What kinds of engineers build bridges?

What do civil engineers do?

Civil engineering focuses on structures that serve the public such as transportation systems, water treatment, government buildings, public facilities such as airports and train stations, and other large-scale projects that benefit the public. A civil engineer must be able to design safe structures in various locations.

In terms of transportation, civil engineers build bridges, tunnels, freeway interchanges, and other structures that are designed to facilitate the smooth, even flow of traffic. Water treatment includes sewage plants, delivery systems for freshwater and dams, and other facilities that deal with both fresh- and wastewater. Government buildings can include courthouses and libraries, and a civil engineer might also work on a city power plant.

Some of the subspecialties in civil engineering are environmental engineering, coastal engineering, surveying, materials engineering, structural engineering, construction engineering, and water resource engineering.

What do structural engineers do?

Structural engineers are specialists in design, construction, repair, conversion, and conservation. They are concerned with all aspects of a structure and its stability and safety. Structural engineering is considered a subspecialty of civil engineering.

Structural engineers are a key part of the design and construction team, working alongside other engineering disciplines to create all kinds of structures, from houses, theaters, sports stadiums, and hospitals, to bridges, oil rigs, and space satellites. They also consider the aesthetics of the site and the community in which it will be built.

Every structure must be built with consideration of the conditions of the its location. Bridges in cold, snowy climates will need to be built with continuous snow and ice loads in mind. Bridges need to carry different kinds of loads, be it people, cars, or high-speed trains. It is a structural engineer's job to consider all the possible factors, such as dead load (the weight of the structure) and dynamic load (loads that can change or are applied with motion). The structures have to be stiff enough so they do not exceed the vibration limits for which they were designed.

Fatigue (the tendency of material to break under repeated stress) and torsion are also important factors to consider when deciding the materials best suited to a bridge design, taking into account the durability of the materials and possible causes of deterioration.

What do electrical engineers do?

An electrical engineer focuses on designing, maintaining, and improving products that are powered by or produce electricity.

Although the terms *electrical engineer* and *electronics engineer* are often used interchangeably, some distinctions can be made. Electrical engineers typically focus on products that supply, generate, or transmit electricity. Electronics engineers generally focus on products that use electricity as a power source. For example, an electronics engineer might design a car's computer system, and an electrical engineer would design the car's electrical system that supplies power to the computer system. Sometimes, however, both types of engineers are referred to as electrical engineers.

An electrical engineer will plan the circuitry and wiring of electronic components. Generally a prototype is built and extensive tests are conducted on it to make sure that it works as designed and that all of the components work well together. An electrical engineer might test existing products that have malfunctioned or broken to determine what went wrong and whether any design flaws can be corrected

The engineer often is responsible for overseeing the installation of the product to ensure that it is installed properly and safely. The electrical engineer will often create technical drawings, instructions, and specifications that can be followed to ensure that the product will be properly installed and correctly operated.

What do mechanical engineers do?

The work of mechanical engineers spans a number of different fields and disciplines, with a great deal of the emphasis on the creation, design, construction, and installation of mechanical devices (things with moving parts) that make modern life more comfortable, such as elevators, engines, and motors.

Product development is also an area that requires the talents of a good mechanical engineer. In some cases, this may be the refinement of an existing product, such as automobiles or household kitchen appliances. As part of this type of application, the mechanical engineer may seek to enhance current products so that a higher level of efficiency is achieved resulting in household products becoming more affordable, such as microwave ovens.

Mechanical engineers also develop products that create something new, such as new concepts for space exploration and communication. Some of the most important technological innovations of the last century are directly attributed to mechanical engineers, whose creativity and vision often helped to make the impossible become a reality within a short number of years.

What is materials engineering or materials science?

Materials engineers design, produce, and evaluate materials and their use. They bring valuable expertise in materials to just about every industry, often working closely with other engineers, to make a real difference in the world.

Materials engineering is all around us. From buildings to transportation to the electronic devices we use every day, the materials involved have been designed or chosen carefully for the task. Materials engineers understand the properties of matter (both natural and synthetic) and atomic structure.

The materials we use and how we make them can determine the function, feasibility, cost, environmental impact, and many other aspects of things we create.

Materials engineers are experts on materials—how they are made, how and why materials are useful, and how materials can be made better. Materials engineers are concerned with every stage of a material's life cycle, from mining to recycling. They design new materials, devise processes for making and disposing of materials, select the best material for a particular job, monitor its performance, and figure out why a material failed.

Materials engineers take science innovations and use them in real-world applications that exploit their desirable properties. Materials science is also involved in forensic engineering: airplane crashes and failure analysis of structures (bridges) and equipment.

What do design engineers do?

A design engineer is responsible for the whole project and directs the creation of the initial blueprints and schematics for various structures, systems, machines, or equipment. A design team includes draftsmen, civil or mechanical engineers, and possibly materials engineers and electrical engineers. Design engineers use advanced computer technology and applications, such as computer-aided design (CAD) software, to help them create and test virtual models. Depending on the type of structure or machine that is being built, an engineer may be asked to construct a physical model or prototype to test in realistic situations. Designers are employed in many different government organizations and industries, including research and development companies, construction firms, and product manufacturing plants.

Professional design engineers communicate with planning committees and other engineering specialists to coordinate design plans. A design engineer often begins the process by creating sketches by hand or using CAD programs. Computer software programs allow designers to draw detailed lines, form curves, and input measurements. Other programs can put designs through virtual simulations to test their integrity (or soundness in construction), efficiency, and effectiveness.

It is common for an experienced designer to take the lead on projects to create scale models or prototypes from plans or blueprints. With the help of engineering technicians and assistants, designers carefully follow plans and computer models to fabricate actual machinery, equipment, products, or models of buildings. Engineers put their models through physical tests to determine their practicality.

It is important for design engineers to thoroughly understand the machines or structures they draw. For example, a mechanical designer who works for a consumer electronics manufacturer may be asked to formulate schematics for a new television. In order to accurately organize and draw the internal parts, the designer must know what each piece does and how it fits into the system as a whole. The mechanical designer must also be familiar with the principles of electrical currents and how they are distributed through coils, wires, and transformers. By conceptualizing the finished product, the design engineer can create reliable plans.

Name: ____ Group: ___________

Date: __________________________

Building Big synopses

You will write a synopsis of three online activities.

Go to *pbs.org/buildingbig*.

Do the following activities and write a concise synopsis of each. **Provide lots of detail and use appropriate vocabulary from the glossary you have.**

It might make more sense if you do them in order.

⊗ **Bridge Basics**: Be sure to click on the links and take notes on the information provided about basic bridge types.

⊗ **Bridge Challenge**: Record**[OK?]** the statistics related to each location. Relate this to the work you have done on maps: What does the terrain at each location look like? How long is the span? Again, be sure to click on the links and provide lots of detail.

⊗ **Forces Lab**: Provide details about forces, loads, materials, and shapes.

Grammar and spelling count; write as you would for language arts.

Company name: ____

Members: ____

As part of your assessment you will need to write an article about your bridge. The article should include input from all company members.

Follow the rubric so you'll know what needs to be included. All members of the company will receive the same grade, so all members should read and contribute to the article.

	3	2	1	0
Bridge history	Reasons for building bridge, history, and location; specific explanations for choice; many details included	Reasons for building bridge and location; no history or explanations for choice; many details	Includes few details; no history about choice	No evidence
Location and profile	Area described with information about climate/weather and terrain; lots of detail provided; contour profile matches the description of the location	Area described with information about climate/weather; some detail provided; contour profile matches the description of the location	Some information provided about climate/weather; minimal description of surrounding area; contour profile partially matches location	No evidence
Design	Design clearly stated; reasons for design explained with reasons to justify choice; connected to location	Type of design clearly stated; some reasons for design choice; connected to location	Type of design stated; minimal reasons for choice	No evidence
Materials	Specific information about materials for bridge; details provided for structure and bridge deck; details such as concrete vs. asphalt	Specific info about materials for bridge; details provided for structure and bridge deck; some detail about materials supplied	Types of materials stated but little detail about choices; minimal detail about reasons for choices	No evidence
Engineers	Types of engineering needed clearly stated with lots of detail about what they do and their contributions to a bridge project	Types of engineering stated/some details about what they do and their contributions to the project	Types of engineering stated but minimal detail about what they do or their contributions to the project	No evidence
Load	Dead load, dynamic load, and bridge are explained; specific information about types of load on the bridge, e.g., cars, pedestrians, trucks	Dead load, dynamic load, and traffic are mentioned; no specific information about loads	Use is mentioned with minimal information about loads	No evidence
Forces	Forces are mentioned,	Tension and	Mention of tension or	No evidence

	e.g., tension, compression, torsion, shearing; detail provided	compression mentioned; no specific information about other forces; some detail provided	compression	

Steps to building a bridge

1. Using the topographic map, look at the terrain of the location and decide which type of bridge best suits the site. Refer to your bridge synopses and teammates to help determine the design.

2. You and the team decide which types of engineering you'll need to build your bridge. Remember that many duties of one type of engineer may overlap with duties of a different type of engineer. For example, structural engineers and design engineers must know many of the same things—materials, how to read blueprints, etc.

3. Draw a contour profile of the location.

4. Using scrap paper, collaborate and sketch out the design for the bridge.

Some things to think about:

- How long does it need to be?
- Will it be lighted?
- What kinds of loads will it carry?
- What types of materials do you need?
- What is the climate like?
- What will the bridge deck be made of?
- What will it cost?
- What kinds of supports or anchors are needed?

5. Assemble the materials and determine the sequence of building. Can another member of the company build some of the bridge while other parts are being worked on?

6. Keep track of expenses as you move through the process.

7. Once the framework of the bridge is complete, plan and pave the bridge deck.

8. Make sure the article is written and proofed using the rubric.

9. Get ready for the load test.

Resources

Bridges: Design and Function—http://store.discoveryeducation.com/product/show/49525

Building Big—*www.pbs.org/wgbh/buildingbig/bridge* (free access)

Crash of Flight 111—www.pbs.org/wgbh/nova/aircrash

Glossary of Engineering words—*www.pbs.org/wgbh/buildingbig/glossary_head.html* (free access)

David Macaulay: Building Big Bridges—www.shop pbs.org

MyTopo—*www.mytopo.com*

Pollard, J. 1999. *Building toothpick bridges (math projects: Grades 5–8*). Upper Saddle River, NJ: Dale Seymour Publications Secondary.

Understanding: Bridges—http://store.discoveryeducation.com/product/show/52144

USGS—*www.usgs.gov/pubprod* (free)

The Queen's lumber company

Land (foam board)	$500,000	
Lumber (toothpicks)	$125,000 per half box	
Cable (string)	$500 per cm	
Welding Material (glue)	$850 per day	
Building plans (2 sheets graph paper; wax paper)	$40,000	
Audit (I'll be checking your balance sheets)	$2000	
Engineers		
Design engineer	$450/hour	
Structural engineer	$400/hour	6 hours/day
Civil engineer	$450/hour	4 days/week
Mechanical engineer	$300/hour	
Materials engineer	$275/hour	
Extra checks (beginning checks are free)	$65 for six	
Consultation with the Queen (for any questions)	$50/minute	

Balance sheet

Date	Item	Cost per item	Total cost	Audit services	Beginning balance $1,500,000
				Balance	

Date	Item	Cost per item	Total cost	Balance audit services	Balance
				Total	