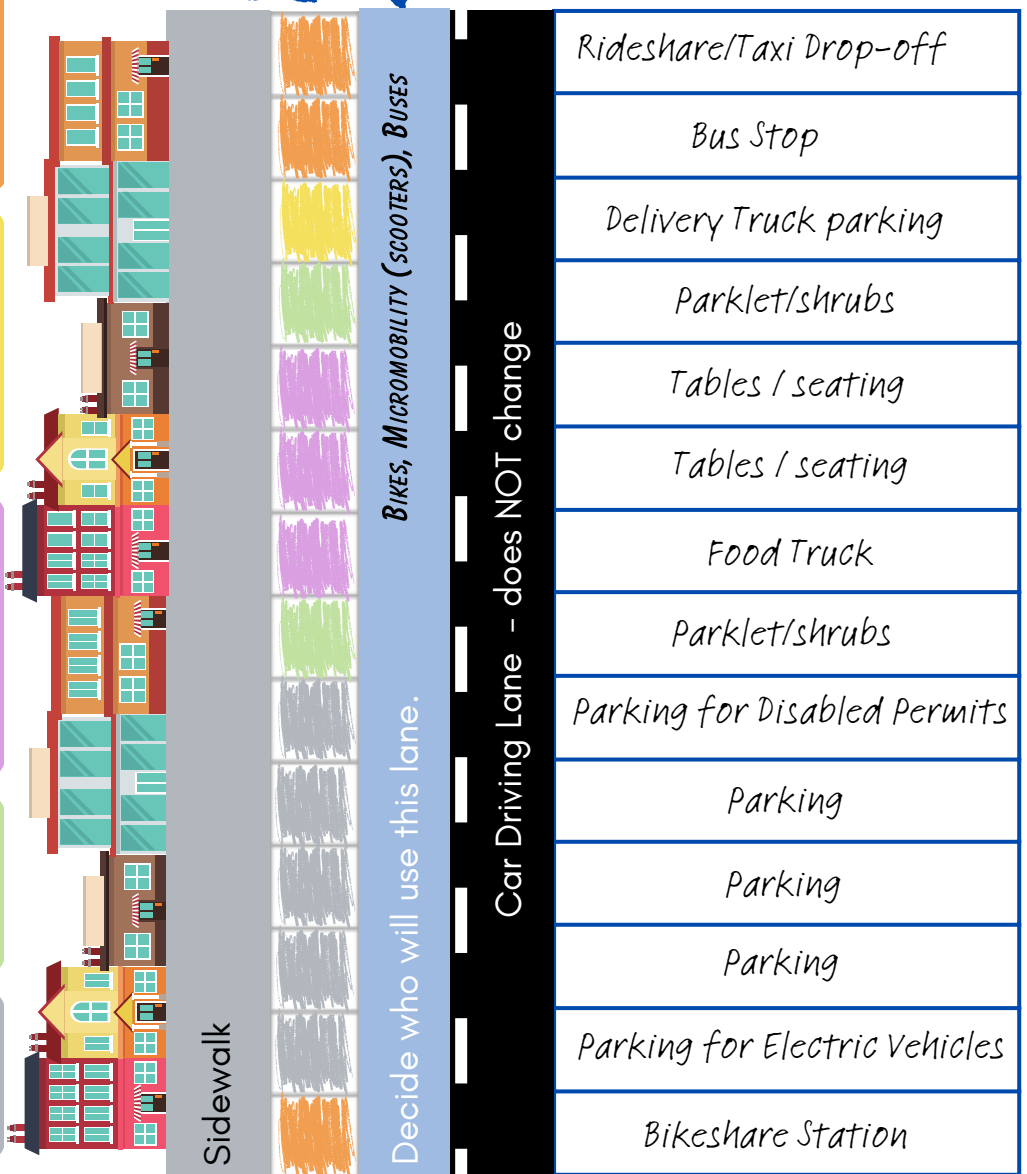
Access for Commerce & Services  
Yellow

Activation  
Purple

Greening  
Green

Storage  
Gray

Mobility



# Step 2: Design Your Curb Space - YOUR PLAN

#1 #2

#3

## Functions & Colors

**Mobility**



Blue

**Access for People**



Orange

**Access for Commerce & Services**



Yellow

**Activation**




Purple

**Greening**

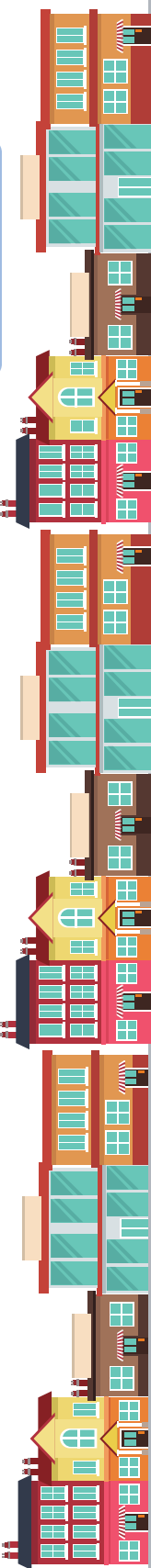


Green

**Storage**



Gray



Sidewalk

Decide who will use this lane.

Car Driving Lane - does NOT change

<div style="display: flex; justify-content: space-around;"> <span>#1</span> <span>#2</span> <span>#3</span> </div>			

## Step 3: Create a Revenue Plan



The Department of Transportation needs to pay for construction, road maintenance, meter maintenance, and labor. **Develop a plan to raise \$60/day from your curb spaces.** Be realistic about what you can charge for and how much. While some uses, like benches, may not make money, they are still important because they help create a vibrant, enjoyable city.

Design Feature	# Spaces	Amount/ Hour	Hours/ Day	<b>CALCULATE</b> Revenue (# spaces X Amount/Hour X Hours/Day)	Total Revenue/ Day
<b>Example:</b> Car Parking	1	\$0.50 / hour	8 hours/day	1 X \$0.50 X 8 =	\$4/day
<b>TOTAL REVENUE</b>					

How did you decide what to charge?



## Step 4: Develop a Marketing Plan



### Your Challenge

- The Department of Transportation is going to select the plan they believe will create the most enjoyable downtown while also generating enough revenue.
- Develop and present a marketing plan that highlights all of the features of your curb management plan and why it should be selected.

### Marketing Plan

How did you address the needs of the different users?

What users or functions were most important to you? How did you prioritize this in your design?

Explain how your revenue plan works.

How does your plan create a more vibrant, enjoyable street for everyone?

How does your plan change at different times of the day? Or on different days?

Are there innovative ideas or technologies that you will include to implement your plan?

What is the most important thing for the Department of Transportation to know about your plan?

# Step 5: Evaluate and Vote on a Plan



- Score how well your plan does on the following criteria.
- Score two other plans from your class and vote for the best one.

Score how well the plan does the following.	#1 Your Plan	#2 Plan	#3 Plan
<b>Mobility:</b> Helps people move around using different forms of transportation (sidewalks, bus and bicycle lanes). (10 points)			
<b>Access for All People:</b> Helps everyone arrive at their destination (bus stops, bicycle parking, passenger loading). (15 points)			
<b>Access for Commerce &amp; Services:</b> Allows for goods to be delivered and provides space for emergency vehicles. (10 points)			
<b>Activation:</b> Creates spaces for people to socialize (food trucks, parklets, benches, tables/chairs, events). (10 points)			
<b>Greening:</b> Improves the environment (trees, planters, rain gardens). (10 points)			
<b>Storage:</b> Provides storage for vehicles or equipment (parking, construction). (10 points)			
<b>Overall Livability:</b> Creates a vibrant, enjoyable street for everyone with limited congestion. (15 points)			
<b>Revenue:</b> Generates a realistic amount of revenue. (10 points)			
<b>Marketing:</b> Presentation highlights all aspects of the curb management plan. (10 points)			
<b>TOTAL (out of 100 points)</b>			

What features would you most like to see in a downtown?

# Activity 3

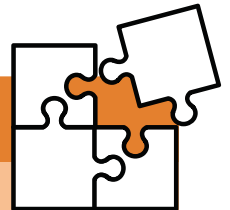
## Design an App

### for Safer School Zones



Many people use apps on their phone to get directions, communicate, or have fun. In this activity, you will learn how to design an effective app that will help make school zones safer.

In this activity, you will learn how to



- Use the engineering design process to solve a problem by designing an app paper prototype.
- Critically evaluate how well the design solution meets a given set of needs.
- Learn how apps detect location.
- Apply the design challenge to real-world examples.
- Discuss safety considerations in the design and use of apps.

## Steps

1. Learn about apps.
2. Brainstorm solutions.
3. Design your app.
4. Evaluate your app.
5. Improve your app.





# Design an App for Safer School Zones

## Step 1: Learn About Apps

- Make a list of apps that you have used.
- Answer **yes** or **no** for each question.



App	Does the app know or show location?	Does the app alert when you are close to something (a friend, a store)?	Do people use this app when driving?

With a partner, discuss the following questions.



How many of the apps had a "yes" in at least one column?

How do you think apps determine where you are?

## Step 1: Learn About Apps

### How do apps determine a location?

Phone apps use **GPS (Global Positioning System)** to determine a location. GPS is a navigation system that uses a network of 30 satellites orbiting around the Earth. To identify a location, at least four different satellites broadcast a signal to a GPS receiver (such as in a phone). By measuring the time it takes for each signal to reach the receiver from the precise location of each satellite, the GPS can calculate a location typically within 16 to 50 feet.



### How do apps know when you are close to something?

Apps can alert users when they enter a **geofenced area**. A geofence is a virtual perimeter that often uses GPS that acts like an “invisible fence” around a specific location.

#### 3-Min Video

*How Your Smartphone Knows Where You Are* provides an introduction to GPS. Produced by KQED Quest.

<https://youtu.be/VMekmh3zjzc>

- Apps can send messages to smartphone users when they enter the virtual perimeter defined by a geofence.
- Emergency weather alerts
  - Ads from businesses

## Step 2: Brainstorm Solutions



### Your Challenge

- The speed in a local school zone is posted at 15 miles per hour in the morning and afternoon.
- Recently, drivers have been ignoring the speed limit signs and going 30 or 40 miles per hour as students are coming to and leaving school.
- Design an app that will make the school zone safer for students.

### User Experience (UX)

Who will use your app?

- What exactly will your app do? How will it do this? What features will it have?

What are some challenges that the user may experience when using your app? How can you address these?

- 
- 
- How will you make sure users are not distracted by your app while driving?

What are some unique needs that some users might have? (e.g., hearing impairment, don't speak English)

- 
- How will you advertise your app?

How will your app communicate with the user?

- How will you encourage people to use your app?
- 
-

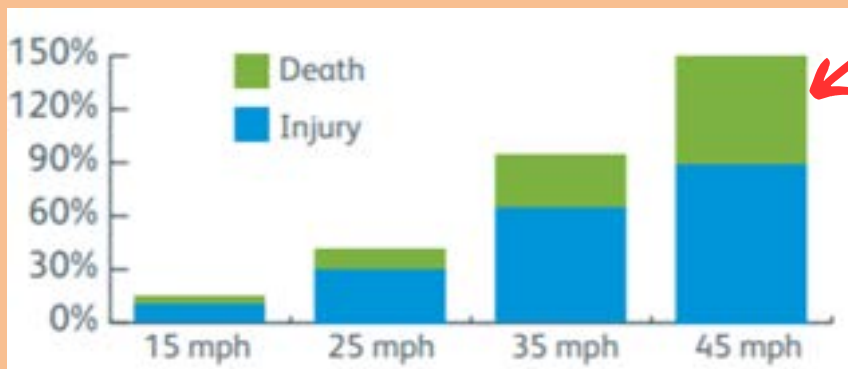
## Step 2: Brainstorm Solutions

### What is a School Zone?

A school zone is an area around a school where special traffic rules and regulations are in place to ensure the safety of children who may be walking or bicycling to school. These zones are typically marked by signs, pavement markings, and traffic signals and are designed to reduce speeds when children are arriving or leaving school. Speeds in schools zones may vary from 15 to 25 miles per hour.



### Why are slower speeds important?



**HIGHER  
SPEEDS  
ARE MORE  
DEADLY!**

Source: <https://www.safekids.org>

### How bad is distracted driving?

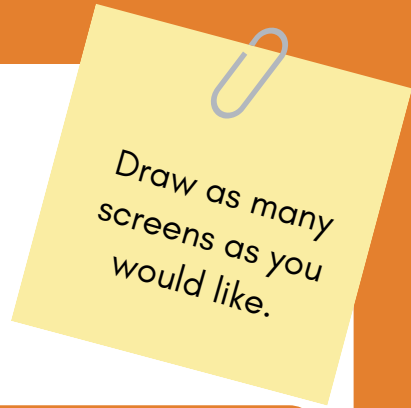
Distracted driving refers to any activity that takes a driver's attention away from driving, such as texting, talking on the phone, eating, or adjusting the radio. Texting while driving takes a driver's eyes off the road for an average of five seconds, which at highway speeds, is enough time to travel the length of a football field.

According to the National Highway Traffic Safety Administration (NHTSA), in 2020, 3,142 people were killed in crashes involving distracted drivers. An additional 324,652 people were injured.

Source: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813309>

# Step 3: Design Your App

- Draw simple sketches of the screens.
- Draw arrows to show how the user navigates.
- This is called a wireframe.



Name of app

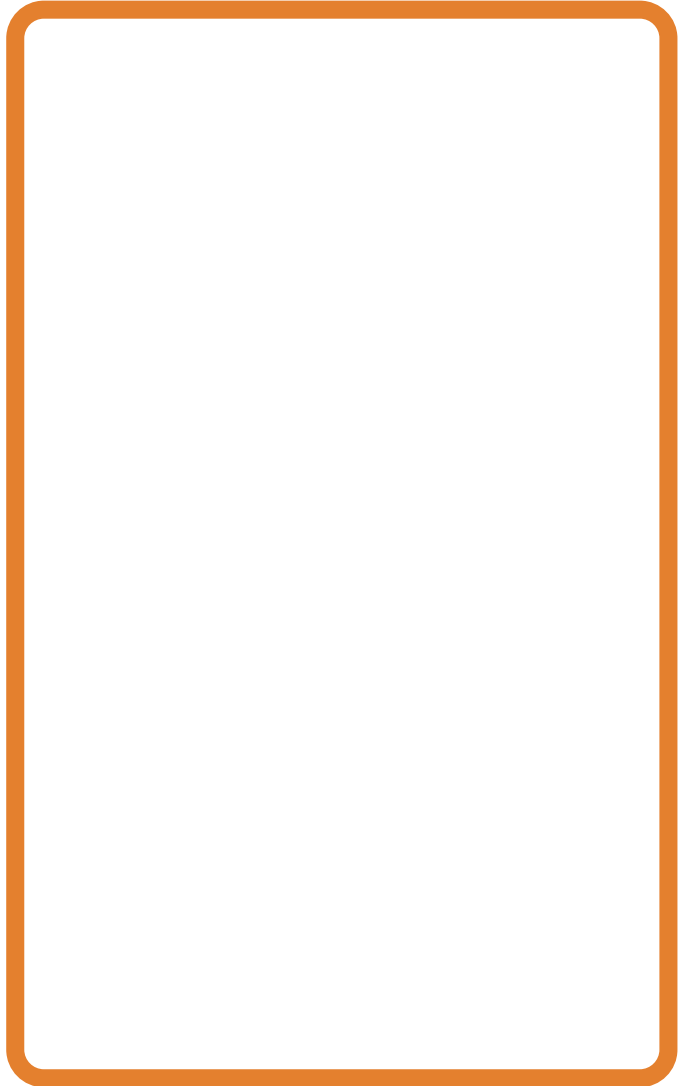
Logo/Icon

Cost of app

Large empty box for drawing the app wireframe.

Large empty box for drawing the app wireframe.

## Step 3: Design Your App

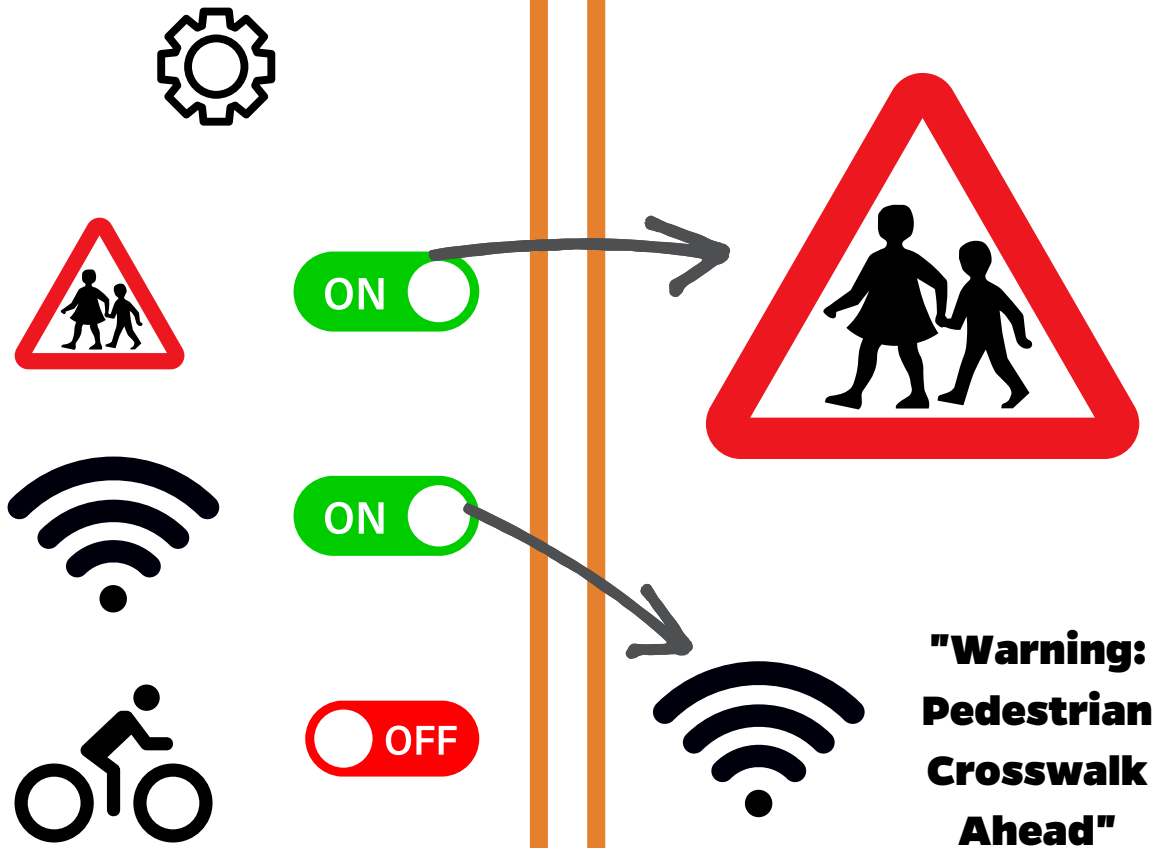


Describe any features of the app that cannot be seen on the screen.



## Step 3: Design Your App - EXAMPLE

### School Zone App



Describe any features of the app that cannot be seen on the screen.

- The School Zone App has settings where you can turn on/off features of the app.
- The second screen shows what the screen would look like if the car was approaching a crosswalk area in the school zone. There would also be a voice alert. This area would have to have a geofence around it so that the app would know when it was entering this area.

## Step 4: Evaluate Your App

- Score how well your app does on the following criteria.
- Share your app with the class.
- Score two other apps from your class.

Score how well the app does the following. 1 to 20 points	YOUR app	App #2	App #3
Warns drivers to slow down in the school zone. (20 points)			
Does not distract drivers' eyes from the road. (20 points)			
Encourages drivers to use the app. (20 points)			
Works for drivers who have different needs. (20 points)			
Is easy to use. (20 points)			
<b>TOTAL (out of 100 points)</b>			

## Step 5: Improve Your App

What are some ways you would improve your app?





## Additional Educational Resources

For an electronic version of this booklet and to find more engineering and transportation activities, please visit the **STRIDE Center website** at <https://stride.ce.ufl.edu/k-12-workforce-development/resources-for-educators/>

## Contact

For additional information about these activities including training opportunities, please contact  
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