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Automotive Industry

Introduction

The automotive industry changed people's ideas of boundaries, limits, and distance. With the arrival of the automobile, people suddenly had the freedom to go farther faster than ever before. It changed where people lived and worked. It changed how and where they shopped and traveled. It changed how they thought about distance and time, making a significant impact on how people live their lives and how they behave on a daily basis.

Engineering played a great part in making the automotive industry the important force that it is today. Engineering breakthroughs and innovations in the field are found throughout the industry's history, beginning with components such as shock absorbers, disc brakes, tilt steering, and windshield wipers, and followed by systems such as the self-starting internal combustion engine, electronic fuel injection systems, anti-lock brakes, and air bags. Many of these innovations not only made vehicles more user-friendly, but also made them a good deal safer.

And, engineering innovation was more than just the improvement and development of automobile parts. The production process itself was an innovation and one whose impact can hardly be overstated. The face of the industry (and manufacturing as a whole) was changed forever when the Ford Motor Company introduced the first moving assembly line. The new process meant that more cars could be produced and that prices would drop, changing the car from a luxury item into an affordable means of transportation for the masses.

As motor vehicles became more accessible, they played an increasingly prominent role in everyday life and it quickly became clear that a more robust infrastructure was needed to support the new mode of transportation. Here too, engineers played their part. The Office of Public Roads started an engineer trainee program in 1904, and the Federal Aid Road Act of 1916 required each state to have a highway agency staffed with engineering professionals in

Educational Goals:

After completion of this module, you should:

- **Be familiar with the scope of and future directions of the automotive industry.**
- **Have a greater understanding of the operations and standards that are used in the automotive industry.**
- **Be able to identify and evaluate the opportunities available to engineers in the automotive industry.**
- **Be prepared to start a productive and focused job search in the automotive industry.**

order to carry out its subsidized road construction projects.

The industry and its place in the public consciousness grew exponentially as roads grew more crowded and a wider variety of motorized vehicles were offered. Commercial vehicles like buses and trucks became prominent, changing the face of public transportation and bringing goods and services to new and wider areas. Consumers were soon choosing from sedans or station wagons, hatchbacks or convertibles, motorcycles or recreational vehicles. And, with all these vehicles on the roads, the environment and public safety became issues of great importance and necessary considerations for engineers.

And there are still plenty of innovations to come. Even now, the automotive industry is in the midst of an engineering revolution with government regulations, environmental concerns, and the need to lower costs. New vehicle designs, the use of new and different materials, and improved engine design are needed to increase fuel efficiency, improve safety, continue cutting down on harmful emissions, and manage production efficiency and costs. Automotive engineering thus remains important for the industry and offers a challenging career with the potential to make a significant impact on society.

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Industry Scope

Let's talk about the state and scope of the industry today. In 2006, 49 million new cars were sold around the globe, and those new cars joined the approximately 800 million vehicles already on the roads. By 2020, that number will reach 1 billion. Currently, those vehicles burn nearly 250 billion gallons of fuel yearly.

The United States, Japan, China, Germany, and South Korea are currently the top five automobile manufacturing nations, but you'll find automotive operations in India, Latin America, the Middle East, and the rest of Europe as well. The industry is an economic powerhouse, with revenues in 2006 of over $85 billion, accounting for almost 10% of world consumer trade and 13% of manufacturing exports worldwide. Product categories include passenger cars, motorcycles, buses, trucks, farm equipment and other commercial vehicles, and automotive components and parts.

All over the world, you will find engineers in the automotive industry working in a plethora of roles, on a variety of components and systems, and in different types of companies. Engineers can take credit not only for designing the engines that power our cars, but also for the heating, ventilation, and air conditioning that keeps us comfortable, the seat belts and airbags that keep us safe (and the testing that is done to ensure safety), the control of the noise and emissions given off, the look and performance of the car, and much more. They are responsible for the efficiency of the production plants (as well as the robotic machinery in the assembly lines) and the consist quality of the finished product. Engineers work at large automobile manufacturers like General Motors and Toyota as well as companies like Delphi that supply the big auto manufacturers with things like fuel injection systems and sell, directly to consumers, items like GPS devices.

As in many industries, advances in engineering are the key to competitiveness in the automotive industry. As the industry adapts to changing social priorities, geopolitical pressures on the energy

industry, and an increasingly global marketplace, the opportunities for engineers will only increase.


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Automotive Industry

Industry Operations

The design and development of vehicles requires a large team of specialists from a wide variety of disciplines working over a period of years to achieve the goal of a high-performance, competitive product. Engineers are involved in all phases of this highly interdisciplinary process - from the initial concept through manufacture and even into marketing. As a result, engineers from all disciplines can find a role in the automotive industry process.

Styling and Packaging Phase

The first stage of the automotive development process is two-fold: styling (exterior as well as interior design) and packaging.

Styling begins with sketches. Those that are selected for further development are then rendered in more detail - first digitally and finally as clay models. Exterior and interior designers work closely together, consulting with aerodynamics and ergonomic engineers as the design progresses.

Packaging is the process by which all the component parts are fit together within the close dimensions of the vehicle. Today's design concepts place a premium on the use of space, and components must fit together within these design constraints but in such a way that the strength and safety of the system is never compromised. Once the overall design is set, there is little room for change.

With the detailed drawings and models resulting from the styling and packaging phases of development in hand, the development or feasibility engineer begins the challenging work of finding the right balance between desired product design and real-world achievability. Thanks to the wide variety of computer simulation and 3-D modeling technologies available, testing that once would have been difficult or even impossible this early in the process is now common practice.

Issues such as environmental efficiency, compact design, safety, and style all have to be accommodated in the design segment. This means that, to a large extent, the success of an automotive company is often in its design and development process. With so much riding on this phase, it's not surprising to find that in addition to the designers, cross-disciplinary teams include scientists, graphic artists, and, of course, engineers.


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Production and Manufacturing Phase

With the completion of the styling and packaging phase, the process moves on to production and manufacturing. For many people in the U.S. the automotive industry is the very epitome of manufacturing, and though the process is always being refined and each company has some proprietary systems in place, the basic assembly-line system used in the vast majority of automotive production is the same. In the broadest terms, the basic phases of production -- component fabrication followed by assembly -- do not vary tremendously.

Component Fabrication
This phase creates the building blocks used on the assembly line and throughout the rest of the process, so ensuring an uninterrupted supply flow is critical to optimizing production. Equally important is avoiding having too much inventory on hand. Excess inventory can consume space and money at the best of times, but should something be found to be wrong with a component after production is underway, any existing inventory will need to be scrapped or re-worked. The lower the inventory level, the lower the cost of any such changes will be.

For these reasons, the component-manufacturing phase was traditionally an in-house function, with auto manufacturers attempting to keep as close an eye on and as much control over the process as possible. This is changing today as more and more suppliers take on at least part of this task, delivering completed or partially completed elements to the assembly line. Of course, some of the elements you see on vehicles - things like tires, batteries, and dashboard instruments - have always been sourced from outside vendors.

Assembly
This is actually a dual-line process with body and chassis assembly happening concurrently. During body assembly, panels are welded

together and doors and windows installed to create the body of the car. Then the upholstery, interior hardware, and wiring are put in place. Finally the paint and trim are applied. Meanwhile, on the chassis line, the frame - with springs, wheels, steering gear, powertrain (engine, transmission, and drive shaft), brakes, and exhaust system - is assembled. Once these are both complete, the car is in large part finished, with only minor items left to address before testing and inspection.

Since its earliest days the automotive industry has led the way in manufacturing innovations, and today it continues to do so, with regular improvements in production and the investment of a large amount of time and money in the manufacturing process.

The truth is that there are few things more complex to put together than today's automobiles. They require manufacturing facilities made up of hundreds of systems designed to do very specific, individual work while working seamlessly together. To create these hardworking – and yet often delicate – systems, engineers work with computer modeling tools to create simulated production systems, which they can then view in action in virtual plants. They can ensure in advance that material will be located exactly where it needs to be at any given time and that machines and equipment are in precisely the right place. They can optimize the process to keep product handling to a minimum and maximize worker safety.

In the manufacturing process itself, engineers have incorporated automation and robotic technology into the assembly lines that are producing the current generation of cars. For the next generation of cars, engineers will re-invent the process all over again, creating production tools and methods designed to handle newer materials, greater electrical and motorized innovations, and even more design features.

It's not only the engineers at the big auto manufacturers that are changing the face of the assembly phase. Engineers at the automotive suppliers are also facing these challenges, as manufacturers look to supply companies to shorten production time and maintain constant, reliable inventories at just the right levels. These suppliers are stream-lining their own segment of the JIT (just in time) supply chain by designing specialized assembly lines as their role expands to include portions of the assembly, in addition to part manufacturing and delivery.

If companies in the industry want to remain competitive, re-engineering this phase of product development will be a critical, top-to-bottom process.

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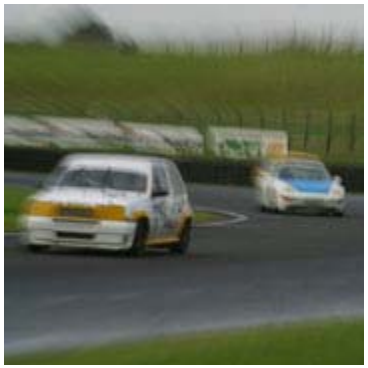
Industry Operations

Testing and Inspection Phase



Testing is done at all levels of a vehicle''s design and construction. Individual components and their materials are tested to assess interaction with other components and for durability. Designs are tested for feasibility and cost effectiveness. Tools and assembly systems are tested for consistency and accuracy. But no amount of early testing eliminates the need for testing and inspection on the completed product.

Naturally, many of the same computer modeling programs and simulations that are used on the vehicle as a whole can be used on an individual component. But once the vehicle assembly is completed, testing is taken to a new level. Engineers take the vehicles to proving grounds, areas designed to demonstrate that the automotive technology works reliably even in extreme conditions and on a variety of road surfaces. There are sections designed to simulate road hazards like potholes, and areas of standing water to test hydroplaning responses. There are inclines and declines, straight-aways, banked curves, winding roads, and tracks laid out with a variety of road surfaces such as sand, gravel, and concrete. These facilities really test the vehicle as a whole and in a variety of areas.

Tires and powertrains are judged on how well they hold up over a period of mileage accumulation. The body of the vehicle is subjected to corrosive conditions to simulate the durability of the materials during a lifetime of even the harshest use. The steering mechanism is evaluated for stability and responsiveness. Another important item on the inspection checklist is the completed vehicle's vibration levels.

Everything from the fuel injection pump to the instrument panel, from the seat to the air bags, will undergo extensive vibration testing. Vibration testing is not merely about comfort and noise levels – though obviously such irritations can be detrimental and should be eliminated – but they are also a safety and performance issue. With

components assembled so tightly, vibration at what we might think of as minor levels can determine whether a system succeeds or fails under various driving conditions. If components are not sitting precisely as they should, they'll move, shake, and rub against other components. That increases the likelihood of wear and tear on hoses, wires, and canisters, which can result in failures like coolant leaks and electrical shorts.

The tests are sweeping and comprehensive: each system and part – electrical systems, brakes, safety features, windows, heating, air conditioning, ventilation – is examined both individually and then again as an integrated part of the whole.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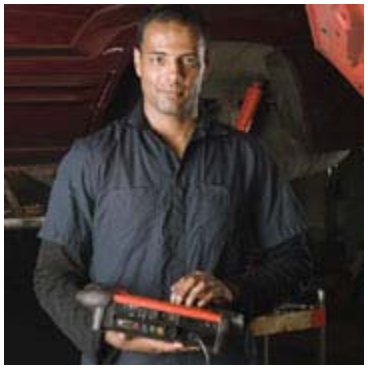
Industry Tools



CAD (computer-aided design) software, CAE (computer-aided engineering) software, and rapid prototyping are all computer-aided engineering tools and process that have changed the way the modern automotive industry designs, builds, and tests its products. These tools have improved quality, lowered costs, and reduced production and development time. Because of this, new and improved products are hitting the marketplace faster than ever before.

For example, a process simulation can be created with CAE for operations such as casting, molding, and die-press forming. Vehicle Durability Identification and Assessment, a CAE method, predicts dynamic durability performance for everything in and on the vehicle, right down to the smallest component. Using detailed, full-color displays, engineers can visualize a vehicle in the most demanding, real-world uses - such as hitting potholes or pulling heavy loads up mountainsides. A stress analysis can be done on components and assemblies using FEA (Finite Element Analysis) – another CAE method. All these CAE capabilities have allowed for the near-elimination of costly prototypes in the product-development process.

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Industry Operations

Industry Standards

Standards promote safety, reliability, productivity, and efficiency in any industry that relies on engineering components or equipment. They provide guidance and direction so engineers can achieve the most effective manufacturing and design processes. These standards are written by experts with knowledge and expertise in the field and may run from just a few paragraphs to hundreds of pages. Some of the organizations providing standards to engineers in the automotive industry include:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Federal Motor Vehicle Safety Standards (FMVSS)
- International Organization for Standards (ISO)
- National Institute of Standards and Technology'sTools for the Auto Industry (NIST)
- SAE International

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Role of the Engineer: Job Functions

Overview

You will find engineers of all kinds (mechanical, electrical, components, chemical, materials, and process) working in each sector of the industry and in a wide range of specialized areas. Within automotive engineering, there are product engineers specializing in chassis design - creating the frame that holds the engine, transmission, driveshaft, and suspension together in such a way that vehicle vibration and noise are minimized while space and performance are maximized. Other engineers are working on vehicle dynamics, which addresses attributes such as the vehicle's ride, handling, steering, braking, and traction. There are durability and corrosion engineers evaluating the toughness and reliability of the vehicle by subjecting it to corrosive salt baths and a variety of severe driving conditions.

Engineers also play a critical role in all stages of vehicle manufacturing. They assess feasibility of design of the proposed vehicle to determine whether each part meets cost, safety, performance, and quality specifications. Engineers are also designing the automation and robotics systems used in the plants, arranging assembly stations, establishing work standards and laying the groundwork for the technology and innovations that will be incorporated into the vehicles of the future.

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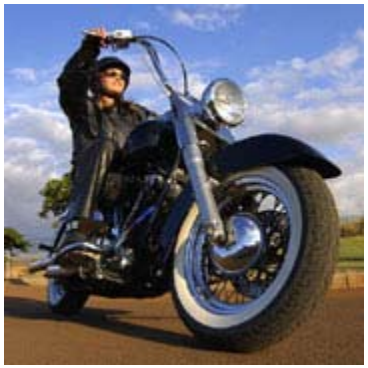
Role of the Engineer: Job Functions

Specializations



While passenger cars and their systems make up a large share of the automotive engineering market, the industry also includes a wide variety of trucks and other recreational, motor-sport, commercial, and agricultural vehicles. Engineers may be found working both at the manufacturers of these vehicles as well as at the suppliers to the major manufacturers. The job possibilities include a variety of options and may focus on individual components or complex systems.

Some typical engineering roles might involve:

- Developing computer-models and test procedures to assess and improve materials and material behavior under a variety of conditions.
- Assessing various crash scenarios and testing new designs against stringent governmental regulations. Assessments done using computer crash simulations, crash test dummies, partial-system-sled, and full-vehicle crashes determine seat belt and air bag functionality, as well as front- and side-crash stability.
- Measuring and modifying the noise and vibration characteristics of vehicles, ultimately working to eliminate as much of these distractions as possible to create a smoother, quieter, more stable ride.
- Working on ergonomics with interior designers, analyzing the vehicle's occupant accommodations (seat roominess); occupant's access to the steering wheel, pedals, and other controls; ingress/egress points of the vehicle; and the driver's field of vision (gauges and windows).
- Working on packaging issues and component placement (e.g.

placing components in the tightly packed engine compartment).

- Designing manufacturing facilities and production processes that maximize efficiency, limit environmental impact, and maintain consistent production levels over long-term production runs.

- Maintaining quality control over a vehicle. Vehicles must continually be checked and assessed to ensure they continue to meet the standards of the manufacturer and the expectations of the marketplace.

There are even automotive engineering careers outside the automotive industry itself. At the Environmental Protection Agency engineers certify the compliance of vehicles with government emissions and fuel economy standards, as well as develop new pollution control techniques to enhance those standards. The Department of Energy's FreedomCAR/Vehicle Technologies Program and Hydrogen Fuel Initiatives also offer career paths to engineers with an interest in automotive technologies. These programs are seeking to develop advanced combustion technologies like clean diesel and low temperature combustion (LTC), along with fuel cells and advanced hybrid propulsion systems - transportation technologies that will significantly increase vehicle fuel efficiency and lessen our dependence on oil.

As you can see, there are a variety of possible career roles for engineers with an interest in the automotive industry and automotive technologies.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Automotive Industry

Companies

The list below represents the key players in the automotive industry and are employers of engineers - both automotive manufacturers (as well as their subsidiaries, divisions, and brands) and suppliers.

Automotive Manufacturers

- BMW (Mini, Rolls-Royce Motor Cars)
- Caterham
- Chrysler (Chrysler, Dodge, Jeep, Mercedes, Maybach)
- Citroen
- Daewoo - U.S.
- DaimlerChrysler
- Fiat (AlfaRomeo, Ferrari, Iveco, Lancia, Maserati)
- Ford (Ford, Lincoln, Mercury, Jaguar, Mazda, Volvo, Land Rover)
- General Motors (Buick, Cadillac, Chevrolet, Daewoo, GMC, Holden, Hummer, Isuzu, Opel, Pontiac, Saab, Saturn, Vauxhall.)
- Honda (Acura)
- Hyundai
- Jeep Eagle
- Kia
- Lotus
- Mercury
- MGRover
- Mitsubishi
- Nissan (Infiniti)
- Peugeot
- Porsche
- Proton
- Renault (Dacia, Samsung)
- Subaru
- Suzuki
- Tata
- Toyota (Daihatsu, Hino, Lexus, Scion)

- Volkswagen (Audi, Bentley, Bugatti, Lamborghini, SEAT, Skoda)
- Volvo

Automotive Suppliers
As we've discussed, automotive suppliers have taken on growing levels of responsibility in the industry, and because of these increased roles, suppliers have become less vendors and more integrated partners in all facets of development and production. This shift means that engineers will find both general and specialist opportunities among companies such as:

- American Axle & Manufacturing
- ArvinMeritor
- Dana Corporation
- Delphi Automotive Systems
- Eaton Corporation
- Goodyear
- Johnson Controls
- Lear Corporation
- Magna Steyr
- Metaldyne
- Robert Bosch GmbH
- Tenneco
- TRW Inc.
- Visteon Corporation

While this list represents many of the key players in the industry, it is by no means a comprehensive list of employers in the field. For more information on finding positions at these and other companies, check out the Career Planning module.


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Job Outlook

Overview

Despite recent headlines that sound discouraging, the automotive industry, remains a stable, profitable arena in which to work, even as it regularly expands and contracts. The industry is extremely large and reporting on such a huge industry may sound extreme without context. When profits are reported, the numbers are suitably impressive, but when losses are reported, the numbers can sound pretty dire. There always seem to be headlines on factory closings, consolidation, outsourcing, labor contracts – all of which can make the automotive industry sound as if it is in serious trouble. But it's not.

This cyclical expansion and contraction is perfectly normal for vehicle manufacturing and comes as a direct response to swings in the economy. Motor vehicle manufacturers have responded to these changes in the past by hiring or laying off workers, but the industry – and the big auto manufacturers - do not move in lock-step in this regard as much as the public seems to think. Yes, there is always the possibility of layoffs, but this is hardly a given in the industry.

Motor vehicles aren't a trend or a fad. The world needs cars and trucks to function and competitive pressure dictates that new products will be bought regularly. Not only is demand not going to disappear, it is likely to increase dramatically in the next few years as established consumer markets of the Western and industrialized nations remain stable, new products find their niche, and emerging markets of the developing world fulfill their promised global consumer and manufacturing expansion.

In the past, the automotive industry was synonymous with the U.S. and Detroit. Detroit is still very much an industry town but there are many more cities in many more countries for those seeking to work in the industry.

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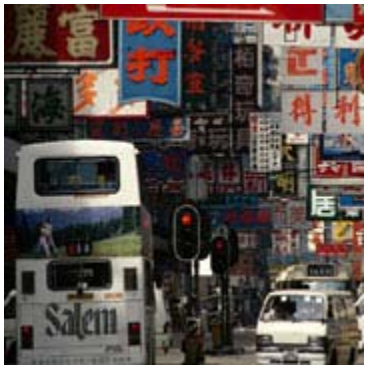
Job Outlook

Globalization



In terms of vehicle assembly, nearly one-third of the global automotive industry's growth over the period 2004-2012 will come from China. India and Eastern Europe are also quickly emerging as strong growth markets during this period. Even now, many automakers are realizing greater profits in emerging markets than in the more mature regions they call home.

PricewaterhouseCoopers AUTOFACTS forecast 2007

Additionally, with foreign manufacturers like Hyundai-KIA, Toyota, and BMW expanding their manufacturing operations in the U.S., there are likely to be both international and domestic positions available with some overseas companies. The Association of International Automobile Manufacturers estimates that by 2009 these foreign automakers will have invested $3.3 billion and hired 10,000 additional workers in the United States.

In fact, Asian car manufacturers, led by Toyota and Honda, are experiencing tremendous success in general. In 2006, Toyota's 2006 sales figures topped those of Chrysler – the first time any of the Big Three have been outsold by any other manufacturer. South Korean makers like Hyundai and KIA have shown themselves to have true staying power and now have a growing global customer base.

The Asian consumer marketplace is also showing significant growth. Automotive manufacturers from all over the world have rushed to establish their presence in China to serve a burgeoning domestic market created by the explosive growth of the Chinese economy and the rising affluence of their consumers. With the low labor costs and increasing product quality offered by China, manufacturers are

looking for export opportunities as well. While motor scooters are still selling as fast as ever in India, the growing middle class of this outsourcing giant has begun demanding more cars and has sent vehicle sales soaring. There is also a growing manufacturing sector in that country, with the Tata Group planning the 2008 launch of a low cost, no-frills Indian car.

European manufacturers are grappling with the same high costs that the U.S. manufacturers face, and with the labor laws and regulations unique to that market there have been some delays and problems in the recent past. But the European market remains strong and full of opportunities, with Audi and Porsche continuing to show excellent results and BMW showing consistent growth in market share.

So the industry needs just as many engineers as ever. The job market isn't shrinking so much as it is changing focus and becoming less centralized.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Job Outlook

Environmental Impact

Environmental concerns in general will continue to play an important role in putting pressure on automakers around the world to take such issues seriously. This important issue provides a lot of opportunity for engineers to innovate while at the same time contribute to the health of the environment.

Automobile Emissions
Many countries' governments are concerned with emissions control and global warming. In the United States, President Bush used his 2007 State of the Union to call for tougher fuel economy standards by 2017. In Europe, previously voluntary emission standards put in place by the EU are likely to become mandatory, in large part because most automakers aren't going to make the voluntary 2008-09 target deadlines. In Asia, Japan's fuel economy requirements are more than twice as stringent as those in the United States, and China plans on raising its own requirements (already higher than the U.S. requirements) in 2008.

Additionally, some of the most well-known organizations in the world are taking emissions control and global warming into consideration when planning their own vehicle and transportation. FedEx, for example, has over 170 EPA low-emission-certified vehicles in its fleet of pickup and delivery vehicles and has equipped all of its B727s with proprietary "hush kits" to significantly reduce engine exhaust and fan noise levels (although at the slight expense of fuel efficiency). The demands of such large corporate consumers will naturally also affect the automotive industry’s product planning and R&D commitments.

Hybrid Vehicles
The past few years have been a pivotal period in the automobile industry. As gasoline prices started soaring in 2004, there was a greater public demand for fuel efficiency, and sales of SUVs - which had been very popular for years - began to lag. By 2005-2006 - with

gasoline prices topping $3.00/gallon - large SUVs were losing their appeal, and interest in hybrids was on the rise.

In the United States Ford, General Motors, and Chrysler - often referred to as the Big Three - hurried to adapt to this shift in demand. These adaptations included the introduction by General Motors of the EVI, the first electric car to be mass-produced in the United States in modern times. The car was only available in limited test regions however, and production was cancelled after only a few years, so consumers and government regulators began looking more closely at the new technologies and designs available elsewhere.

Hybrids had been available from Toyota and Honda for several years and had gained ground, steadily if not rapidly. These sales are now showing a sharp increase, and customer satisfaction with the cars and their performance is high.

Other big manufacturers have also all launched hybrids into the market but, generally speaking, consumers have reported disappointing mileage results and sales have not met company expectations. Despite this, it's clear that there is a healthy spot in the marketplace for these types of cars, and that more hybrids will be produced as technology improves.

In the public sector, transit systems like the New York MTA are making hybrids and alternative fuel vehicles the cornerstones in their own environmental efforts. In 2000, the MTA implemented the Clean Fuel Bus Program, which combines several different technologies - including CNG (natural gas) buses, fuel cell engines, hybrid buses, and clean diesel technologies - to achieve their goals of lowering emissions below U.S. standards and cutting operational fuel costs. Fuel cell buses are being tested in Chicago and Vancouver with great success and hybrid buses in particular have exceeded all expectations in regards to reliability and efficiency. All this suggests that these technologies will be in increasing demand as large fleets are replaced and redesigned.


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Mapping Your Career

Educational Preparation

College/University Coursework
The majority of engineering programs regardless of specialty include core curriculums that will enable the recent graduate to work in any of the job functions discussed in previous sections. If, however, you want to start pursuing this specific path right away, the coursework you'll want to consider if you have an interest in this field would be:

- Applied Dynamics
- Applied Mechanics
- Automotive Electronics and Instrumentation
- Body/Frame Structure and Design
- Brakes and Powertrain Systems
- Combustion Engine Theory
- Engineering Measurements
- Fluid Mechanics
- Fuels, Lubricants, and Emissions
- Manufacturing Processes
- Materials Testing
- Mechanics of Materials
- Suspension and Steering
- Thermodynamics and Heat Transfer
- Engineering Graphics
- CAD Software
- Queue Theory
- Optimization Networks
- Theory of Machines
- Design and Synthesis of Mechanisms
- Quality Control
- Mechatronics

Internships and Co-ops
Workplace experience is one of the best ways to prepare for a career in the automotive industry. You'll learn not only about the companies

themselves, but also about how the industry works and what roles engineers play in it. You'll see how different segments of development and production work together, and what kinds of non-engineering skills you will need to be a productive member of the industry workforce.

In addition to looking for leads on campus, you may want to look at opportunities offered directly by employers. Many of the major players in the industry have programs in place designed to bring students at all levels into the workplace and give them real-world experience. Some such programs include:

- American Axle & Manufacturing Cooperative Education and Summer Programs
- Bosch Internship and Co-op Programs
- Chrysler College Automotive Programs
- Delphi Automotive Student Programs
- Ford Summer Intern Programs
- General Motors Cooperative Education & Intern Programs
- Goodyear Student Programs
- Harley-Davidson Internship Program
- Renault Internships and On the Job Training Programme and Rolls-Royce Graduate Experience
- Tata International Internships
- Toyota Technical Centers Co-op & Internship Programs
- Visteon Education Program and the Summer Intern Program

For more information on opportunities at specific organizations, check the company websites (usually under their careers section).


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Mapping Your Career

Finding the Right Job

A job search actually starts long before you make the first appointment or send the first resume. It is important to decide what areas of the industry or world you want to focus on so that you can concentrate on companies and opportunities in those areas. How do you make that first, critical decision? With research.

Research
Get to know the industry—the trends and current events—and get to know more about the key players and firms in the field as well. Which company has recently brought out a significantly redesigned product? Which company is opening new plants or relocating existing ones?

The automotive industry serves as a major indicator of consumer confidence and economic health. It is a rare day indeed that the business section doesn't have a story or two about it. Few industries receive as much media coverage. Begin by scanning your local newspaper's business section, as well as the Wall Street Journal and the web sites of other major dailies.

The publications you should review regularly are the car and automotive trade magazines, such as AutoWeek, Automotive Engineering, Automotive News, Motor Trend, and Ward's AutoWorld. Publications like this report on all aspects of the industry and can help focus your search and help you target specific companies. More industry news sources can be found in the Additional Reading section below.

Once you have your industry sources established, you can start researching the companies you intend to target. Don't forget that one of the best sources of information about a company is the company itself. Most companies now have Web sites that include not only information on product lines, but also company history and links to employment opportunities. For a list of leading companies in the

industry, check out the Companies section of this module.

For more information on researching companies and identifying targets for your search, review our Career Planning module.

On-Campus Recruiting
Many companies visit campus for recruiting purposes. Your university Career Services Office should be able to tell you what companies are coming and when. They might also be able to provide information and contacts related to internships. For more information on using these on-campus options, review our Career Planning module.

Networking
Many people dismiss networking as simply "asking around" but it's much more than that—it can be the key to getting in the door and standing out from the crowd. You might hear of job openings not yet advertised or about people who plan to leave a job in the near future. Another advantage is that being able to associate yourself with someone known to the hiring manager means you will have an edge in your first interview over an applicant who is just one of many names on a list. For tips and suggestions on effective networking, review our Career Planning module.

On-Line Job Listing Sites
You can certainly find industry jobs on the large, general job-listing sites like Monster.com or careerbuilder.com, but winnowing down the list to the jobs in areas you want to focus on can be time consuming. Still, these resources are very comprehensive and it's worth looking at them—if only to get a sense of the range of engineering positions available at any given time.

If you want to give your search more focus, you can check out these sites specifically aimed at those looking for positions in the automotive industry:

- ASME Career Center
- Auto Pro Technical Recruiting
- Auto Careers
- Engineering Central: Automotive section
- Car Design Jobs
- International Federation of Automotive Engineering Societies Job site
- InAutomotive.com
- SAE Career Center
- SME Job Connection Center

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Mapping Your Career

Staying Current and Getting Ahead

Continuing Education
Success is more than showing up regularly and doing your job consistently. In an industry as fast moving and competitive as automotive engineering, it means keeping your edge and keeping as far ahead of the curve as possible. Staying apprised of the latest industry news, as mentioned previously, is important, but another important channel for improvement and success is through continuing education options like online classes, seminars, and conferences. Professional societies like ASME, SAE, and SME are great places to start in order to find resources like these.

- ASME Continuing Education Institute
- ASME Professional Practice Curriculum
- SAE Continuing Education Programs
- SME Professional Development Programs

More professional development options can be found through some of the places listed in our Industry Resources section.

Networking as an Ongoing Practice
Networking as a career development tool does not stop once you get your first job. It will be a valuable way to help move up the career ladder. If you have the opportunity to attend industry meetings and conferences or get involved with specific activities of your trade association, give it some serious consideration.

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Automotive Industry

Industry Resources

Reading: Magazines, Journals, and Websites

- Automotive Design and Production Magazine
- Automotive Digest
- Automotive Engineering International
- Automotive Industries
- Automotive News
- Electric and Hybrid Vehicles Today
- Off-Highway Engineering
- WARD'S AutoWorld

Professional Societies and Associations

Professional organizations offer the opportunity to meet, network and exchange technical information with other industry professionals. These activities keep engineers connected to the latest technological advances and also aid in their professional advancement. Professional societies also offer information on careers, industry information, and events that can be invaluable, not only as you start your job search, but later on as you seek to take your career to new levels. Some you might want to check out include:

- Alliance of Automobile Manufacturers
- American Society of Body Engineers
- Association of International Automobile Manufacturers, Inc. (AIAM)
- International Federation of Automotive Engineering Societies (FISITA)
- Motor & Equipment Manufacturers Association (MEMA)
- Society of Automotive Engineers
- Society of Manufacturing Engineers
- United States Council for Automotive Research (USCAR)
- Women's Automotive Association International (WAAI)

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Automotive Industry

Summary

The automotive industry is an economic force that employs millions worldwide and has annual reported revenues of well over half a trillion dollars. It has also been an agent of social change, influencing the way we live. Automotive engineers have been at the center of these changes since the industry's inception: first with the creations and designs that got people and goods moving, and then with the improvements and refinements that moved them faster and further, in more comfort, and with greater safety.

The industry itself has been going through some dramatic changes as well, and the field of automotive engineering is changing right along with it. Greater awareness of and commitment to tackling environmental concerns have engineering teams exploring new materials and design processes that will result in cleaner-running and more-efficient vehicles. At the same time, escalating labor and material costs have engineers searching for ways to improve not only vehicle performance but operational efficiency as well. Even the automotive marketplace is changing. North America remains the largest market, but the industry is expanding dramatically throughout Asia, Eastern Europe, and South America. In all these places, engineers are hard at work developing new engine designs, establishing new production facilities, and testing new materials and products.

Engineers in all disciplines will find their skills and background in demand across the whole of the industry's operations. General engineering skills can be a solid stepping-stone to careers in several specialized areas, including vehicle dynamics, NVH, ergonomics, and much more.

The automotive industry is currently adapting to meet the demands created by an expanding marketplace, increasing social concerns, and rising costs. To make the changes needed to meet these challenges, the industry will rely on engineers to find innovative solutions and deliver reliable results. If you are looking for an exciting,

dynamic field that offers a wide range of career paths, the potential for overseas positions, and the promise of being part of one of the largest industries in the world, then the automotive industry just might be the industry for you.

Provide feedback on this module.