

LAND TRANSPORTATION - MONORAIL DESIGN

STUDENT INFORMATION

Area of Study: Transportation

Objectives: Students will construct a working model of a monorail and will test the results.

Related Occupations:

Civil Engineer

designs and supervises the construction of roads, buildings, airports, tunnels, bridges, dams, water supplies, and sewage systems.

Graphic Designer

puts abstract ideas with their artistic ability to create the “look” of a product or idea. The designs may include clothing, publications, living space, automobiles, movie, television, or theater sets.

Urban Planner

develops land use plans to provide for the growth and revitalization of a community. Their titles may be community, regional or city planners. They address issues of traffic congestion, alternate means of transportation, protection of ecologically sensitive areas, and the effect of growth and change within a community.



A graphic designer created the “look” of this monorail & it’s surroundings.

Figure 1

Key Words and Definitions:

- 1. Composite:** A substance that is made by combining two or more materials. The materials that form the composite are not changed. They work together to form a more desirable material. Two common composites are concrete and plywood.
- 2. Fixed Route:** A predetermined path in which a vehicle is guided by a track or a wire system.
- 3. Guideway:** A means such as tracks, channels, or wires which provide a controlled path for a moving vehicle.
- 4. Maglev:** (short for MAGnetically LEVitated) These are vehicles which are levitated, or floated above a guideway (track) and propelled (moved) by magnetic fields. This type of transportation system allows for higher speeds as there is little or no friction between the ground and the vehicle.
- 5. Mode:** A method of doing something.

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Occupational Choices

Focus: Civil Engineer

Classes to take in School:

- Drafting
- Math
- PLTW
- Technology & Engineering
- Computer Science
- Biology
- Chemistry
- Physics
- Humanities
- English
- Social Studies

After High School:

College/University - 4 or 5 years to earn a bachelors degree. Most engineering programs involve a concentration in an engineering speciality within Civil Engineering (structural, water resources, environmental, construction, transportation, and geothermal, are some of the specialties in Civil Engineering).

Admissions requirements for engineering schools will include a solid background in mathematics (listed), sciences (listed), and courses in English, social studies, humanities, and computers.

Earnings:

In 2009, people with a bachelor's degree in civil engineering earned a average **starting salary** of **\$52,048**.

In 2010, Civil engineers nationally had median yearly wages of **\$77,600**. In Utah, the wage was lower coming in at **\$73,400**.

In 2010, earnings ranged nationally from **\$50,600 to \$119,300**. Earnings vary by experience and location.

The Work:

Employment of civil engineers will be needed to design and construct transportation systems, water supplies, pollution control systems, and large buildings. They will also be needed to repair roads, bridges, and other public structures.

Employment Opportunities

- Federal Government
- State and Local Governments
- Construction Industries
- Manufacturing Industries

Personal Characteristics

- Good Communications skills
- Excellent Math Skills
- Computer skills to test & analyze designs
- Ability to read and write technical reports
- Must work in team situations

6. **Random Route:** Determined by necessity and changed at will to meet the needs of individuals.
7. **Transportation Technology:** All the means we use to move through the air, in water, or by land¹.

Transportation Technology:

Transportation technology is all the means and processes by which we move people, animals, products, and materials through the air, water, or by land. A mode is a method of doing something. There are many different modes of transportation for moving people or goods over land, water, and air. Modes of transportation are classified by the way goods or people are transported. For that reason, these are the general classifications of transportation: **Land**, Air & Space, Marine, and Pipelines & Conveyors.

Regardless of the mode of travel, all the collective parts that are used in the method of travel form a system of transportation. For instance, a monorail system includes, the fuel for the vehicles, the vehicles, the fixed route rail system, and drivers for the vehicle. Many more components could be listed to describe all the transportation system which would be required for it to operate efficiently.

Every transportation system, no matter how simple or complex, (from walking to a monorail system) will be designed with the common elements of **input** (energy, people, and money), **processes** (actions required to move the goods), and **outputs** (result of arriving).

What is a Monorail?:

In the transportation system above, the mode of transportation was a monorail. What is a monorail? In defining a monorail, the first half of the word or “mono,” literally means one. Consequently, a monorail is a method of transportation in which the vehicle travels on **one** rail.

A monorail is a vehicle on a single rail serving as a track for passenger or freight vehicles. In most cases the rail is elevated, but monorails can also operate on the ground or in subway tunnels. Vehicles are either suspended from or straddle a narrow guideway. Monorail vehicles are **WIDER** than the guideway that supports them.²



Suspended Monorail Car.
St. Paul MN 1888, Minnesota Historical Society.

Monorails are often thought of as a method of transportation that is very new and modern. Many people would be surprised to learn that the first monorail in the United States that carried passengers was actually used in 1825.³ The picture above is of an electric monorail car that was built and proposed for transportation for the city of St. Paul, Minnesota in 1888.⁴ The project was abandoned when the city council failed to approve the plans on the transportation system.

¹ Brusic, S., Fales, J. and Kuetemeyer, V.

² Monorail Society

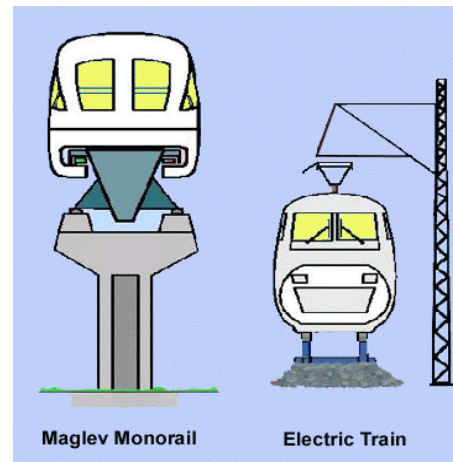
³ Monorail Society

⁴ Minnesota Historical Society

Means of Power:

Monorails may be powered electrically, by forced air, and magnetically. The majority of monorails are powered electrically and are relatively slow moving.

Some newer monorails are magnetically levitated from their rail by a magnetic charge on the rail, and the same charge on the monorail carrier. (Like charges repel.) The world's first magnetically levitated passenger vehicle began taking passengers on January 1, 2003 in Shanghai, China.⁵ The 450 passenger vehicle's average travel speed is about 270 miles per hour. The transportation system cuts travel time from 30 minutes to 8 minutes as it speeds from downtown Shanghai to the airport. *If the magnetically charged vehicle is on 2 rails or if the vehicle is not wider than it's guideway, it is classified as **Maglev train**.*



Comparison of a maglev monorail and a light rail system.

Figure 2

Construction:

The monorail's body or passenger shell is primarily made of **composite** fibers. Composite fibers on a monorail are materials formed by mixing liquid plastics, and graphic fiber with a hardener (catalyst), and then pouring the mixture into a mold. The process could be compared to what takes place when making Jell-O.

Cost:

The cost of monorail systems will vary with distance to be covered and other factors such as speed, passenger requirements, and the number of tunnels the system will require. Depending on the needs of the system, an average monorail would cost approximately 25 - 30 million dollars per mile.⁶

New technologies are more expensive until they gain widespread use. The Shanghai Maglev Monorail is the first of it's type and; as a result, it would be very expensive. The Maglev Monorail in Shanghai was estimated to cost about 60 million per kilometer.⁷ This estimate roughly converts to about 38 million a mile.



Shanghai's Maglev Monorail

Photo: Jian Shuo Wang

Monorails in Use:

Each and every day hundreds of thousands of passengers are carried on Monorails. Most of the world's transit monorails exist in **Japan**, seven of which are full-scale urban transit systems.

Surprisingly, Walt Disney World's monorail system near Orlando, Florida, has one of the highest ridership of all monorails.⁸ At least 100,000 passenger trips are recorded each day on the 14

⁵ Popular Science

⁶ Monorail Society

⁷ Monorail Society

⁸ Wang, J. S.

miles of guideways. The system is there to move people between six stations. The resort would be a transit nightmare without the monorail.

Monorails in the United States are found at places where great numbers of people gather such as Disneyland in California, and Disney World in Florida. Monorails are used as urban transit systems in Seattle, Washington; Las Vegas, Nevada; Jacksonville, Florida; Kennedy International Airport, New York; Tampa International Airport, Florida; and Newark International Airport, New Jersey.

Impacts on Society:

Monorail systems have not made significant positive impacts in countries that are sparsely populated or that are quite large in geography. Monorails as a mode of transportation, are very limited to areas of a high population density or resort destinations. In most of the world, the expense of implementing monorails has limited the widespread utilization of this mode of transportation.

However, monorails have become an essential means of transportation in high density population areas because monorails can transport large numbers of people within a short time period. Monorails have definite advantages as a means of public transportation because they are not affected by traffic lights, speed zones, traffic jams, or **poor weather conditions**. Monorails are a safe mode of transportation. Whether they are of the straddle-beam or suspended variety, the nature of their design does not allow derailments. Modern monorails can not have accidents with other systems of transport as they are always separated from surface traffic and pedestrians. Zero accidents translates to no system down time, less liability suits and most importantly, **no injuries or deaths**.



Straddle-beam Monorail at Disney Land in 1985.
Photo: Transport-of-Delight.com

Environmentally, monorails have also limited pollution by allowing great numbers of people to be transported without the congestion and pollution that their individual vehicles would have created. Monorails by themselves are nonpolluting and most are powered by electricity. However, if this electricity is coming from power plants that burn fossil fuels (coal or oil) they can pollute the environment; but the fact that there is one vehicle traveling rather than several thousand to a destination makes their impact on the environment a very positive one.

DESIGN BRIEF:

Problem: Design a fixed transportation route which will transport goods (clothespin) between 2 points.

Constraints: Only human hands may touch the system before vehicle departure and after arrival. Human hands may also touch the system to reset the vehicle if the vehicle fails in-between these two points.

If you need a special tool such as a scissor consult your instructor or the student assistant. You may use all the materials in the bag. *You do not have to use all the materials in the bag.* The bag itself can not be used. One strip of tape will be supplied for each group. If a balloon pops; it can not be replaced.

Procedure:

Step 1: Read the Problem Statement above.

Step 2: Brainstorm as many ideas as possible within your group after you receive the supplies you will be using. List all your ideas, no matter how “weird.”

Step 3: The research has been done with the reading of this booklet. Continue on to step 3.

Step 4: Design or illustrate your best idea to solve this problem individually.

Step 5: Pick the idea that looks the most promising in your group. Don't share your ideas with other groups. Keep it top secret!

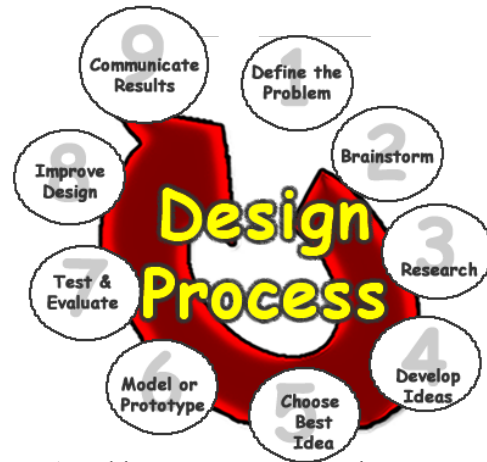
Step 6: Make the model of your idea this is known as the prototype. Please work as a team.

Step 7: Test your prototype. Remember to include the clothespin (represents the people or product).

Step 8: After testing, modify your design if necessary.

Step 9: As a group, complete your final model. Call your instructor over for the final demonstration.

Place the materials back in the bag at the end of the period that your instructor tells you to. Remember the approximate distance that your monorail traveled for the work sheet.



A multi-step process used to invent or innovate a product.

Figure 3

LAND TRANSPORTATION - MONORAIL DESIGN

Student Work Sheet

Name: _____ Period: ____ Date: _____

Directions: In the blank on the left, write the correct answer to the statement or question.

1. _____ _____ Technology is all the means that we use to help us move through the air, in water, or over land.
2. _____ The four major classifications of transportation are: _____ Air & Space, Marine, and Pipelines & Conveyors.
3. _____ A monorail is a method of transportation in which the vehicle travels on _____ rail.
4. _____ Monorails are _____ than the guideway that supports them.
5. _____ If a vehicle is powered magnetically while operating on two rails it is classified as a _____ train.
6. _____ Monorail's passenger shell is primarily made up of ____ fibers.
7. _____ Most of the world's transit monorails exist in _____.
8. _____ Some advantages of monorails are that they are not affected by _____, _____, _____, or poor weather conditions.

9. _____ The multi-step process used to invent or innovate a product is called the _____ process.
10. _____ feet _____ inches Estimate how far your monorail vehicle traveled?