Transportation Technologies

Foundations of Technology (ITEA 18)

Outcomes

In this lesson, you will learn:

- Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture (ITEA 18-J)
- Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another. (ITEA 18-K)
- Transportation services and methods have led to a population that is regularly on the move. (ITEA 18-L)
- The design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. (ITEA 18-M)

Transportation Shapes our World

People have basic needs for food, shelter, and clothing. Another basic need, that is commonly overlooked, is the need for transportation. Transportation has shaped the world in which we live. Nearly everything we do is in some way related to or made possible by transportation and transportation systems.

Our work, home, and recreational activities are all impacted and sometimes even directly driven by transportation. Imagine the limitations of a world in which you could only travel as far in a day as you could walk. Today's society is completely dependent on safe, reliable, and efficient modes of transportation.

Transportation is the way we relocate people and goods. Whether it is a family taking a cruise to the Bahamas, someone riding the subway to work, or people moving oil through a pipeline to a refinery, goods and/or people are being moved.

A Brief History of Transportation

Many people think nothing of jumping into a car and going to the supermarket or mall. Other people catch planes to faraway places. Transportation was not always so easy. In the earliest times, people had to walk everywhere they went. To improve transportation, people started to develop new ways to move loads.

They developed sleds, rafts, and other crude devices. These people started to use pack animals to carry loads. Later, they developed canoes and other boats. By 4000 B.C., the sailboat was in use. About 5000 years ago, the wheel was invented. These devices laid the foundation for new land transportation systems.

People developed ships to carry themselves on the water and wagons to move loads on land. By the 1400s, sailing ships were used to explore the world. A steam power carriage was developed in 1769. The Montgolfier brothers flew the first hot air balloon in 1783. The first railroad locomotive was developed in the early 1800s.

Rail lines were used for streetcars during the same period. In 1885, Karl Benz built the first practical automobile. The Wright brothers flew their airplane in 1903. In 1926, Robert Goddard flew the first liquid fuel rocket. The first commercial jet, the *Comet*, flew in 1949. The Russians launched *Sputnik*, in 1957.

Neil Armstrong became the first man to walk on the Moon in 1969. The space shuttle started flying in 1981. As you can see, transportation has advanced greatly over time. Much of this change has come in the last 250 years.

Transportation Systems

Transportation, like all other technologies, can be viewed as a system. It is a series of parts that are interrelated. The parts work together to meet a goal. Transportation uses people, artifacts, vehicles, pathways, energy, information, materials, finances, and time. These parts work together to relocate people and goods.

People use four environments, or “modes,” for transportation. Transportation systems have been developed for

- **Land**
- **Water**
- **Air**
- **Space**

Land Transportation

Transportation systems operating on or beneath the earth's surface are known as **land transportation**. They move over or through constructed pathways. These systems include the following types:

- Fixed path systems
- Variable path systems

- ***Fixed path systems.*** These systems have one degree of freedom. They move from one origin to one destination. Fixed path systems include railroads, pipelines, and conveyors. They also include on-site systems, such as elevators, moving sidewalks, and escalators.
- ***Variable path systems***. These systems use vehicles that can be guided through two degrees of freedom. These vehicles include automobiles, bicycles, buses, trucks, forklifts, and motorcycles. In addition, tractors are variable path vehicles used in factories, on construction sites, and at airports.

Land transportation systems have developed into three major types. They are…

1. Highway systems: Automobiles, buses, and trucks
2. Rail systems: Freight, passenger, and mass transit
3. Continuous flow systems: Pipelines, conveyors, and cables

Water Transportation

The next system developed was water transportation. From the humble hollow-log canoe, water transportation has grown to be an important mode for moving people and cargo. Water transportation systems use water to support the vehicle. Water transportation includes inland waterways (rivers and lakes) and ocean-going systems.

Waterways provide another type of transportation. Some waterways are human-made channels, such as the Suez and Panama Canals. **Water transportation** is generally cheaper than land transportation. It can be used, however, only where rivers, lakes, and other bodies of water are navigable.

The bodies of water must be wide enough and deep enough for heavily loaded watercraft to travel on them. There are two major types of waterways used for transportation. These are **oceans and inland waterways**. Oceans and seas are the masses of water separating continents and major landmasses. Inland waterways are the rivers and lakes within a landmass.

Ocean transportation carries freight and people on ships. Ships carrying people are called ocean liners. Freighters carry products and solid materials. Tankers carry liquids like petroleum and chemicals. There are no constructed paths or highways on the ocean seas. Ships do, however, keep to regular routes over the water. These routes are known as *sea-lanes*, or *shipping lanes*.

A number of vehicles are used for inland shipping. *Barges* are large floating cargo boxes without engines. *Tugboats*, or towboats, are small vessels that move the barges over the water. Ferries are used to move people and vehicles across bodies of water.

Air Transportation

Air transportation became practical in the twentieth century. Orville and Wilbur Wright made the first successful flight in a power-driven airplane in 1903. The flight took place at Kitty Hawk, North Carolina. During the succeeding years, air travel has become a large industry.

A mode of transportation developed in the last century is *air transportation*. It uses aircraft of all kinds to move people and cargo to their destination. Aircraft include all vehicles traveling within Earth's atmosphere. Airplanes are the most commonly used aircraft. These airplanes may be commercial airliners, company planes, or private aircraft.

Helicopters can be used for air transportation. They are usually used for short, commuter-type hops. Like the ocean, the sky has no highways. To be safe, aircraft follow established routes. In addition, air lanes are at various heights. For example, planes flying west may travel at a different altitudes than planes flying east.

Space Transportation

Space transportation systems are the fourth transportation mode we use. Space transportation can best be described as *emerging*. On the horizon is personal space travel. Hypersonic aircraft will merge air travel and space travel technologies. People will be able to travel anywhere on the globe in a matter of hours.

Space transportation is a very new transportation mode. It includes unmanned and manned flights. Unmanned flights have rockets traveling far into outer space. They are used to explore the universe. Cameras aboard the space vehicles send back photographs of unexplored space.

Manned flights have taken astronauts to the Moon. The space shuttle ferries humans between space stations and Earth. The space shuttle is expected to be used until 2010 at which time it will be replaced by a new space transportation system.

Interdependent Systems

The transportation system is a complex network of interconnected components that operate on land, on water, in the air, and in space. Although traveling into space has been realized, it has not yet become a fully integrated part of the larger transportation system.

Many of the subsystems of the transportation system, such as highways, ports, airports, and others, are dependent upon each others subsystems, and each in turn is made up of yet smaller components that are themselves interlinked and interdependent.

Transportation Technologies Change Society

Transportation services and methods have led to a population that is regularly on the move. For instance, people today can travel to foreign lands or to sites of interest hundreds of miles from home as quickly as they used to take a relatively short trip into town in a wagon 200 years ago.

Too often little attention is paid to the environmental consequences or to the effects of rapid expansion that has accompanied transportation improvements. Future use of transportation systems should take into account ways to reduce energy consumption and air pollution, while promoting economic development and supporting international commerce.

Transportation Values

Consider a family buying their first new car. Many personal, social and cultural values must be considered. What type of car do they need? How large a vehicle does the family require? Is the car reliable? Does it have a reputation for safety? Where was the car made? These questions deal with the social-cultural values of the family. It is up to the individual to decide which values are important to them.

Political influences are the regulations and rules designated by the government to control the system. Companies that ship hazardous chemicals must take these into account every day.

Environmental factors have become a big concern for transportation systems. Every transportation system affects the environment in some way. Emissions from automobile exhaust have been linked to the greenhouse effect, leaking oil from engines pollutes ground water, noise from trains disturbs people, and oil spilling from tanker ships kills wildlife. Using a personal vehicle may be convenient, but causes many environmental problems.

Technical factors must also be taken into consideration for decisions about transportation. These factors are especially important when new and innovative transportation systems are developed.

Economic factors often are a large factor in transportation decisions. People must deal with the cost of shipping products every day. Some modes of transportation cost more than others and the cost may vary depending on what is being transported, how large and heavy it is, how far it is going, and how quickly it needs to get there. When people travel, economic factors come into play as well.

Personal factors must be taken into consideration. Sometimes, half the fun of traveling is the journey itself. This is why some people like taking cruises, train rides or travel the scenic routes. If they wanted to get to their destination as quickly as possible, a different mode of transportations, such as flying, might be a better choice. Your personal needs and wants are very important in choosing a transportation system.

Intermodalism

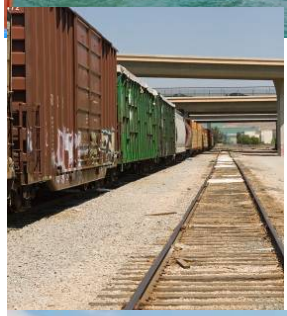
Often, moving people and goods from one point to another requires more than one transportation mode. For example, travelers may travel from home to the airport in a taxi or shuttle. They use land transportation. These people may fly to a port city by using air transportation. There, they may board a cruise ship for a holiday vacation. In all, they used three modes of transportation.

Likewise, a shipment of apples may be loaded in a refrigerated container. The container may be transported to the port on a train. There, it is loaded on a ship bound for Japan. This use of more than one mode of transportation is called **intermodal**

Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another.

An example of Intermodalism is a semi-truck container that is hauled on an ocean cargo ship from another country, transported to a railcar, and finally attached to a semi-truck that travels a highway to deliver goods.

Intermodal Systems



Airplanes, ships, trains, and trucks all have particular advantages, but no single system is better than the others. Ships can move the largest loads from country to country.

Trains carry large loads efficiently over long distances on land, but they cannot collect and deliver goods to your door or to the store around the corner.

The amount of cargo that trucks carry is limited, and while planes are the fastest means of travel, the cost of planes is the highest.

In recent years, there has been a willingness to integrate separate transportations systems through an intermodal chain. Freight might be transported by ship to the West Coast from China, packed in containers.

Intermodalism Standards

A container is a box measuring 20′ long, 8′ high, and 8′ wide. As its size has been standardized worldwide, ships and lifting equipment are available in all ports and rail terminals to handle the containers.

Goods are shipped in bulk, so costs are reduced and cranes can handle the containers quickly. The contents are protected from damage and theft, and containers can be stacked to minimize storage space.

Now that shippers can think in terms of a variety of transportation methods, they can move away from the dominance of trucks and address concerns about congestion, safety, and environmental pollution.

Planning for Intermodalism

Intermodalism has emerged as a major new approach to the planning of transportation systems and its further development is inevitable for all countries.

Regardless of the quality and efficiency of the various transportation modes, domestic and international pressures are creating a need for the intermodal system.

To begin with, it is obvious that the existing infrastructure in the U.S. and in many other countries is being strained to the limit and that it will be no easy matter to expand the existing intermodal system.

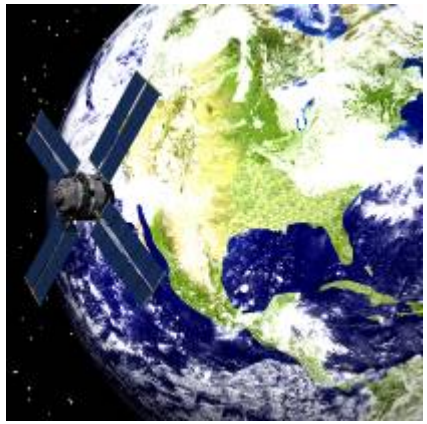
The demand for both passenger and freight transportation continues to grow steadily, placing increasing pressures on ports, airports and highways.

An intermodal system is one in which the individual modes are linked, governed, and managed in a manner that creates a seamless and sustainable transportation system.

Such a system should be economically efficient, environmentally sound, safe and secure, and ethically based.

Technology and Intermodalism

One area requiring particular educational attention is technology for it is clear that new and emerging technologies have to play a key role in dealing with the numerous physical impediments that constrain the seamless flow of passengers and freight.



Technologies have already had a profound impact on the development of Intermodalism – double stack trains, super container ships, large aircraft and the operations of such innovative companies as UPS, DHL, and FedEx.

There is little doubt that technologies such as satellite communications specifically and information and communication technologies generally will have a similar impact in the future on Intermodalism.

Passenger Intermodalism

For passenger Intermodalism to succeed, for example, it is not sufficient to build transit systems; an appropriate information infrastructure that facilitates a seamless journey is required.

This kind of infrastructure exists for automobiles in the form of road signs, maps, driver education programs, news of traffic conditions and the like.

Someone using public transit, on the other hand, has no such aids readily available. The traveler is forced to develop the necessary information by identifying transfer points and checking one or more schedules.

There is often a lack of clear and precise information on how one can shift from one mode to another, especially where airports are concerned.

New developments in communication and information hold great promise for facilitating such journeys by integrating information systems and ticketing systems but many issues of standardization and coordination still have to be overcome.

Intelligent and Non-Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) are part of the national strategy for improving the operational safety, efficiency, and security of our nation's highways. ITS refers to transportation systems which apply emerging hard and soft information systems technologies to address and alleviate transportation congestion problems.

Since the early 1990s, ITS has been the umbrella under which significant efforts have been conducted in research, development, testing, deployment and integration of advanced technologies to improve the measures of effectiveness of our national highway network.

These measures include the level of congestion, the number of accidents and fatalities, delay, throughput, access to transportation, and fuel efficiency.

A transportation future that includes ITS will involve a significant improvement in these measures while remaining environmentally friendly, and assuring the safety and security of the traveling public.

For example, using advanced surveillance systems, the early stages of a traffic bottleneck situation can be detected, and traffic can then be directed to other routes to mitigate the congestion and to provide faster and more efficient routes for travelers. New technologies enable this type of surveillance and guidance response to occur in real time, and therefore, to allow potential congestion situations to be addressed before they develop into serious traffic jams.

Intelligent Infrastructure

ITS is made up of 16 types of technology based systems. These systems are divided into ***intelligent infrastructure systems*** and ***intelligent vehicle systems***.

Intelligent Infrastructure Includes:

- Arterial Management (traffic control signals)
- Freeway Management (ramp and lane control)
- Transit Management (public transportation)
- Incident Management (vehicle crashes)
- Emergency Management (fire and rescue)
- Electronic Payment (smart card use at toll stations)

Intelligent Infrastructure and Vehicles

Intelligent Infrastructure Includes:

- Traveler Information (trip and en-route information)
- Information Management (data archiving)
- Crash Prevention and Safety (warning signs)
- Roadway Operations and Maintenance (repair work)
- Road Weather Management (message signs)
- Commercial Vehicle Operations (truck weight stations)
- Intermodal Freight (freight tracking)

Intelligent Vehicles Include:

- Collision Avoidance Systems (Vehicle Sensors)
- Driver Assistance (Global Positioning System)
- Collision Notification (OnStar Communication)

Non-Intelligent Transportation Systems

Non-intelligent transportation systems, such as walkways and bicycle paths, attract individuals and groups of people through innovative designs that capitalize on natural settings and provide convenience.

Elevated walkway over a major highway

Summary

- Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another
- Technology has facilitated intermodal transportation by inventing new techniques to transfer freight from one mode to another
- The most important development in intermodal travel is the standard shipping container. Ships and lifting equipment are available in all ports and rail terminals worldwide to handle shipping containers
- Transportation systems have been developed for land, water, air, and space
- There are intelligent and non-intelligent transportation systems that depend on many processes and innovative techniques
- Intelligent transportation system are smart highways, that require the use of coordinated subsystems to determine capacity of lanes, traffic flow
- Non-intelligent transportation systems, such as walkways and bicycle paths, attract individuals and groups of people through innovative designs that capitalize on natural settings and provide convenience
- Too often little attention is paid to the environmental consequences or to the effects of rapid expansion that has accompanied transportation improvements
- Every day people must make decisions about transportation technology and transportation systems regarding social-cultural values, political, environmental, technical, economic and personal factors
- Transportation systems and technology have become more advanced, and humans have become more dependent upon transportation in their daily lives
- "ITS" stands for "Intelligent Transportation Systems," which are systems that utilize electronics, communications and information processing to improve the efficiency and safety of surface transportation