Sloan Career Cornerstone Center

Mechanical Engineering Overview

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The Field

Mechanical engineering is one of the largest, broadest, and oldest engineering disciplines. Mechanical engineers use the principles of energy, materials, and mechanics to design and manufacture machines and devices of all types. They create the processes and systems that drive technology and industry.

The key characteristics of the profession are its breadth, flexibility, and individuality. The career paths of mechanical engineers are largely determined by individual choices, a decided advantage in a changing world.

Mechanics, energy and heat, mathematics, engineering sciences, design and manufacturing form the foundation of mechanical engineering. Mechanics includes fluids, ranging from still water to hypersonic gases flowing around a space vehicle; it involves the motion of anything from a particle to a machine or complex structure.

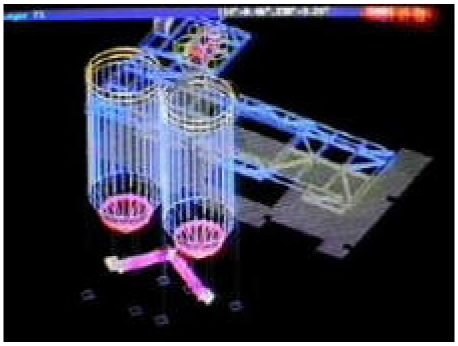
Mechanical engineers research, design, develop, manufacture, and test tools, engines, machines, and other mechanical devices. Mechanical engineering is one of the broadest engineering disciplines. Engineers in this discipline work on power-producing machines such as electric generators, internal combustion engines, and steam and gas turbines. They also work on power-using machines such as refrigeration and air-conditioning equipment, machine tools, material handling systems, elevators and escalators, industrial production equipment, and robots used in manufacturing. Mechanical engineers also design tools that other engineers need for their work. In addition, mechanical engineers work in manufacturing or agriculture production, maintenance, or technical sales; many become administrators or managers. Analysis, design, and synthesis are the key functions of mechanical engineers. The question is often how devices and processes actually work. The first step is to visualize what is happening and clearly state the problem. A mechanical engineer will then use computer-based modeling, simulation, and visualization techniques to test different solutions.

Design is one of the most satisfying jobs for a mechanical engineer. To design and build a new car, you must reckon with power, weight, size and shape, materials, reliability, and safety. "Synthesis" is when you pull all the factors together in a design that can be successfully manufactured. Design problems are challenging because most are open-ended, without a single or best answer. There is no best mousetrap -- just better ones.

The field is notable for emphasizing versatility. A mechanical engineering education is an excellent foundation for work in other fields. Some mechanical engineers work on medical problems, such as the mechanics of bones and joints, or the fluid dynamics of the circulatory system. Mechanical engineers deal with economic issues, from the cost of a single component, to the economic impact of a manufacturing plant. M.E.'s can be found in sales, engineering management, and corporate management. Versatility is a decided asset in a world that is undergoing constant economic, political, industrial, and social change. Mechanical engineers are educated and positioned, not only to adapt, but to define and direct change.

The diversity of the field of mechanical engineering is represented in the following areas of involvement.

Basic Engineering



Fundamentally, mechanical engineers are involved with the mechanics of motion and the transfer of energy from one form to another or one place to another. ME's design and build machines for industrial and consumer use -- virtually any machine you find, had a mechanical engineer involved with its development and production. They design heating, ventilation, and air conditioning systems to control the climate in homes, offices, and industrial plants, and develop refrigeration systems for the food industry. ME's also design heat exchangers, key components in high-tech mechanical and electronic computer equipment.

Applied Mechanics: Mechanics can be applied to almost anything -- metal bars, rocks, water, the human skeleton, or complex systems such as buildings, automobiles, and machines. The basic question is how things work and whether they work well. To find the answers, a mechanical engineer uses a knowledge of shock and vibration, dynamics and motion, fracture and failure in components, and the behavior of high-tech materials. New computer applications make it possible to model and visualize all of these processes.

Fluids Engineering: There's a mechanical process involved in anything that flows -- air, water, heat and cold, even the sand along our shores. Whatever the substance may be, M.E.'s know how to describe and control its movement. M.E.'s design fluid machines and systems -- pumps, turbines, compressors, valves, pipelines, biological devices, hydraulic systems, and the fluid systems in car engines. The fluids engineer can be found in industries ranging from aerospace to food, manufacturing, medicine, power, and transportation.

Heat Transfer: Heat is generated and moved by any use of energy, in everything from computers to automobiles and ventilating systems in buildings. This is an issue in all modern technology, given today's emphasis on conservation and wise use of resources. This field touches on combustion, power generation and transmission systems, process equipment, electronic devices, thermal controls in manufacturing, environmental controls, biotechnology, aerospace applications, transportation equipment, and even cryogenics (for those who like to freeze things).

Bioengineering: Mechanical engineering principles are used to design and perfect biomechanical devices or systems. Almost any part of the human organism can be described mechanically, whether it's a knee joint or the circulatory system. This field involves artificial organs, biomechanics, biomaterials, bio-instrumentation, biotransport processes, human factors, medical devices, biomedical modeling, and biological systems. Bioprocess Engineering focuses on the processes, systems, and equipment used in the biotechnology and pharmaceutical industries -- everything from cell cultures, to bioprocessing, to unit operations. M.E.'s in this field work closely with biologists, chemists, and chemical engineers.

Tribology: Tribology may not be a familiar term, but if you are designing an artificial hip socket, a laser printer, or a locomotive, you will have to think about friction, heat, wear, bearings, and lubrication. Otherwise your product probably won't run well or for very long. By reducing wear, the tribologist prevents the failure of everything from computer disk drives to the seals used in space vehicles.

Energy Conversion

We live in a world of dependent on the production and conversion of energy into useful forms. Mechanical engineers are involved in all aspects of the production and conversion of energy from one form to another. We design and operate fossil fuel, hydroelectric, conventional, nuclear and cogeneration power plants. We design and develop internal combustion engines for automobiles, trucks and marine use and also for electrical power generation.

Internal Combustion Engines: Mechanical engineers design and manufacture IC engines for mobile, marine, rail, and stationary applications. Engine design requires a broad knowledge base, including mechanics, electronics, materials, and thermal sciences. Problems must be solved in fuels and combustion, intake systems, ignition, instrumentation and controls, lubrication, materials, and maintenance.

Fuels & Combustion Technologies: Mechanical Engineers may specialize in the understanding of fuels and combustion systems in modern utility and industrial power plants or in internal combustion, gas turbine or other engines. These ME's work with combustion systems, fuel properties and characteristics, fuel processing and alternative fuels, and fuel handling transportation and storage.

Nuclear Engineering: M.E.'s in Nuclear Engineering use their knowledge of mechanics, heat, fluids, machinery and controls. They develop advanced reactors and components, heat exchangers, pressure vessels and piping, radwaste systems, and new fuel technologies.

Power Engineering: Power Engineering focuses on electricity, produced by steam and water-driven turbines. Power M.E.'s design and develop these systems, as well as industrial and marine power plants, combustion equipment, and the equipment that goes into power plants -- condensers, cooling towers, pumps, piping, heat exchangers, and the controls to make it all work.

Energy Resources

Mechanical engineers are experts on the conversion and use of existing energy sources and in developing the equipment needed to process and transport fuels. At the same time, mechanical engineers are active in finding and developing new forms of energy. In that effort, ME's deal with the production of energy from alternate sources, such as solar, geothermal, and wind.

Advanced Energy Systems: Most energy has come from the conversion of chemical or thermal energy into electrical and mechanical energy. M.E.'s are developing alternatives to thermal energy, power cycle devices, fuel cells, gas turbines, and innovative uses of coal, wind, and tidal flows.

Solar Engineering: M.E.'s in Solar Energy are finding new ways to produce mechanical and electrical power for heating, refrigeration, and water purification. They design devices and structures to collect solar energy, and they work with architects to design buildings that use solar energy for heating, cooling, and lighting.

Petroleum: Mechanical engineers play important roles in the petroleum industry, working in oil and gas drilling and production, offshore and arctic operations, hydrocarbon processing, synfuels and coal technology, materials, equipment design and manufacture, fuel transport, new fuel technologies, and pollution control.

Ocean, Offshore & Arctic Engineering: Much of our energy already comes from offshore sources. M.E.'s design and build ocean structures, systems, and equipment -- hyperbaric chambers, life support equipment, marine vehicles, submersibles and ROV's, propulsion systems, remote sensing systems, moorings and buoys, ship structures, and ocean mining equipment. Any given project may call for expertise in acoustics, construction and salvage technologies, corrosion, and high-tech materials. Offshore Mechanics differs from Ocean Engineering in that it focuses more on the science of mechanics. An M.E. specialist in this field deals with hydrodynamics, structural mechanics, computational methods, offshore materials science, materials fatigue and fracture, hydrodynamic forces and motion, fluid-solid-soil interactions, deepwater platforms, cable and pipeline dynamics, sensors and measurements, robots and remote control, and the mechanics of offshore drilling operations. The arctic engineer deals with a unique set of problems, such as ice mechanics, pipeline operations, and the behavior of materials in cold climates.

Environment & Transportation

Transportation is a large and growing field for mechanical engineers. Existing modes of air and surface transport require continuous improvement or replacement. ME's work at the cutting edge of these efforts. Wherever machines are made or used, you will find mechanical engineers. They are instrumental in the design, development and manufacturing of machines that transmit power. They are also critically involved with the environmental impact and fuel efficiency of the machines they develop and with any by-products of the fuels used to power those machines.

Aerospace & Automotive: They used to be called "flying machines." Very true. Aircraft are, in fact, flying "machines." One of the major activities of mechanical engineers is in the design, development and manufacture of things that move on land, sea, air and in space. M.E.'s design propulsion engines and structural component systems, crew and passenger accommodations and life support systems. M.E.'s also develop the equipment used to build automotive, aircraft, marine and space vehicles.

Environmental Engineering: Most environmental conditions involve a mechanical process -- the movement of heat, noise, or pollutants in air, soil, or water. M.E.'s deal with questions about environmental impact and recyclability in the design of products and systems. They use modeling techniques to understand air, ground, and water pollution and to develop effective controls. For example, M.E.'s analyzed and modeled the mechanical relationship between power plant emissions and acid rain in the northeastern states.

Noise Control & Acoustics: Sound is a mechanical phenomenon -- the movement of waves or vibrations through solids, liquids, or space. Acoustics is the art and science of producing, analyzing, and controlling sound. A mechanical engineering background can help to solve problems in noise control, flow-related noise and vibration, industrial acoustics, instrumentation, acoustical materials, and structures.

Rail Transportation: All aspects of mechanical engineering can be applied to the design, construction, operation, and maintenance of rail and mass-transit systems. Technologies developed in aerospace and energy conversion are being applied to a new generation of locomotives and cars for freight, passenger, and transit services.

Solid Waste Processing: Solid waste processing is a key aspect of environmental protection and energy conservation. M.E.'s are involved in the design and construction of solid waste processing facilities, and in work related to recycling, resource recovery, and the new technologies for waste-to-energy and biomass conversion.

Engineering & Technology Management

Working in project teams is a way of life for mechanical engineers. Deciding which projects to undertake and leading those projects to a successful conclusion is the job of experienced engineers who move into management. On the safety front, all projects involve safety issues. By its very nature mechanical engineering involves the harnessing and channeling of the forces of nature, forces which are often extremely powerful. Consider the contained "explosion" that inflates an automobile air bag or the mechanical forces involved in bringing an airplane load of people to a safe and comfortable landing, or the safety and reliability of an elevator, a power plant, or an incubator for pre-maturely born infants.

Management: Mechanical engineering careers often lead to project, division, or corporate management, on a domestic or international scale. M.E. managers deal with a variety of issues -- quality control, safety, teamwork and productivity, communications, finance, professional development and training, product and market analysis, sales and service, and computer systems.

Manufacturing

In contemporary manufacturing companies, mechanical engineers play a key role in the "realization" of products, working closely with other engineers and specialists in corporate management, finance, marketing, and packaging. ME's design products, select materials and processes, and convert them to finished products. They design and manufacture machine tools -- literally the machines that make machines and design entire manufacturing processes, aided by the latest technologies in automation and robotics. Finally, the finished products are transported in equipment designed by mechanical engineers. This is the largest area of employment for mechanical engineers, especially when the process and textile industries are included. A finished product requires the right materials, a viable plant and equipment, and a manufacturing system. This all comes within the purview of mechanical, manufacturing and industrial engineers.

Manufacturing Engineering: About half of all M.E.'s work in companies that manufacture "something," such as consumer goods, transportation, or industrial equipment. Another 16% work in the process industries, like petrochemical or pharmaceutical. The challenges are as diverse as the products -- from miniature devices used by surgeons, to disk drives, or massive pieces of industrial equipment. This work calls for a knowledge of materials, manufacturing processes, thermal processes, controls, electronics, and, as in all of engineering --- teamwork skills.

Materials Handling Engineering: Materials must be delivered at the right time, place, and in the right form -- a challenge with the costly, exotic, and sometimes hazardous materials used in some industries. Some M.E.'s specialized in materials transportation, handling equipment and procedures, hazard control technologies, and in the training of employees who will work with these materials.

Plant Engineering & Maintenance: Competitive industries must often update their plants, manufacturing equipment, and operating procedures. This must be done quickly and with the least possible disruption. M.E.'s in plant engineering focus on systems, equipment, processes, and facilities. They provide creative solutions that allow companies to meet their goals for quality, safety, and cost.

Process Industries: The M.E. ‘process engineer' changes materials from one form to another or gives them new properties. They can then be used in manufacturing components and finished products. The M.E. `process engineer' designs and builds the systems and machines that heat, cool, soften, harden, or liquefy substances -- anything from industrial fluids and gases, to metals, or even food products and pharmaceuticals.

Textile Engineering: Textile manufacturing is a global industry that depends on automated equipment to prepare and handle fibers, weave or knit fabrics, manufacture finished apparel, and handle finished products. Multinational textile industries turn to M.E.'s for expertise in plant design and construction, equipment installation, programming and control techniques, operations, and maintenance.

Materials & Structures

In order to arrive at the best design for a product, mechanical engineers use a wide variety of metal, plastic, ceramic materials. They also use composites made up of more than one type of material. Once designed, built and in service, elements like pipeline welds and sections, gears and other drive-train elements may need inspection for structural integrity or the effects of mechanical wear. Non-Destructive Evaluation, as its name implies, allows ME's to use X-ray, magnetic particle, ultrasound and other techniques to examine the internal condition of structural and machine parts, without causing them to fail or without removing them from service. This analysis is particularly important in assuring the reliability and safety of pressure vessels and piping systems.

Materials Engineering: Materials has grown into a distinct and important technology. Mechanical engineers focus on the behavior and selection of materials -- preferably before they become part of machines or complex structures. The Materials M.E. focuses on the properties of materials and their effect on design, fabrication, quality, and performance. M.E.'s find ways to give materials specific properties -- strength, ductility, and resistance to fracture, fatigue, and corrosion. The goal is to have materials that can be casted, forged, stamped, rolled, machined, or welded. Mechanical engineers are interested in many aspects of plant engineering, including the pressure vessels and piping that are an essential part of many industrial plants and processes.

Non-Destructive Evaluation: The manager of a large petrochemical plant needs to know whether a massive pressure vessel and two pumps are maintaining their structural integrity. There's a 50-50 chance that it won't be possible to reassemble the equipment once it's taken apart, and replacement will force a month-long shutdown. It's time to call in a mechanical engineer who specializes in Non-Destructive Evaluation -- materials testing, non-destructive testing, pressure vessel research, welding technologies, equipment design, and repair strategies.

Pressure Vessels & Piping: Many industries depend on pressure vessels and piping to perform critical functions. These vessels must be durable and safe when subjected to high-temperatures, pressure, corrosion, or undersea conditions. Mechanical engineers develop materials that will resist fatigue and fracture, plan the fabrication of equipment, perform inspections and tests, and design components using computer visualization and modeling techniques.

Systems & Design

Most mechanical engineers work in the design and control of mechanical, electromechanical and fluid power systems. As a mechanical engineer functioning as a design engineer it is likely that you would be involved with one or more technical specialties, for example: Robotic System Design; Computer Coordinated Mechanisms; Expert Systems in Design; Computer-Aided Engineering; Geometric Design; Design Optimization; Kinematics and Dynamics of Mechanisms; Cam Design/Gear Design; Power Transmission; or Design of Machine Elements. Design engineers take into account a truly wide number of factors in the course of their work, such as: product performance, cost, safety, manufacturability, serviceability, human factors, aesthetic appearance, durability, reliability, environmental impact and recycleability.

Dynamic Systems & Control: Where there is movement there must be control. A modern production line is a dynamic system, because its movement and speed can be controlled. M.E.'s create the software, hardware, and feedback devices that form control and robotic systems. This requires a knowledge of heat and mass transfer, fluid and solid mechanics, the plants or processes to be controlled, elements of electronics and computers. Controls are needed everywhere -- in aerospace and transportation, biomedical equipment, production machinery, energy and fluid power systems, expert systems, and environmental systems.

Fluid Power Systems & Technology: You have been asked to design a massive vehicle to transport rocket boosters around the Kennedy Space Center. A conventional transmission won't work because of the weight and sheer inertia that the vehicle must overcome. You need to apply a lot of power very gradually, so you employ a fluid power coupling. These technologies are used in automotive, aerospace, manufacturing, and power industries, in situations that call for a flexible and precise application of power in large amounts.

Design Engineering: M.E.'s design components, entire machines, complex structures, systems and processes. This work requires a knowledge of the basic sciences, engineering principles, materials, computer techniques, manufacturing methods, and even economics. New and challenging problems come along with regularity. If you are working for an aircraft company, today's problem may be vibration in an engine; tomorrow it may be wind noise, stress on the landing gear, or a need to increase lift at low speeds.

Computers in Engineering: Mechanical engineers have developed a wealth of computer applications software, based on their knowledge of mechanics, fluids, heat, kinetics, and manufacturing. Some of the interests in this area include computer-aided design and simulation; computer-aided manufacturing; finite element analysis; visualization techniques; robots and controls; computer vision and pattern recognition; systems (hardware, software, and networks); and management information systems.

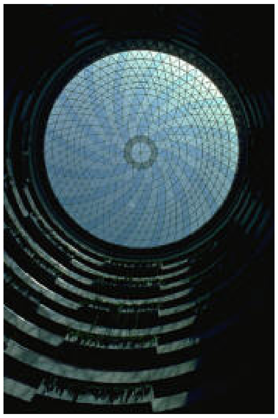
M.E.'s in the Electrical & Computer Industries: There are mechanical components in electrical, electronic, and computer equipment, all of which is manufactured through automated and mechanical processes, all components must fit precisely, and unwanted heat must be transferred elsewhere. All of these activities are in the domain of mechanical engineering. The PC is very largely a mechanical device. Consider disk drives, circuit boards, keyboards, the chasis structure, and, of course, the mouse!

Electrical & Electronic Packaging: A large number of mechanical engineers work for the manufacturers of electrical, electronic, and computer equipment. The major focus for M.E.'s in this area is the physical design and manufacture of these products in such a way that unwanted heat is removed and desired heat is retained where and to the degree it is needed.

Information Storage & Processing Systems: Quite a few mechanical engineers work for companies that manufacture computer peripherals. Any storage device on your computer -- the CD, DVD, diskette, or hard drives -- has electrical, electronic, and mechanical components. M.E.'s help to design and manufacture these precision devices. Their interests touch on hard disk technologies, data storage and equipment, wear and lubrication in data storage devices, micro-sensors, and controls.

Microelectromechanical Systems: Micro-electromechanical systems (MEMS) combines computers with tiny mechanical devices such as sensors, valves, gears, and actuators embedded in semiconductor chips. A MEMS device contains micro-circuitry on a silicon chip into which a mechanical device such as a mirror or a sensor has been constructed. Among the presently available uses of MEMS or those under study are: 1) Sensors built into the fabric of an airplane wing so that it can sense and react to air flow by changing the wing surface resistance; effectively creating a myriad of tiny wing flaps, 2) Sensor-driven heating and cooling systems that dramatically improve energy savings, and 3) Building supports with imbedded sensors that can alter the flexibility properties of a material based on atmospheric stress sensing.

Preparation



If you are curious about how things work or how things are made; marvel at seeing ideas transformed into physical reality, find yourself stimulated by the process of trying to improve the way something works; have enjoyed being a part of a team that work together to accomplish something; or if you are stimulated by your math, science and technology studies, even though, and perhaps because, they can be challenging -- you have already started down the road toward becoming a mechanical engineer.

Some people choose mechanical engineering because they see it as the best way to put to use their interests in math, physics, and technology.

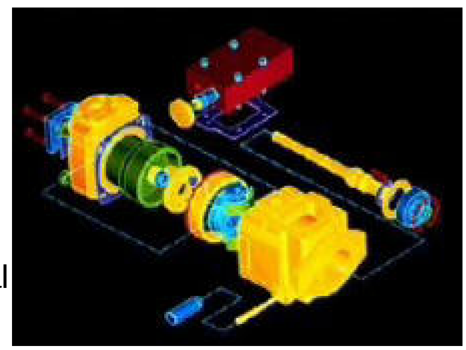
For many, however, it all begins with a fascination for things that move -- cars, trains, planes, spacecraft, amusement park rides. And for others, family or friends in the mechanical engineering profession provide the initial encouragement. Virtually anything that can be imagined, designed, and built has a mechanical engineering aspect to it.

A bachelor's degree in engineering is required for almost all entry-level engineering jobs. College graduates with a degree in a physical science or mathematics occasionally may qualify for some engineering jobs, especially in specialties in high demand.

Studying M.E.

Mechanical Engineering programs provide more than technical training: they teach the more sophisticated skills of analysis and problem-solving that apply to most any type of engineering, manufacturing, business ventures, management, or even legal practice. They teach you how to learn, thought processes and approaches that will serve you throughout your life and career. From the very beginning, but especially in your third and fourth years, you will be involved in projects that will give you experience in the thinking and problem-solving processes that are the essence of what it means to be an engineer.

Maximize the Experience



Work experience is one of the best ways to enhance your education and employment prospects, perhaps through a co-op program, internship, or summer job. Many co-op students and interns are hired after graduation by the same employers, and best of all, they start with a clearer sense of their interests, capabilities, and career paths to follow within a company or industry. Employers prefer people whose practical and teamwork experiences make them "ready to produce."

Apart from work experience, students should consider an elective course in public speaking, or get into student organizations such as an ASME Student Section on campus, where they can practice their presentation and "people" skills. Engineers are expected to present ideas and plans to other engineers, management, bankers, production personnel, and customers. Even great ideas are worthless if they cannot be communicated.

▶ Accredited Programs

Those interested in a career in mechanical engineering should consider reviewing engineering programs that are accredited by ABET, Inc. ABET accreditation is based on an evaluation of an engineering program's student achievement, program improvement, faculty, curricular content, facilities, and institutional commitment. The following is a current list of all universities offering accredited degree programs in mechanical engineering.

- **The University of Akron**
- **Alabama A&M University**
- **University of Alabama at Birmingham**
- **The University of Alabama in Huntsville**
- **The University of Alabama**
- **University of Alaska Fairbanks**
- **Alfred University**
- **Arizona State University**
- **Naval Postgraduate School**
- **University of Nebraska-Lincoln**
- **University of Nevada-Las Vegas**
- **University of Nevada-Reno**
- **University of New Hampshire**
- **University of New Haven**
- **New Jersey Institute of Technology**
- **College of New Jersey**

- University of Arizona
- Arkansas Tech University
- University of Arkansas
- Auburn University
- Baker College
- Baylor University
- Boise State University
- Boston University
- Bradley University
- Brigham Young University
- Brigham Young University - Idaho
- Brown University
- Bucknell University
- California Institute of Technology
- California Maritime Academy
- California Polytechnic State University, San Luis Obispo
- California State Polytechnic University, Pomona
- California State University, Chico
- California State University, Fresno
- California State University, Fullerton
- California State University, Long Beach
- California State University, Los Angeles
- California State University, Northridge
- California State University, Sacramento
- University of California, Berkeley
- University of California, Davis
- University of California, Irvine
- University of California, Los Angeles
- University of California, Riverside
- University of California, San Diego
- University of California, Santa Barbara
- Carnegie Mellon University
- Case Western Reserve University
- The Catholic University of America
- Cedarville University
- University of Central Florida
- Christian Brothers University
- University of Cincinnati
- Clarkson University
- Clemson University
- Cleveland State University
- University of Colorado at Boulder
- University of Colorado at Colorado Springs
- University of Colorado at Denver and Health Sciences Center
- Colorado State University
- Columbia University
- University of Connecticut
- The Cooper Union
- Cornell University
- University of Dayton
- University of Delaware
- University of Denver
- University of Detroit Mercy
- University of the District of Columbia-Van
- New Mexico Institute of Mining and Technology
- New Mexico State University
- University of New Mexico
- University of New Orleans
- State University of New York at Binghamton
- State University of New York at Buffalo
- New York Institute of Technology
- City University of New York, City College
- North Carolina Agricultural and Technical State University
- University of North Carolina at Charlotte
- North Carolina State University at Raleigh
- North Dakota State University
- University of North Dakota
- University of North Florida
- Northeastern University
- Northern Arizona University
- Northern Illinois University
- Northwestern University
- Norwich University
- University of Notre Dame
- Oakland University
- Ohio Northern University
- The Ohio State University
- Ohio University
- Oklahoma Christian University
- Oklahoma State University
- The University of Oklahoma
- Old Dominion University
- Franklin W. Olin College of Engineering
- Oregon State University
- University of the Pacific
- Pennsylvania State University
- Pennsylvania State University, Behrend College
- University of Pennsylvania
- University of Pittsburgh
- Polytechnic University
- Polytechnic University of Puerto Rico
- Portland State University
- University of Portland
- Prairie View A & M University
- Princeton University
- University of Puerto Rico, Mayaguez Campus
- Purdue University at West Lafayette
- Purdue University Calumet
- Rensselaer Polytechnic Institute
- University of Rhode Island
- Rice University
- Rochester Institute of Technology
- University of Rochester
- Rose-Hulman Institute of Technology
- Rowan University
- Rutgers, The State University of New Jersey
- Saginaw Valley State University
- Saint Louis University
- Saint Martin's University

Ness Campus

- Drexel University
- Duke University
- University of Evansville
- Fairfield University-School of Engineering
- Florida A & M University/Florida State University (FAMU-FSU)
- Florida Atlantic University
- Florida Institute of Technology
- Florida International University (University Park)
- University of Florida
- Gannon University
- The George Washington University
- Georgia Institute of Technology
- Gonzaga University
- Grand Valley State University
- Grove City College
- University of Hartford
- University of Hawaii at Manoa
- Henry Cogswell College
- Hofstra University
- University of Houston
- Howard University
- Idaho State University
- University of Idaho
- University of Illinois at Chicago
- University of Illinois at Urbana-Champaign
- Illinois Institute of Technology
- Indiana Institute of Technology
- Indiana University-Purdue University Fort Wayne
- Indiana University-Purdue University Indianapolis
- Iowa State University
- University of Iowa
- The Johns Hopkins University
- Kansas State University
- The University of Kansas
- University of Kentucky (Extended Campus-Paducah)
- University of Kentucky
- Kettering University
- Lafayette College
- Lake Superior State University
- Lamar University
- Lawrence Technological University
- Lehigh University
- University of Louisiana at Lafayette
- Louisiana State University and A&M College
- Louisiana Tech University
- University of Louisville
- Loyola Marymount University
- University of Maine
- Manhattan College
- Marquette University
- San Diego State University
- San Francisco State University
- San Jose State University
- Santa Clara University
- Seattle University
- University of South Alabama
- University of South Carolina
- South Dakota School of Mines and Technology
- South Dakota State University
- University of South Florida
- University of Southern California
- Southern Illinois University at Carbondale
- Southern Illinois University-Edwardsville
- Southern Methodist University
- Southern University and Agricultural & Mechanical College
- St. Cloud State University
- University of St. Thomas
- Stanford University
- Stevens Institute of Technology
- Stony Brook University
- Syracuse University
- Temple University
- University of Tennessee at Chattanooga
- University of Tennessee at Knoxville
- Tennessee State University
- Tennessee Technological University
- Texas A & M University
- Texas A & M University - Kingsville
- University of Texas at Arlington
- University of Texas at Austin
- University of Texas at El Paso
- The University of Texas at San Antonio
- University of Texas at Tyler
- Texas Tech University
- The University of Texas-Pan American
- The University of Toledo
- Tri-State University
- Tufts University
- Tulane University
- The University of Tulsa
- Turabo University
- Tuskegee University
- Union College
- United States Air Force Academy
- United States Coast Guard Academy
- United States Military Academy
- United States Naval Academy
- Utah State University
- University of Utah
- Valparaiso University
- Vanderbilt University
- University of Vermont
- Villanova University
- Virginia Commonwealth University
- Virginia Military Institute

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Day in the Life

There is no typical day for most M.E.'s. Engineering projects are multi-disciplinary organizational efforts often involving scores of people inside and outside the company. Project life cycles call for different skills and people at different times. The issues and challenges start-off numerous and evolve throughout the project. It is difficult to characterize a typical day under these circumstances. Laced within and among other activities is a great deal of communication --- on the phone, via e-mail, in meetings, in memos and reports. No engineer works alone. Engineering is a team sport.

Some projects will turn over in a week, some in three months or a year, and projects may run concurrently. Workload can change as a project advances or encounters obstacles. Diversity and challenge are among the things that mechanical engineers like about their work.

First Job & Beyond

What are you likely to be doing? In their first job, about half of today's mechanical engineers have a primary focus on some form of design engineering and three-quarters do some work in this area. Product, Systems, and Plant Equipment Design are forms of design engineering. This can be a broadening experience, for engineering designers often work in teams consisting of engineers of different disciplines who work in design, production, testing, sales and service, people with finance, legal and marketing backgrounds and project and corporate management. The solution to a problem may require learning new things in other fields, which can help to develop career options that may not be apparent when you are just starting out. Some M.E.'s are surprised by the responsibilities that go with their first job. No one expects you to know everything on Day One, but you will be expected to learn by doing the job, improving and growing as you move forward. You won't be doing this alone, for much of your work will involve interaction with managers and members of your project team.

No Cookbook Solutions

Your courses and projects in mechanical engineering will introduce you to the ways of engineering, but then experience intervenes. Out in the real world you will find that it's not just a matter of applying a formula or theory. Most problems simply don't have a "cookbook" solution, so you have to draw upon all of your education and experience, and you will routinely have to learn new things to solve a problem. This will be a challenge, but also is a great source of satisfaction as you move forward.

Satisfactions

Mechanical engineers enjoy making a contribution to improving the quality of life. Whether it's improving the performance and safety of an automobile, or the latest in medical diagnostic equipment or gas turbine engines, M.E.'s enjoy being part of the solution of an important problem. Finding satisfaction in overcoming obstacles, whether they are technical, financial, legal, or managerial is central to the engineering psyche. Many find satisfaction in the variety of jobs that they do, the opportunities for travel and meeting people, the completion of projects, and the knowledge that they've done something that not everyone can do. For some it's simply the satisfaction of seeing their designs in production, used, and enjoyed by people.

Challenges

Mechanical engineers thrive on solving complex problems. These are not purely technical problems -- M.E.'s deal with management requirements, unique customer needs, budgetary and legal constraints, environmental and social issues, as well as changes in technology. It is the M.E.'s training in mathematics, the sciences, engineering fundamentals, and computer applications that provides the ability to anticipate and respond to change. For the working engineer, the key is staying abreast of emerging technologies. That's where ASME's lifelong learning programs can provide the tools that you need, when you need them.

Engineering Means Business

Mechanical engineering and business are closely intertwined. ME's develop products and services to meet the customer needs and cost objectives identified by corporate management. ME's advise financial and marketing managers on the feasibility of new initiatives, and when all systems are "go," they design and build the production facilities. More important, but less obvious, are the thousands of Engineering Service companies, many of which are large businesses. Business and management occupations are major career options for mechanical engineers.

Global Engineering

In a global economy many employers compete for business overseas, have multinational operations, and work through overseas partners. Product realization is often an international team effort, in which a manufacturing company might design a product in the U.S., modify it for assembly in Europe, use overseas contractors and suppliers, or set up and run a plant in Germany. Even if you do not work overseas, it's entirely possible that you will someday be dealing with international clients. Language skills could become an item on your list of "lifelong learning" objectives. A number of U.S. engineering schools participate in exchange programs with universities in the Americas, Europe, Asia, Africa and beyond. Students who participate in these programs find that language skills and international experiences distinguish them from other engineering graduates and job candidates. Later on, engineers with this background have a wider choice of assignments.

Communication and Teamwork

One image of mechanical engineers is that they spend most of their time doing engineering analysis. Not true. When you talk to a group of working M.E.'s, they speak of their roles as planners, decision-makers, and managers who need communication and "people" skills as much as technical knowledge or hands-on skills. One of the most important things to seek during your undergraduate years is experience in teamwork. The graduates who are in greatest demand are those who have teamwork experience, acquired through laboratory work, team projects, extracurricular activities, and jobs -- co-op, part-time, or summer.

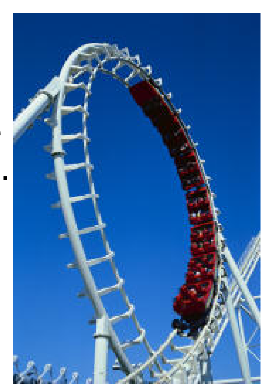
Diversity

Engineering continues to diversify in terms of the gender, ethnicity, and national origins of students and graduates entering the engineering workforce. Mechanical Engineering offers excellent opportunities for women and minority students who want 21st century careers that are challenging, progressive, flexible, and well-paying. A study by the Society of Women Engineers (SWE) found that although women were awarded slightly over 16% of all engineering degrees, a greater proportion of women choose to earn graduate degrees. Women were also somewhat more likely to be working for large or very large companies. Various organizations specifically serve women and minority engineering students through programs for high school students as well as working professionals. Just as students "network" through ASME and its student sections, additional important contacts with fellow students and working engineers can be made through these organizations. Several of the major organizations are listed in the Data File.

Professionalism

Ethics and Professional Responsibility: Ethics are standards or rules that govern your behavior in a given situation. That doesn't mean that the rules can change with each situation -- they should stay the same. One indication of a true profession is the existence of a code of ethics and a clear sense of professional responsibility. For an engineer, an ethical "situation" could be when you have to choose between doing what is best for the customer or the public, or doing whatever is best for you -- they may not be the same. It could be a situation where you have used someone else's ideas -- have you given them credit or compensation? Or it could be a question of being qualified to do a certain kind of work. Situations often come up in the design, development, and manufacture of products. This is why questions of ethics, safety & health, and reliability are built into the design projects you will do as a mechanical engineering student.

Earnings



Earnings for engineers vary significantly by specialty, industry, and education. Even so, as a group, engineers earn some of the highest average starting salaries among those holding bachelor's degrees. According the U.S. Department of Labor, Bureau of Labor Statistics, the median income for mechanical engineers is $69,850.

According to a 2007 salary survey by the National Association of Colleges and Employers, mechanical engineering graduates saw one of the higher-end increases of the engineering disciplines. Their average salary offer rose

5.7 percent to $54,695, pushed along by a good number of offers from aerospace manufacturers who extended an average offer of $56,382 to mechanical engineering grads. In addition, an ASME Career Path Survey indicates that:

- Experience counts: Without adjusting for inflation, mechanical engineers with 10 years of experience reported a 106% salary gain, while those with 15 years of experience reported a 249% difference between their starting and current salary.
- Education counts: In the early years of your career, a Master's degree is a decided plus factor in competing for many of the more desirable positions.
- Money is a very important factor in career planning, but it is by no means the only important factor.
- The choice of a career track counts: In larger companies, there are salary differences between the management and technical tracks. In a large company, your job may revolve around a fairly specific role, while smaller companies may offer faster growth in terms of responsibilities, the breadth of experience, and salary. When comparing job offers from large and small companies, salary isn't everything. Think about growth potential, support for your continuing education, technical resources, and always consider the stability of the hiring division or company -- and don't forget to factor in the cost of living in the local area.
- In the long run, many engineers plan their career around the type of work that they find most satisfying. Money doesn't seem to compensate enough if you find that you're going everyday to a job you don't like that's not taking you where you want to go.

Employment

According to the U.S. Bureau of Labor Statistics, mechanical engineers hold about 227,000 jobs. This represents 15.1% of the 1.5 million jobs held by engineers in the U.S. Mechanical engineers are capable of working in a wide variety of industry sectors, and new technologies will create industries that don't exist today. Your opportunities are determined by education, your interests and attitudes, and the contacts that you make. According to an ASME Career Path Survey, about half of mechanical engineers were employed in the original equipment industries. The next largest industry sector was non-manufacturing employers, followed by process industries.

Evaluating Employers

Remember that there are two parties in an employment relationship. When preparing for any job search, write down what you expect from an employer and a job. This may not be easy the first time, when you can't fall back on experience. Setting money aside for a moment, here are five questions that working engineers see as important:

- Can I expect a variety of assignments, and will those assignments provide `hands-on' experience in interesting, worthwhile areas? Will these projects prepare me for bigger and better things?
- How much actual responsibility will I have for the projects assigned to me? What kind of team will I be assigned to, and what will be my role?
- Will I get a chance to broaden my experience by working in different areas of the company? Does the company have rotational assignments?
- Were the people who I met during my interview energetic and enthusiastic about their jobs? Was there anything about employee morale that didn't seem positive?
- Is there support for continuing education, through in-house training, graduate studies, or other professional education programs?

Job Search

About 60% of mechanical engineering graduates say that they find jobs through their campus placement office, while some conduct their own job search, particularly where specialized interests are involved. You may be interested in a company that doesn't do much campus recruiting, and some companies have simply cut back on campus interviews -- you have to reach out to them. Contacts can be very important in finding opportunities and getting interviews, so try to build contacts through faculty, co-op jobs and internships, alumni, and professional association student groups. A job search is like marketing a new product, where you first determine who your customers (potential employers) are and what they need. You may have to shape the product (you) to meet customer requirements. Finally, you devise a marketing message and focus on the most appropriate customers, or in this case, employers. Think of the things that most interest you, target companies that do those things, be persistent, and follow through on leads. Presenting yourself effectively is a big part of getting hired. Try to anticipate what the employer's needs are, and what information you should provide to address those needs.

The following is a partial list of employers of mechanical engineers:

- 3M Company
- Adobe Systems, Inc.
- Advanced Micro Devices.
- Alcan Aluminum
- ALCOA
- Allegheny Ludlum Corp.
- Alliant Techsystems
- Amoco
- Applied Materials
- Argonne National Laboratory
- Babcock & Wilcox
- BASF Corporation
- Bayer Corp.
- Bechtel
- BF Goodrich
- Black & Decker
- Boeing Company
- Chrysler Corporation
- Cincinnati Milacron, Inc.
- Conoco
- Corning Incorporated
- Deere & Company, Inc.
- Dow Chemical
- Duracell
- Eastman Chemical Co.
- Eastman Kodak
- Eaton Corp
- EI DuPont
- Exxon Chemical Company
- FMC Corporation
- Ford Motor Company
- General Electric
- General Motors
- Georgia Pacific
- Hewlett Packard
- IBM
- Ingersoll-Rand
- Intel Corporation
- International Paper
- ITT
- Johnson Controls, Inc.
- Los Alamos National Lab
- LTV Steel
- Lucent Technologies
- Michelin
- Microsoft Corporation
- Mobil Corporation
- Motorola
- Nissan Motor Corporation USA
- PPG Industries
- Procter & Gamble
- Sun Microsystems
- Sundstrand Aerospace
- Texas Instruments, Inc.
- Timken Co.
- United Technologies
- W.L. Gore
- Westinghouse
- Wheeling-Pittsburgh Steel
- Xerox

Development

A successful mechanical engineering career is the result of a building process that starts during the undergraduate years, if not earlier. Once on the job, the process continues through networking, on-the-job training, graduate studies, and continuing professional education.

Practicing engineers tell us two things: First, today's engineer is expected to be more self-reliant and more self-managed in planning and doing work. Second, and more important, employers will not plan your career -- nor do you want that to happen. Once you find a company and job that you like, you still need a strategy for moving ahead. Your career building efforts will be more successful if you understand how your aptitudes mesh with your surroundings. Are you doing the work you are best suited for, or are you headed that way -- if not, what additional experience and training do you need to secure the right job?

You are in charge of managing your career, before and after your first promotion.

▶ Managing Your Career

From Day One, evaluate your options within the company, looking for interesting work and good career-building assignments. Find out where that work is located, and what you must do to position yourself for opportunities. You must take steps to manage your own career. Be constantly on the lookout for more experienced advisors and mentors. Tactfully make management aware of your capabilities and interests and illustrate how you think you can benefit the company in a new assignment. This must be done as a result of a serious examination of yourself and the needs of the company -- in that order -- and by keeping your eye on the big picture of where the company is headed.

What if your current employer cannot move you into more desirable work? Well-planned and timely job changes are part of the mechanical engineers' career strategy for broadening one's experience and advancing in position, responsibility, and salary. Most mechanical engineers gain an understanding of their field and true interests in their very early career experiences. There is a dramatic increase in job changes in years 3 to 5, with related salary gains.

▶ How Long Do Mechanical Engineers Stay in Their First Job?

About 43% of the mechanical engineers surveyed were continuing to work for their original employer five years after graduation. Another 25% were with their second employer. We were not able to tell how many, if any, of the changes of employer were due to company mergers or sales.

Lifelong Learning

As a mechanical engineer, you will shape future technology by using the latest developments in current technology. You will be employing technologies and ideas used elsewhere as solutions in your own projects. You will find yourself being challenged to keep abreast of changes in engineering and technology.

The fundamentals will always be with you, but technological information and resources change continuously. Once you enter the engineering profession, new, self-directed learning becomes a daily objective. You must look for learning opportunities on the job through company resources, advisors and mentors and company training programs. You will also need to look outside the company to resources provided by suppliers to your company, technical societies, professional development programs, publications and products and to graduate studies to meet your learning needs.

Continuously take stock of your learning needs as your career progresses. Ask yourself "what must I know to do my job today, what will I need to learn to the reach that level, how much can I learn on the job, and where can I find the rest?"

Graduate Studies

Graduate studies can be an important part of an engineer's career building plan. In the early stages of your career, a Master's degree can make you more competitive for key positions and better salaries. When evaluating job offers, find out about employer support for graduate course work and proximity to graduate schools. Within the first year or two on the job, step back and assess your interests and what type of graduate studies could help you to move to the next level or into specific jobs.

If you are still in school, seek the advice of professors concerning opportunities at the graduate level and programs that mesh with your interests and capabilities. Remember that faculty recommendations can be a deciding factor in gaining admission to the right graduate program. Get acquainted with the research and teaching assistants in your department, for they can direct you to research jobs that provide the hands-on experience that graduate schools and employers like to see. And if you decide to work for a few years, keep in touch with your advisors.

P.E. License

There's a difference between current job requirements and mid- to long-range career requirements. Taking the longer view, you should be aware of licensing as a Professional Engineer (P.E.). The P.E. license won't be needed for your first job (you need engineering experience before you can sit for the P.E. exam), and it may not be an issue in every engineering occupation. But a few years down the line your employer may land a contract that requires P.E.'s in key positions, or you may need a P.E. credential to work for a government agency. You may need professional recognition in another country where you have been asked to lead a project. Look at the number of Engineering

Service firms in the Employer Data Base -- in a few years you might be applying for a consulting position in one of those firms, or starting your own consulting business. In either case, the P.E. could be a job requirement. Before you can take the P.E. Exam, you will need to take the FE (Fundamentals of Engineering) Exam. Many students take this exam while in their senior year. Employers often support efforts toward the P.E. You will need four years of supervised professional experience to qualify for the P.E. exam. The licensure procedures vary somewhat from state to state.

▶ Adaptability

Adaptability is an important attribute for a mechanical engineer. A mechanical engineering education will provide the essentials - subject knowledge, problem-solving skills, and a capability for future learning. When you first start out, it's important to be curious and open-minded about new learning experiences, and to network within the profession and in your industry. It's up to you to keep current so that you have the knowledge base needed to take advantage of changes in technology and the marketplace. Adaptability is a function of time, knowledge, and contacts. Flexibility is important too -- engineers often have concurrent projects, each calling for different types of knowledge, hands-on skills, and teamwork.

▶ In Case of Adversity

School projects are often based on a given set of assumptions, specifications, and defined variables. Career planning starts out the same way, but life seldom runs along a predictable path. In reality, change actually becomes a constant, coming from many directions- customers, economic and monetary policy, global markets and overseas competition, company priorities, and required job skills. All can affect what your job consists of, and where, when, and for how long you do that job.

Working mechanical engineers stress the importance of a positive, flexible, forward-looking attitude, of being prepared for the next job, whatever and wherever that may be. They speak of how networking and professional contacts have enabled them to turn downsizing, layoffs, and gaps between projects into positive job changes. As difficult as these potential occurrences might seem, they are also significant opportunities to redirect and energize one's career.

▶ Networking

Being active in a professional society is a key part of networking. Skill in networking is an important attribute, a basic skill of the successful engineer, a skill that you should begin to develop during your undergraduate years. Networking can help you to land your first job and it becomes more important in every subsequent career move. Start today: make a list of the people who can help you advance your career. They can be faculty, students, members of student organizations, and working engineers. Over time, build your own network for the exchange of information, advice, and job leads.

▶ Multiple Tracks

Mechanical Engineers have an abundance of riches when it comes to choosing a career path. The field can take you nearly anywhere you want to go.

▶ Technical or Management

In many industries, mechanical engineers are presented with a choice between a management "track" to project and potentially division or corporate management; or a technical "track" to increasing sophisticated technical roles and expertise. As valuable as these programs can be, in engineering practice the engineer in management still has to understand technology, and the technically focused engineer may well have management functions. It's important to determine whether a prospective employer has personnel development structures of this type, when and how decisions are made, and whether you will have opportunities for experience in the different tracks. Some companies offer rotational assignments to help young engineers find the area best suited to them.

▶ Beyond M.E.

A mechanical engineer has career options that extend to other fields. A mechanical engineering education develops critical thinking, organizational and problem solving abilities that translate well to fields as diverse as business and management, law, information technologies, and medicine. The combination of an engineering education with one's personal interests and talents can result in almost any career path. This does not mean that if you want to be a concert violinist, you should study engineering first, but mechanical engineering is replete with people who have used their education as a springboard to other disciplines and career paths. Training prepares you handle what is happening now; education prepares you to determine your future.

Career Path Forecast

According to the U.S. Department of Labor, Bureau of Labor Statistics, mechanical engineers are projected to have 4 percent employment growth over the projections decade of 2006-2016, slower than the average for all occupations.

This is because total employment in manufacturing industries -- in which employment of mechanical engineers is concentrated -- is expected to decline. Some new job opportunities will be created due to emerging technologies in biotechnology, materials science, and nanotechnology.

Additional opportunities outside of mechanical engineering will exist because the skills acquired through earning a degree in mechanical engineering often can be applied in other engineering specialties.

Professional Organizations

Professional organizations and associations provide a wide range of resources for planning and navigating a career in mechanical engineering. These groups can play a key role in your development and keep you abreast of what is happening in your industry.

Associations promote the interests of their members and provide a network of contacts that can help you find jobs and move your career forward. They can offer a variety of services including job referral services, continuing education courses, insurance, travel benefits, periodicals, and meeting and conference opportunities. The following is a partial list of professional associations serving mechanical engineers and employers. A broader list of professional associations is also available at www.careercornerstone.org.

▸ **ASME** (www.asme.org)
Founded in 1880 as the American Society of Mechanical Engineers, today's ASME is a 120,000-member professional organization focused on technical, educational and research issues of the engineering and technology community. ASME conducts one of the world's largest technical publishing operations, holds numerous technical conferences worldwide, and offers hundreds of professional development courses each year. ASME sets internationally recognized industrial and manufacturing codes and standards that enhance public safety.