Engineering Disciplines

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Wednesday August 10th

- Writing – what would life be like without the battery?
- Engineering Careers
- In groups of two – Powerpoint Project
  - Graded based on handout
  - Will present to class
- Test on Friday on Careers in Engineering

Essential Questions

- What are the different engineering disciplines?
- What is the occupational outlook and expected salary of engineers?

Engineers are constantly evolving

- Some disciplines have become extinct because of society's changing needs
- As we progress through this new millennium it is inevitable that new engineering disciplines will develop and more will fall to the wayside

Acoustical Engineering

Plan, perfect, or improve the sound of an architectural space

- Deals with 2 basic properties of sound: reflection and absorption
- Investigate how different noises and background sounds affect productivity in a building
- Sets the mood of a structure's environment by deciding what it will sound like
- Work on an architectural space can range anywhere from examining the innumerable surfaces in a church to drawing CAD plans for a subwoofer enclosure
- HVAC or air conditioning systems are the hardest sounds to eliminate in large, high-productivity office spaces
- Acoustical engineers are in high demand, but there are very few of them

Automotive Engineering

Plan, coordinate, and implement the specifications for a new car, engineering every part

- Design and draw automotive parts
- Combine the automotive parts into components
- Integrate the components into the car's systems
- Make the mechanical aspects of the car fit into the aesthetic design
- Emissions laws, cost of materials and development, performance requirements, and consumer demands create challenges
- Requires a degree in engineering, interpersonal and communication skills, ability to multitask, technical knowledge, and design experience

Aerospace Engineering

Design, develop, test, and help manufacture aircraft, missiles, and spacecraft

- Develop new technologies for military and commercial use
- Can be divided into 2 fields:
  - Aeronautical engineering: works will aircrafts
  - Astronautical engineering: works with spacecrafts
- Can specialize in many fields, ranging from propulsion to thermodynamics
- Requires an engineering-related degree from a 2- or 4-year college, completion of a formal training program, and licensing or examination

Agricultural Engineering

Concerned with the production and processing of agricultural products, which are critical to our ability to feed the ever-expanding world population

- Can specialize in many fields:
  - Power machinery
  - Bioengineering
  - Soils and water
  - Electrical technologies
  - Food processing
- An example of an agricultural engineer's work is designing and implementing an irrigation system for crop production

Bioengineering

The application of engineering principles to biological systems

- Encompasses many fields of study, including chemistry, physics, technology, and medicine
- One of the newest and fastest growing disciplines
- Applies the fundamentals of engineering to meet the needs of the medical community
- Requires an undergraduate, and often graduate, degree in bioengineering
- Examples of their work:
  - Genetically modifying a plant or animal to produce a disease-resistant strain
  - Developing the chemical process necessary to make an artificial kidney function

Chemical Engineering

Take what chemists do in a laboratory, apply fundamental engineering, chemistry, and physics principles, and design and develop processes to produce products for use in our society

- Solve problems that involve the production and use of chemicals
- Focuses on chemistry and the chemical nature of products and processes, unlike other disciplines
- Design of large-scale chemical production facilities is the most common employment
- Must develop processes that minimize harmful waste since many chemicals and their byproducts are dangerous to people and the environment
- Requires a Bachelor's degree and strong math, science skills, and computer skills

Civil Engineering

Designing and supervising the construction of roads, buildings, airports, tunnels, bridges, and water and sewage systems

- Main objective: design systems that are functional, efficient, durable, and minimize harm on the environment
- Affected by population shifts, urban planning and renewal efforts, zoning laws, and building codes
- Structural engineers are the most common type of civil engineers. They are concerned with the integrity of the structure of buildings, highways, and bridges
- Other types of civil engineers are transportation engineers, surveyors, urban planning engineers, and construction engineers

Computer Engineering

Design and build computer-related hardware products for many applications, such as personal computers, cell phones, automobiles, and even washing machines

- Apply the theories of science and mathematics to design hardware, software, networks, computer chips, and processors
- Often work in teams
- One of the fastest growing disciplines
- Difference between computer science:
  - Computer scientists focus on software and its optimization
  - Computer engineers focus on computer hardware or the machine itself
- Security is becoming a huge concern of computer engineers

Construction Engineering

Concerned with the management and operation of construction projects

- Interested in improving construction methods and materials to make them safer, more reliable, cost effective, and environmentally friendly
- Incorporate technical, financial, and legal requirements into a plan to meet project deadlines
- Requires project management skills and knowledge of computer tools

Electrical Engineering

Responsible for the design, development, testing, and supervision of the manufacturing of electrical equipment, such as household appliances or guidance systems for satellites

- Work with all products and systems that use electricity
- Concerned with making their designs efficient, long lasting, cost-effective, and safe
- The most populated and traditional of the engineering disciplines
- Can be divided into 8 areas:
  - Computers
  - Circuits and solid waste devices
  - Instrumentation
  - Bioengineering
  - Communications
  - Control
  - Signal Processing
  - Power

Environmental Engineering

Apply engineering principles in order to improve and maintain the environment

- Uses science to make the world a safer place for humans and animals
- 3 components of environmental engineering:
  - Disposal – disposing industrial and residential waste
  - Remediation – cleaning a contaminated site
  - Prevention – reducing or eliminating the amount of waste from the manufacturing process
- Requires knowledge of engineering fundamentals and environmental laws and regulations

Fire Protection Engineering

Design fire sprinkler, alarm, and exit systems, as well as aid in the investigation of fires and explosions

- Analyze risk of major facilities and consult with architects on large projects
- Can work in private or public sector for consulting firms, petrochemical societies, federal agencies, insurance companies, and in health care industries

Food Process Engineering

Concerned with providing healthier products to consumers, who increasingly rely on food products

- Involved in the efficient and safe processing and delivery of food products
- Design processing, handling, and packaging equipment for the food industry
- Can work in food, chemical, and pharmaceutical industries

Genetic Engineering

Use science to research genes found in the cells of plants and animals to develop better products

- Demand is growing
- Surrounded by complicated political, economic, and moral conflicts
- Specializing in the study of a disease and its affects on humans is a common focus
- Must follow rigid safety measures and work with dangerous chemicals, electron microscopes, and gene guns to carry out research
- Can be divided into 4 categories: human, animal, plant, and microorganism

Geological Engineering

Use science to work with land and water

- Range of tasks vary due to the ever-growing and changing field
- Investigate sites of major land-related projects, such as bridges or tunnels
- Mitigate toxic waste and land contamination
- Use physics to predict the flow of water
- Build and maintain earth-related power sources, such as hydroelectric plants
- Requires a graduate degree

Industrial Engineering

Design, improve, and install integrated systems of people, materials, and energy

- Involves the integration of technology, mathematical models, and management practices
- Traditionally work on a factory floor, but skills can be applied to many other applications and industries
- Focus on 4 main areas:
  - Production is concerned with optimizing product production by reducing cost and production time, and increasing quality and reliability
  - Manufacturing addresses the concerns of each individual station in the production process and optimizes the actual material processing
  - The human factors area studies the interfaces between people, machines, and objects
  - Operations research involves mathematically modeling systems to identify ways to improve them

Manufacturing Engineering

Applies science and math to the design, development, and implementation of manufacturing systems (i.e. they produce goods)

- Often involves the supervision of skilled craftsmen
- Make decisions about technology, machinery, people, and money to produce high-quality goods at affordable prices
- Often work in teams to launch new products
- Partner with design engineers, marketing specialists, supply chain managers, human resources, and accountants
- Must know how to use resources, including machines, robots, people, computer-based tools, information networks, and money
- Work at the core of industrial companies and can therefore easily advance into management and executive positions

Marine and Ocean Engineering

Concerned with the exploration of oceans, the transportation of products over water, and the utilization of resources in the world's oceans, lakes, and seas

- Design and operate ships, boats, and submarines, especially their propulsion, navigation, and steering systems
- Design underwater pipelines, offshore drilling platforms, and offshore harbor facilities
- Study wave action and design ways to reduce erosion while protecting marine life
- Control and treat pollution in the ocean and find alternative sources of energy from the ocean

Materials Science Engineering

Develop new materials, improve traditional materials, and produce materials that are economical and reliable through synthesis and processing

- Concerned with 4 components of materials:
  - Structure – study the molecular bonding and chemical composition of materials
  - Properties – optimize the strength, crack growth rates, hardness, and durability of materials
  - Processes – different processes of creating materials give materials different properties, so materials engineers design processes that give each material its desired properties
  - Performance – ensure that a material meets its performance demands by designing test procedures that make sure these requirements are met
- Work with materials such as metals, ceramics, plastics, and composites

Mechanical Engineering

Design, produce, operate, and service machines and mechanical devices

- Second largest engineering discipline after electrical engineering
- Often involved in automating time-consuming or expensive procedures
- Composed of 2 main divisions:

  1) Design and controls is concerned with:
     - The strength of machine parts and the stress that each part will be subjected to
     - Developing tools that help the design engineer design a machine
     - Controlling machines through mechanical, hydraulic, and digital controls
     - Minimizing the unwanted noise of a machine

  2) Thermal science is concerned with:
     - The flow of fluids and energy between systems
     - Study and predict the temperature of machines parts, and design cooling devices for them
     - Heating, ventilating, and air conditioning of buildings
     - Performance and efficiency of large power generation plants, and developing alternative energy sources

Mineral and Mining Engineering

Maintain the flow of raw materials by discovering, extracting, and processing minerals for products

- Explore land, the ocean floor, the earth's core, and asteroids for ore and mineral deposits
- Design mining tunnels, open pit mines, and blasting techniques while keeping the environmental impact to a minimum
- Purify and separate minerals through chemical and mechanical processes
- Design safer equipment for the dangerous mining industry
- Use mining knowledge to create subways systems and railroad tunnels

Nuclear Engineering

Study nuclear energy, radiation, and their beneficial uses

- Work in nuclear plants to design and operate reactors
- Responsible for the production of nuclear fuel and safe disposal of radioactive waste
- Integrate nuclear power in the propulsion systems of ships, submarines, rockets, and satellites, which allows them to go years without refueling
- Find ways to use radiation to improve the medical and agricultural fields.
- Requires the ability to shift work to meet production schedules, identify hazards, and weigh risks and benefits constantly

Petroleum Engineering

Concerned with maintaining the safe flow of petroleum, exploring for crude oil deposits, removing and transporting oil, and refining oil

- Use satellite and geological information to locate gas and oil deposits
- Design and operate oil drilling equipment and facilities, both on land or on offshore platforms
- Extract oil safely and in a way that minimally harms the environment
- Design and operate the chemical process of refining petroleum into other products, like gasoline, motor oil, lubricants, and plastics

Robotics and Automated Systems Engineering

Concerned with programming robots and systems to perform tasks autonomously

- One of the newest and most exciting disciplines
- Design more efficient and skilled robots to assemble complex products and operate spacecrafts
- Requires competency in many programming languages and UNIX operating systems, as well as the ability to work in a team and communicate effectively
- Requires a Bachelor's degree in chemical engineering, computer science, or chemistry for entry-level jobs
- Requires a Master's or Doctorate degree to become a senior engineer or executive

Software Engineering

Responsible for the coding of computer software that results in a simple and friendly environment for computer users

- Can create programs for internal office use or coordinate technical systems and growth within a company
- One of the fastest growing professions in the United States
- Unlike many other engineers, software engineers work in a large office setting
- Requires a Bachelor's degree in a computer or technology related field, broad knowledge of computers and technology, and certification of fluency in certain programs

Structural Engineering

Create safer structures and fit more people and objects per square inch into these structures

- Analyze and design almost any structure imaginable, such as skyscrapers, bridges, tunnels, canals, and space platforms
- Determine:
  - The best structural system
  - The sizes of columns, beams, walls, staircases, and foundations
  - The type of reinforcement that each element requires
- Prepare detailed structural sketches in accordance with standard specifications
- Must design structures to withstand their own weight, plus natural forces such as gravity, wind, and earthquakes

Occupational Outlook

- Expected to grow as fast as the average for all occupations over the next decade (about 11%)
- Growth will vary by specialty
- Environmental and Civil engineers should experience the largest growth
- Technological advances will not to limit employment in engineering, like in other occupations, because engineers continue to develop new products and systems
- Offshoring of engineering work will slow domestic employment growth because foreign engineers are willing to work for lower salaries
- Engineers work on long-term research and development projects so they are less affected by economic slowdowns
- Engineers must continue their education throughout their careers since much of their value depends on their knowledge of the latest technology

Salary Information

Curriculum	Bachelor's	Master's	Ph.D.
Aerospace/aeronautical/astronautical	$53,408	$62,459	$73,814
Agricultural	49,764		
Architectural	48,664		
Bioengineering and biomedical	51,356	59,240	
Chemical	59,361	68,561	73,667
Civil	48,509	48,280	62,275
Computer	56,201	60,000	92,500
Electrical/electronics and communications	55,292	66,309	75,982
Environmental/environmental health	47,960		
Industrial/manufacturing	55,067	64,759	77,364
Materials	56,233		
Mechanical	54,128	62,798	72,763
Mining and mineral	54,381		
Nuclear	56,587	59,167	
Petroleum	60,718	57,000	

* Data comes from the Bureau of Labor Statistics' Occupational Outlook Handbook, 2008

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