Standards: 6th
ENGR-EET-2: Students will evaluate the impacts of engineering & technology on society
ENGR-EET-4: Students will demonstrate an understanding for a technological world through hands-on projects
ENGR-EET-6: Students will examine & research careers in fields related to engineering & technology
ENGR-EET-7: Students will develop leadership skills & work ethics

Standards: 7th
ENGR-II-5: Students will examine the impacts of inventions & innovations on society
ENGR-II-6: Students will develop leadership skill & work ethics

Name 5 examples of land transportation
1.
2.
3.
4.
5.

A transportation system is a way of moving people or products from one place to another. Each has terminals or locations where these people and products enter or leave the system. Airports, bus stops and boat docks are examples of terminals.

Transportation systems have inputs, processes, outputs and feedback. The people who operate the buses and fuel to provide energy would be example of input. Driving the bus and loading passengers would be processes. Arrival at scheduled stops would be output. Comments from satisfied customers would be feedback.

Transportation systems are interrelated. Each one often depends on others. Buses and care take passengers to the airports and ship docks. They are also embedded within larger technological, social and environmental systems that make up our world.

Land Transportation

There is more to land transportation than just automobiles. Those automobiles have to get from place to place which includes roads, bridges and service centers. These are just a few subsystems within a land transportation system that allows one to make good use of a vehicle. Government regulations often influence the design and operation of transportation systems. State governments regulate the speed at which you drive your car on roads, resulting in another subsystem, the highway patrol.

Automobiles

Why are cars so important in the United States?

The United States is one of the largest countries in the world. About half of the world's automobiles are used in the United States.

What is mass transportation?

Mass transportation systems are expensive to develop in a country as large as the US. That is one reason why automobiles are important to our way of life. They are for personal transportation, not mass transportation, which can sometimes be slower and less convenient.

Modern automobiles are different from early cars, but they have at least two things in common with these early models: both have transmissions and most have front-mounted engines.

Transmission

What is a transmission?

What is the purpose of a transmission?

The gears of a transmission work on the same principles as the gears on a bicycle. When you pedal uphill, you shift into a low gear because it takes more effort to pedal uphill. The rear wheels move slower. On level ground, it takes less effort to pedal and the rear wheel turns quicker. The engine of a car operates better if a lower gear is used to climb a steep hill or starting from a dead stop. The higher gears are used when traveling on a flat highway.

Driving Wheels

What is a driving wheel?

What is rear-wheel drive?

What is front-wheel drive?

What is four-wheel drive?

Other Subsystems

Automobiles have many subsystems besides the transmission and driving wheels. The frame, engine, steering wheel, springs and brakes are all subsystems that work together to make a car function properly.

Many of these subsystems are manufactured by outside suppliers. The ABS, or anti-lock braking system, GPS, the radio, CD player and windshield are all manufactured elsewhere. Toyota Motor Manufacturing in Georgetown, Kentucky, uses 350 outside suppliers.

Do you believe people would be more likely to obey traffic laws if they knew their actions were being recorded? Do you feel this would be an invasion of privacy or the price to pay for safer driving?

Buses

More buses are used in the United States than any other country. They are large and boxlike and can carry 30 or more passengers. Between and within cities, they are used for mass transportation and known as intercity transportation. They are also used for school transportation. School systems alone use over 400,000 buses.

Why do you think school buses are yellow?

Buses were used for school transportation beginning in the 20s. They made it possible for students to gather together from small rural areas in order to go to larger schools with improved facilities. About 24,000,000 students ride buses safely each day of the school year. They are well designed from steel to meet federal manufacturing requirements. Seats and other support systems are specially designed for safety. Many use diesel fuel, which doesn't burn as easily as gasoline if unexpected leaks occur.

Intercity buses use diesel engines and carry up to 64 passengers. They are less expensive to ride than trains or airplanes. They make stops in smaller communities not served by trains and airplanes. They transport nearly 800,000,000 passengers each year in the US.

Urban or in-city buses can carry more people than intercity buses because they allow some passengers to stand. They ease traffic congestion and saves fuel. However, they only account for about 15% of all passenger miles traveled in the US. The federal government also provides money to improve bus fleets.

Trucks

Trucks move much of our country's freight. US cities rely on trucks to supply their food, fuel, furniture and other products. They play an important role in our transportation system because they can go directly from the supply location to the customer. Trains, airplanes and ship don't share this advantage.

Trucks are involved in many processes. They move and deliver cargo and require places they can pick up or unload cargo. People who work in the trucking systems must evaluate, market and manage services.

What is a tractor-trailer?

We use hundreds of different kinds of trucks. They are usually diesel powered. Some are as small as pickup trucks. Some are as large as 18-wheeler semi-trailer trucks. Most are either one of 3 types: light, medium or heavy duty. Pickup trucks are light duty. Sanitation trucks, delivery trucks & fuel trucks are medium duty. 18-wheeler trucks, trucks that carry large loads, are heavy duty.

The flat front and square shape of many trucks create a large surface that air can pass against. Running 45 miles per hour, 1/3 of a trucks power us used just to overcome air resistance. This means that trucks waste fuel. Manufacturers have tried 2 different ways to help trucks slip through the air more easily. One was to change the shape of the tractor and front of the trailer. The other was to place a wind deflector on the tractor's roof. Properly designed deflectors can reduce air resistance by 20%, directing air around the truck.

Locomotives

In the 1800s, trains fired imagination in everyone. When that faraway whistle was heard, ears listened. But by the 1960s, steam locomotives had been replaced by diesel-electrics on mainland railroads. Now, approximately 21,000 diesel-electric locomotives run across railways in the US.

Railroads earn their money by hauling freight. They deliver bulky items like coal, iron ore, automobiles and electronics. About 10,000 freight trains roll over tracks every day, some over 200 cars long.

AMTRAK, an intercity passenger railroad, operates passenger trains, which are busiest along the east coast. The most popular of these are the terminals at Washington, DC and Boston, with stops in between. They are generally short distances, with trains traveling directly downtown to downtown. However, trains carry less than 1% of all US intercity passengers. This is a very low number, especially when in some countries, trains carry up to 50% of intercity travelers. Commuter and subway trains, also a part of the mass transportation system, transport workers, tourists, students, shoppers and others traveling to their daily destinations.

What does it say to you when in the US, trains only account for 1% of passenger travel and in other countries, it accounts for about 50% of travelers?

Name 4 types of cargo that are transported commonly by train.

1.

2.

3.

4.

High-Speed Trains

What are bullet trains?

How do you think bullet trains got their name?

Bullet trains are the newest all-electric locomotive. They can reach speeds of between 125-200 miles per hour and have a pointed nose. The very first bullet train was Japan's *Shinkansen*. The *Acela Express*, in the US, entered service in 2000. Its travel time from Boston to Washington, DC is about 6 ½ hours, which includes stops at intermediate stations.

Maglev Trains

What is a maglev train?

What drives a maglev train?

Maglev trains do not roll on wheels or touch the ground. The name stands for magnetic levitation. The forces of magnetic attraction and repulsion allow the train to float, or levitate, less than one inch above the guideway, or path. The same forces interact to move the trains.

Maglevs are quiet and produce little vibration. They are expensive to build and only a few experimental guideways have been built in the US.

Do you think maglev trains have a place in our transportation systems? Explain why or why not.

Pipelines

How can cargo travel through pipelines?

Water, oil and natural gas can travel long distances through pipelines. Pipes can be anywhere from 2 inches to 15 feet in diameter and are mostly buried in the ground. When they are laid out in straight lines, transportation time is reduced.

Pipelines require service facilities such as pumping and control stations. They are located along the pipelines and keep the cargo moving. When the cargo is made of particles, it is mixed with liquids. The pump forces the material through the pipeline. When the pipe gets clogged, a tool called a pig is pushed through to clean it.

Water Transportation

Water has been used to provide transportation for centuries. Oceans, rivers, lakes and other navigable waterways make natural routes between cities, states, countries and continents.

What are navigable waters?

Name 3 examples of navigable waters.

1.

2.

3.

Boats and Ships

What is the difference between a boat and a ship?

There are about 24,000 boats and ships in the world today. Water transportation vessels are grouped into three different types: passenger vessels carry people, like ocean liners; cargo ships transport different products; specialty crafts, like river barges, tugboats and icebreakers have specific jobs they are used for.

Why do you think it costs less to transport goods by water?

What is displacement?

What are supertankers?

Why do you think supertankers are called what they are?

Ships deliver most of the overseas cargo leaving or arriving in the US. Because of this, docks with special loading and unloading equipment are required, properly trained people to operate ships are needed and good communications for weather data and other information are needed. Each of these make the entire system operate smoothly.

For centuries, sailing ships were used to haul cargo and passengers. The ships of the 1800s had a displacement of about 1,200 tons. This is an indication of the ships size. The average cargo ship today, about 600 feet long, has a displacement of 21,000 tons. Wind also limited how much older ships could carry. Heavier ships are more difficult to push than lighter ones and move slower. Today's ships are pushed by powerful engines. Ocean liners and cargo ships use gas turbines. Specialty ships use steam turbine, gas turbine or diesel engines. Some ships of today can displace 100,000 tons, which means they are 80 times bigger than the ships of the 1800s. Supertankers can displace up to 500,000 tons.

Intermodal Transportation

What is intermodal transportation?

Why is it efficient?

Can you think of a time when you used more than one mode of transportation in a single journey?

Different transportation systems are organized to work together to help a person on his or her travels. When two or more forms of transportation are used together to move people and cargo, it is more efficient. Cargo is packed in large containers when traveling overseas, making loading and unloading easier because they are usually the same size and shape. When the containers are unloaded, they can be easily moved to trains then to semi-trailers in order to continue their journey to the customer. This form of transportation is more efficient because it saves time and money.

What are container ships?

Name 3 port cities in the US.

1.
2.
3.

Air and Space Transportation

Name 3 forms of air travel.

1.
2.
3.

Airplanes are the most common form of air travel, but there are many others. There are many components that are necessary for air travel, such as airports, training programs and radar. Many airplanes and other aircrafts are in the air at the same time, which is why air travel is the most complex transportation system. Government regulations specify how air travel is carried out.

Airplanes

Name 4 airline companies.

What is a commercial airplane?

What is a jumbo jet?

After the Wright brothers first flight in 1903, several other important airplanes were built and flown. In 1935, the DC-3 was the first commercial airplane used to profit from carrying passengers. It had 2 gasoline engines. The Boeing 707, built in 1958, was the first American jet. It carried 179 passengers. Over the years, the number of passengers has increased. The Boeing 747 was the first to carry about 500 passengers.

Because jumbo jets have such powerful engines, they can lift more weight than other planes, which means they can carry more fuel and stay in the air longer, which is why we have non-stop flights. Smaller jet aircraft, such as the 2-engine DC-9, are used for shorter flights. They use less fuel and don't need long runways to take off. Some airplanes only carry cargo, but even the biggest cargo plane can only carry a fraction of what a ship or train can carry. A Boeing 747 can carry 100 tons of cargo, which is about the most any airplane can carry. This makes air travel expensive. Mail, electronics and other lightweight items are usually shipped by air.

Lift

What is lift?

The shape of a plane's wings lifts an airplane off the ground. As the plane races down the runway, it gathers speed and air rushes over the wing. The shape of the wing causes the air to travel faster over its upper surfaces. This reduces air pressure above the wing and increases the pressure on the wing's lower surface, pushing it upward and creating lift.

Helicopters

What is a helicopter?

Helicopters can be small, carrying only one passenger, and have gasoline engines or can be cargo-carrying helicopters, which can easily lift ten tons. The larger helicopters are powered by 1 or 2 gas turbine engines. Some have small tail rotors to keep them from spinning out of control. The twirling blades of the rotors create lift. There are passenger-carrying helicopters, some specializing in industrial operations and others that monitor car traffic and transport people to hospitals.

What are some other uses for helicopters?

Lighter-than-Air Craft

What is a lighter-than-air craft?

Examples of lighter-than-air craft are dirigibles, zeppelins, blimps and airships. Helium lifts this type of air travel into the air while gasoline engines turn propellers to move them forward. The engines are located in cars suspended from the craft. The passenger compartment is located in another car. Hot-air balloons are also lighter-than-air craft. They use torches to heat the air inside a nylon bag. Hot air weighs less than cooler air, allowing the balloon to rise. The direction is controlled by ascending or descending into wind currents that push them along.

What is the difference between dirigibles, zeppelins, blimps and airships? Explain why we use so many different names for these types of craft.

Space Vehicles

What does NASA stand for and what do they do?

Space transportation is the most exciting way to move people and cargo. NASA is responsible for regulating and directing the US space program, which includes space shuttles and vehicles for exploration.

Space Shuttles

What is payload?

What is the purpose of a shuttle?

On a typical mission, a shuttle carrying 4 astronauts orbits 115 miles above Earth at speeds of 17,000 miles per hour. Once in orbit, an astronaut opens the doors to the cargo bay, which usually contains a communication satellite. A 50 foot mechanical arm, controlled by an astronaut, removes the satellite, releasing it a safe distance away from the shuttle. The arm can also grab satellites already in orbit. Shuttles can carry a complete scientific laboratory in its cargo bay. But, most experiments are done on the International Space Station nowadays. When it is time to return, the astronauts fire small rockets to show the shuttle down. It re-enters Earth's atmosphere and glides to the landing strip.

Exploratory Vehicles

The distance between planets and other points in space are massive. Humans must bring life support systems and fuel into space because they cannot survive their without it. Currently missions are being done without humans. The payload, which is usually cameras and other equipment, sits in the hollow nose of a booster rocket. Once out of Earth's gravity, the nose opens, releasing the payload, which continues on its journey using smaller engines. A few missions that used no humans were the *NEAR-Shoemaker* in 2001, the *Sprint* in 2004 and the *Mars Reconnaissance Orbiter* in 2005.