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CAREER AS AN INDUSTRIAL ENGINEER

Institute Research Number 206
ISBN 1-58511-206-2

DOT Number 012.167-030, 012.267-010
O*Net SOC Code 17-2112.00, 17-3026.00

CAREER AS AN

INDUSTRIAL ENGINEER

EFFICIENCY EXPERTS, SAFETY ENGINEERS, ERGONOMICS ENGINEERS, ENVIRONMENTAL HEALTH ENGINEERS

Every Organization Today Needs These Professionals Who Understand What All the Factors Affecting Its Mission Are, How They're Related, and What Can Be Done to Make it All Work Better

AN INDUSTRIAL ENGINEER'S JOB is to find the best combination of people, tools, materials, parts, information and power to provide products or services efficiently. Unlike the engineering specialties such as civil engineering or mechanical engineering, this career track isn't restricted to one industry or type of work. It may be industrial in the sense of

working in a traditional manufacturing, mining or transportation environment. Or it can lead to work for a financial services firm, a government agency or a magazine publisher.

Industrial engineers research, analyze, model and test whole systems. They're efficiency experts; safety engineers; ergonomics engineers; environmental health engineers; and in many cases, managers, principals or business owners. Almost any organization that you can name has a need for someone who understands what all the factors affecting its mission are, how they're related, and what can be done to make it all work better. That's what industrial engineering does – it makes a system, a process or an organization work better.

There are almost 200,000 professional industrial engineers in the USA. Over 65 percent of them work in manufacturing industries. However, they're found more widely throughout these and other kinds of industries than other engineers, because their skills are needed practically everywhere.

Salaries for industrial engineers are excellent, averaging over $60,000 annually in manufacturing, motor vehicles and equipment, electronics, computers and data processing services, and aircraft and parts.

The more that information technology is important; the more that companies and agencies need to reduce costs and increase productivity; the more concern there is for health and safety in the work environment; and the more awareness there is of the need for environmental protection – the more there will be an increasing need for industrial engineers, including manufacturing engineers, health engineers and safety engineers.

WHAT YOU CAN DO NOW

WORK HARD IN SCHOOL! APPLY YOURSELF TO YOUR STUDIES. DO EXTRA WORK IN your classes, especially in math, science, and physics. Ask yourself, "Do I know how to take a project from start to finish?"

Observe how things work. Read widely; that is, read about all kinds of subjects. Question things. Read newspapers.

Go to your favorite fast food restaurant and think about how they could simplify their work methods.

Look at the organization of your bedroom or closet and figure out how to set it up in a way that makes your morning rituals easier and faster to complete. Consider your personal life. What's inefficient about the processes that you personally go through each day?

Go through the resources of your school's career center; see how the job market is; learn how to market yourself. Get an internship position.

Take a tour of a local manufacturing company – maybe a tour sponsored by the Institute of Industrial Engineers (IIE). Think about the professional who designed the overall production system. Consider how you could make that system work better. A manufacturing plant near you might also arrange a tour as part of a school career day, or provide someone to speak at your school.

Consider going to a Society of Manufacturing Engineers Student Summit (www.sme.org). This is a free opportunity for students 16 to 18 years old to tour SME manufacturing technology trade shows. You'll get a guided tour and hands-on demonstrations of the latest technology, a chance to ask professionals questions, and an opportunity to explore careers in manufacturing.

Visit the Institute of Industrial Engineers Web site to learn more about industrial engineering: www.iienet.org

HISTORY OF THIS CAREER

ENGINEERING IN GENERAL MEANS APPLYING MATHEMATICS AND SCIENCE TO make efficient use of materials and forces. Products, procedures and systems, whether designed by an engineer or by another designer, work well if sound engineering practices are well applied to the design and implementation. Very early examples such as the construction of the pyramids in Egypt or the functioning of the aqueducts in Rome brought together materials, management, labor and tools to produce the product. In addition, the products, such as the aqueducts, then contributed to a larger system of agriculture and society.

Leonardo Da Vinci was a student of both science and mathematics, and applied them in a vast number of ways in the 16th century. In addition to being a prolific artist and inventor, he worked in a kind of industrial engineering. His real income came from devising war machines and their deployment for his rich patrons. Into the 18th century, big projects were generally designed and organized by military engineers. Then, as civilians performed this work to build things for the rest of society, the "civil engineer" became a new professional term.

During the 1790s and early 1800s, mechanical inventions made large-scale production of goods possible, but at the same time required gathering workers in a factory rather than letting each one work at home. This was the Industrial Revolution, and new power from steam engines, interchangeable parts and production lines combined in factories where, for example, raw cotton went in, and dresses and household goods came out.

At this point, the role of the modern industrial engineer was becoming an important and obvious one. Industrial production systems require the efficient combination of machinery, labor and materials. The techniques, costs and economic considerations of production, sound engineering principles, the safety of the workers, and the layout of the facility and equipment – even marketing and sales information – are all part of the equation.

Lillian Gilbreth and her husband, Frank, worked to develop efficient work systems from the early 1900s into the 1960s. Frank's interest was in the technical factors of efficiency, while Lillian's was with the human aspects of time management. Their life is documented in the book (and 1950 movie) *Cheaper by the Dozen* – so named for their dozen children that they could test their theories on. Fredrick W.

Taylor was another pioneer in the establishment of industrial engineering, using time and motion studies and the principles of scientific management.

Astronaut Neil Armstrong represented the National Academy of Engineering at the National Press Club in February, 2000. He concluded, "The future is a bit foggy, but it's not unreasonable to suggest that the 21st century will enjoy a rate of progress not unlike the 20th. And a century hence, 2000 may be viewed as quite a primitive period in human history. It's something to hope for.

"For three decades I have enjoyed the work and friendship of Arthur Clarke, a prolific science and science fiction writer, who back in 1945 first suggested the possibility of the communications satellite. In addition to writing some wonderful books, he has also proposed a few memorable laws. Clarke's third law seems particularly apt today:

"Any sufficiently developed technology is indistinguishable from magic. Truly, it has been a magical century."

Lieutenant Colonel Nancy J. Currie, PhD, is a Mission Specialist and Space Shuttle Flight Engineer for NASA. She was a member of the crew that put the first USA and Russian components together to start the International Space Station. She says, in the April 2002 issue of The Institute of Industrial Engineers' *IIE Solutions* magazine, "I will never forget the feeling of pride and accomplishment when my commander, Colonel Bob Cabana, made that first radio call – 'Houston, this is the International Space Station.'" In the future, LTC Currie plans to help complete the space station, and to work in Human Factors research, especially interaction with automated systems. She's a good indicator of some of the future possibilities for industrial engineers.

WHERE INDUSTRIAL ENGINEERS WORK

Manufacturing Positions A majority of industrial engineers, industrial engineering technicians and technologists work in a manufacturing environment. The highest paying jobs, on average, are in the automotive industry. Similar kinds of employers are aircraft manufacturers, packaging plants, machine shops, shipyards, and the machine tool industry. Communications companies include manufacturers and suppliers of other kinds of production and services, and make up a growing industry.

The same kind of work may have different titles, such as manufacturing engineer or application engineer. An industrial engineer can branch into work as a sales engineer, or work up to the level of plant manager. Some work independently, in business and management service companies, providing these services to manufacturing and other industries. Engineering services are provided by consulting engineer firms and by industrial engineers working as independent consultants.

Positions Beyond Manufacturing

Industrial engineering doesn't just apply to manufacturing industries. Jobs where you can apply your knowledge, skills and abilities can be found in many different environments, not just in a factory. You can find work in any industry that provides services to large numbers of customers – healthcare, finance, law, insurance, banking, teaching, consulting, business, or transportation. Employment opportunities are abundant for IEs any place where methods, procedures and processes need to be optimized for efficiency, quality, and safety.

Large employers of IEs in the service sector include all major airlines, railroads, logistics companies, hospitals, food services, and government agencies to name a few.

The future directions and competition or melding of telephone, television, computers and the Internet and other technologies will require new industrial engineering breakthroughs, and those in themselves may determine which employers are successful. You can get into about any kind of organization or environment that interests you, though your title may not be "industrial engineer." You can also work anywhere in the USA, or just about any other country in the world, if you want to.

There are opportunities to work in any of these areas with government at all levels. There are also jobs requiring industrial engineering skills in nonprofit and charitable organizations, like educational foundations or humanitarian agencies that assist disadvantaged populations, for example in poor countries or American towns hit by setbacks and layoffs within industrial markets.

In a business service company or management consultant position, you might work to improve the communication and interactions between people who have nothing to do with machinery or production. The principles of finding the best combination of people, tools, information and other factors for efficient production apply equally well in organizing a marketing department, for example. In this case, you may find your place through a job title such as sales manager, business consultant, or sales engineer. Any organization can benefit from the application of industrial engineering concepts and principles, even football! NFL Coach Tom Landry was an IE.

THE WORK YOU WILL DO

ALTHOUGH THE GENERALIZED JOB DESCRIPTIONS OF INDUSTRIAL ENGINEERING seem straightforward, the actual jobs available vary widely, and even the job titles may be completely different from employer to employer.

Industrial engineers develop processes and systems to improve quality and productivity. They help to eliminate waste in time, money, materials, and energy. Engineering often crosses into different fields – an industrial engineer often has to know the principles of mechanical engineering, electrical engineering, structural engineering and the rest.

IE work includes resource planning, systems design, logistics, human factors, simulation, quality control, and cost justification among other things. The actual work duties might also involve logistics, sales, business management, personnel or architectural considerations.

The common conception of industrial engineering coincides with the setting we envision from the word "industrial," namely a factory, mine, or transportation type of industry. While many of the industrial engineers are working in these areas, their work is constantly and radically changing with the increasing rate of automation. Today, they

deal with the total process of manufacturing or of another industry. More and more, their main tools are computers.

Industry applies to all kinds of workplaces. In a factory, for example, industrial engineers are likely to develop and implement production control programs, management control systems and information management tools. Traditionally, they would plan the utilization of facilities, equipment, materials, and personnel to improve the efficiency of operations. They'd work between management and operations personnel, using "continuous improvement programs" and "lean manufacturing programs" to help make the business run better.

You could be involved in much more than figuring out how to keep a production line moving, though. You might help select a site for a plant or facility to begin with, considering the costs and benefits of being near the workforce or the raw materials, transportation of the finished products, or working with others (like Intel locating near Microsoft, or the siting of a foundry inside a shipyard).

You might also work on the design and construction, or alteration, of industrial buildings and facilities for the company's future business plans. This could involve doing a facilities utilization analysis. You may have to identify what machines are used in a shop; how many people operate them; how much space they need, including their material handling requirements; how they work, and in what sequence; and how these can best be installed and arranged for efficiency. With a solid engineering background in place, you'll need to apply business and management abilities as well.

You might even manage the facilities and the entire manufacturing process. This can involve performance management over each workstation and capability development, manpower planning and scheduling of the overall operation. You might even have several different plants to manage for a large company, such as an aircraft manufacturer, whose operation is spread throughout many buildings and even two or three states.

Under any circumstances, you will likely spend a considerable part of your time on the production floor finding ways to improve the processes. You may work with a process improvement team, melding your expertise with the specialties of other people, including engineers, technicians, machinists, designers or a specialist whom you bring in for a particular project.

You can also get involved with sales and work directly with your company's customers, enabling them to reduce their manufacturing costs and resolve production difficulties. You might help customers by selecting or designing products especially for their applications. An example would be setting up an aircraft production line to custom-build cargo planes for the military at the same time that other planes of the same model are being finished as passenger airliners. Or you could arrange the production and delivery of another manufacturer's parts to flow smoothly with the aircraft plant's assembly schedule.

Safety and Environmental Health – Ergonomics Many industrial engineers have titles fitting their more specialized jobs in safety, environmental health, occupational safety and health, or ergonomics. A good definition of ergonomics comes from a Web site called Buttpillow: "Ergonomics is the science of fitting jobs to people, including anatomy, physiology, and psychology. Ergonomic design is the application of this body of knowledge to the design of the workplace (work tasks, equipment, environment) for safe use by workers." (www.buttpillow.com/)

Developing and implementing ergonomics programs are an increasingly important and responsible function that applies to all jobs in all industries, and it fits the kind of analytical thinking and comprehensive view typical of an industrial engineer.

A safety engineer or safety officer is responsible for the safe working conditions of everyone in an organization, whether that's a heavy equipment operator on the job site or the president, in the board room or in a freight elevator.

Operations Research

Operations research and management sciences professionals apply information technology for informed decision making. In these positions, industrial engineers use analysis and mathematical and computer modeling to improve systems of people, tools and procedures. They use engineering, management, business economics, math, psychology and other disciplines to support good decision making.

Engineering Technicians Technologists, engineering technicians and engineering aides, perform many of the traditional duties of this field, such as time studies, work methods, job analysis, equipment layout, and ergonomic solutions.

They might create a job description and a video reference library for each job; redesign work areas or reorganize work groups for better efficiency between the people working together; or organize incoming materials to help someone keep working with them and keep things progressing. The work done in these positions includes data-gathering, number-crunching, organizing and other support functions.

INDUSTRIAL ENGINEERS TALK ABOUT THEIR VARIED CAREERS

I'm a Plant Manager "I am responsible for the safe, cost-effective, people-focused, and quality-based work we do in the Production, Sanitation, Maintenance, and Quality departments every day.

I read the book *Cheaper by the Dozen* in sixth grade, and that probably got me thinking about how we use time, at least subconsciously. I was good at math and science in school, and not that mechanically inclined, so IE seemed like the best match. My first job was as an industrial engineer for a small, family-owned toy company in Arkansas.

The most obvious place to find work is in any company that is looking for a person with an industrial engineering degree – and there are many out there. It is perhaps more important, however, to identify those aspects of IE that you enjoy the most, and in turn try to find a job that matches your preferences. Personally, I learned this by experience, as my first three jobs introduced me to a wide variety of possible work situations for someone with an IE degree.

Today, the term 'systems improvement specialist' is synonymous with IE from my perspective. IEs are responsible for systems improvement more than anything else, and in my opinion, they possess the most comprehensive set of skills for making improvements of this nature. If a company is looking to improve its processes, be they big or small, then they need an IE.

I got my MBA in 1990, and I have spent the 10 years since then working on people skills, process improvement skills, personal computer skills and business understanding.

I would say that my time is spent in four main ways – projects, relationship building, analysis, and planning. I also spend way too much time in meetings, as we have yet to discover how to use this time more wisely."

I Am a Managing Principal "I am co-owner of a consulting company that specializes in planning airports. We have an excellent reputation for using computer simulation analysis to improve airspace, airfields, passenger processing, baggage processing and roadways at airports. My responsibilities are twofold: I participate in running all aspects of this small (25 person) business, as well as serving as principal in charge of various airport projects. I specialize in projects that look at the airport terminal, baggage systems and roadway systems.

I became interested in industrial engineering while working as a secretary at an engineering consulting firm. I had switched majors three times and subsequently dropped out of college until I could figure out what I wanted to be when I grew up. As soon as I learned about the IE career I knew it was for me. I like looking at different processes as part of a system. I went back to school at night taking math courses, to make sure I had the aptitude for IE. Then I quit my job and went back to school full time. I have loved it ever since.

My first job out of school was for Sky Chefs. IEs got involved in estimating labor requirements for both flight kitchens (where they assemble airline meals) and airport restaurants. I also pioneered the IE role at Sky Chefs in helping design flight kitchens and airport restaurants using simulation.

Next I went to work for Texas Instruments as a quality engineer working on the first Star Wars missile defense program. Then I worked for Jostens as Engineering Manager for one of their class ring manufacturing plants. Finally, I joined American Airlines' Operations Research Department working as an analyst. Subsequently our department was spun off into a separate subsidiary, ending up ultimately as part of Sabre. Twelve years later, my partners and I purchased our consulting practice from Sabre to start our own firm. We have been in business for four years."

I Am an Operations Research Team Director in Telecommunications

"I am the Director of the QWest Modeling and Optimization Team. We use field research, mathematical and engineering calculations, and computer science to build business case models and improve business processes, and to decrease engineering liabilities. From our studies and modeling, we write reports, build desktop tools, and develop algorithmic engines for computer software (these are procedures for solving certain types of problems). We often do presentations for people who are vice presidents or above in operations or management within the company.

In college, I was interested in mathematics, and began studying engineering as I felt that it pays better than being a mathematician. Industrial engineering interested me, because it uses math more than other engineering fields, and is more generalized. Work in operations research practically requires a graduate school education. Some of the best opportunities in this specialty are with airlines and telecommunications companies, and the latter have the most operations research jobs.

A PhD plus additional graduate study is needed in operations research such as we do. On my team, one person has a master's degree; all the rest have their PhD. The 'technician' type positions we have are called 'staff engineers.' In a telephone company, 'technicians' are the people running the outside plant, installing, repairing, etc."

I Am an Editorial Assistant "I'm a writer for the Institute of Industrial Engineers *Solutions* magazine. In the most basic sense, I produce articles for the magazine. This means that I research a topic, interview the people involved, obtain photographs whenever possible, and write a story. My other duties include maintaining and producing an events calendar of items related to industrial engineering, putting together buyer's guides of products and vendors for our readers, and reporting news about promotions and appointments of industrial engineering professionals.

I was attracted to industrial engineering because of the broad nature of the discipline. At the time, I knew that I wanted to be an engineer but I did not know which type of engineering appealed to me most. I chose IE because it's such an excellent background for any profession I would like to pursue in the future, particularly other engineering fields. With an undergraduate degree in industrial engineering, I could get a specialized advanced degree in another field without encountering any problems. The systems perspective aspect of industrial engineering interested me the most.

I first learned about IE in college at Georgia Tech. As soon as I heard about the major from a fellow student, I did some research to find out more information. I visited the academic advising office within the school and investigated some items online, as well as reviewing the materials the school provided me.

Once I started looking for a job in engineering, I researched the companies that typically hired engineers, including their markets, history, and business practices. I used the career services department as well as my own network of contacts and my membership in multiple professional organizations and honor societies to make the connections, submit resumes, and apply for interviews.

If you like to work on a variety of projects with other people that require several different skills to solve, you would like this occupation. There is plenty of room for creativity and technical knowledge. Good communication skills are imperative for almost every occupation. As a reporter, you get to talk to many

interesting people, often high-ranking business leaders or government officials. With editing, you read tremendous amounts of articles on a wide variety of subjects, and the material is typically cutting edge and even in highly innovative areas.

It is very much a deadline-oriented business. There are many aspects of reporting that are outside your control. Editing can get tedious for people who are not detail oriented. And there's always writers' block, when your energy level or inspiration is lacking.

Let's just say that if you want to be rich, journalism may not be the career for you. Starting salaries for journalists, especially those without any experience, are low. I would estimate in the low $20,000s.

There are thousands of Web sites and books requiring writers, journalists, and editors. My recommendation would be to read as much as you can in the style you want to write (fiction, news, features, etc.)."

I Work in the Airlines Industry "My current job title is Senior Analyst at American Airlines. As you might expect, a lot of engineering work revolves around data collection, analysis, and reporting. On a daily basis, I use spreadsheets, word processing, and presentation software. I currently produce reports for a variety of departments within the airline.

I got interested in industrial engineering by picking my major out of a friend's college catalog in my senior year of high school! I had an older brother who was majoring in chemical engineering, but I liked the IE combination of engineering and business. I thought it was a very practical field of study – a good mix of technical and business training that could transfer to almost any industry.

I started out of college as a facilities engineer in the Western Electric (now AT&T) telephone plant in Shreveport, Louisiana. I was responsible for the design and layout of the telephone ringer assembly line. Of course, those brass bells that you may remember in those old heavy telephone sets are now a small digital chip – so, seeing that my job was already becoming obsolete, I realized I better return to graduate school and a master's degree.

My next job was consulting for Arthur Young, where I used computer simulation for analysis of manufacturing designs. This was way back in 1984 when simulation was just beginning to be more commonly used for this application. At the time, we used software that had been developed by a British company for car assembly in the UK. Some of my projects included simulation of a bread factory and a tank factory. I also alternated projects with traditional industrial engineering work such as time studies and methods analysis and improvement. A couple of projects included a Navy overhaul facility, a county court system, and a door manufacturer.

After six years with Arthur Young, I moved to the airline industry. My simulation work continued with projects that analyzed baggage systems and airport facilities, such as ticket lobbies and Federal Inspection Services (Immigration and Naturalization Service, Customs, USDA). I then moved into a specialized area of simulation – airspace analysis. With software developed by the FAA, we analyzed designs of airports using aircraft movements from the gate to the runways and takeoffs and landings. A project highlight here was analysis of different landing patterns proposed for the Sydney International Airport. While Down Under, we got to plan the takeoff of the Concorde supersonic passenger plane!

You have to like math – and a lot of it! Your entire undergraduate degree will be concentrated on math related courses – physics, chemistry, materials science, electronics, manufacturing methods, and statistics! My 'fun' elective courses were in economics and accounting, but also speech and racquetball. And shop! I missed out on this in high school, but took it in college as 'Manufacturing Processes' – one of my favorites!

Most IE work is going to be project work – define a goal, gather your data, analyze, prepare your report and present your findings. Whether you're a people person or a numbers cruncher, you'll be able to fit in almost anywhere with an IE degree.

Probably the most attractive feature of an IE degree is its flexibility – you can apply it to almost any industry. The business aspect of it can also put you onto a management track if you are

interested in pursuing that. You are not going to get rich being an IE – unless you invent something on the side! But you will definitely have a higher-than-average paying job and skills that should allow you to readily move into a variety of fields."

I Am a Human Factors Manager for UPS "I'm an Industrial Engineering Human Factors Manager. I utilize human factors principles to design equipment, facilities, methods, and procedures in UPS operations to optimize efficiency, comfort, quality, and safety. I also coordinate and conduct research in new technology and develop and facilitate training programs.

I could go on and on about how much I enjoy being an industrial engineer. I was always interested in engineering because of my love for math and science. I decided as a high school sophomore that I wanted to be an industrial engineer because they were efficiency experts who focused more on the business aspects of engineering."

I Am a City Performance Auditor "I have this unusual title because government organizations aren't quite sure what to call industrial engineers. My work program's statement of purpose states that I am to be a 'resource to city departments to insure that quality and efficient services are provided to our citizens.' In practice that means that I apply industrial engineering techniques to evaluate current and proposed city programs and services in terms of effectiveness. How well did we do what we said we were going to do? Efficiency – what's the fewest number of people and the least amount of materials and equipment to do the quality of job expected by citizens? Cost – What's the smallest amount of peoples' hard earned tax dollars required to do the job?

Rather than having a routine set of things that I do every day, I work on a variety of projects throughout the city's operations. For a while I may be working with the Police Department to determine the staffing needs for all the support functions in a planned new district station. Next, I might be working with Public Works to improve how we build city streets, from the design stage

to the crews in the field. I also do a lot of cost analysis, such as determining our cost to perform various services for which we charge fees, such as land development and building plan reviews, issuance of building permits and follow-up inspections, even burials in the city owned cemetery! We want to make sure that we are fully recovering our costs, without overcharging the user.

I was interested in math and science in high school, and I had a teacher who encouraged me to go into engineering. I grew up in a rural area and had never met an engineer or had any real idea of what they did. But I applied for and received an engineering scholarship at my state university, which supplied the financial means for me to go to college, so I thought engineering would be a good place to start. I was also encouraged by what I found out about engineering salaries, which compared to my background were very attractive.

After I started college and my engineering course work I was drawn to industrial engineering because I found that I was more interested in the big picture of things, how systems work, and the people involved, rather than the physical design.

My first jobs after graduation were with several manufacturing firms. After a while that environment seemed too confining, and I had enough of the employment ups and downs that plagued manufacturing at the time. I was then fortunate enough to be hired by the government in this medium-size city."

I Am a Master Planner for the US Department of Defense

"My job title since I was promoted to a position with the Department of the Navy is Industrial Engineering Technician. Previously, I had been a Master Planner with the Department of the Army, but classified as a Civil Engineering Technician. I have been unable to convince anyone in Human Resources to change my title to Master Planner, which would truly reflect my job description.

I have a bachelor's degree and am one of about 7,000 Certified Planners currently working in this country. However, since my undergraduate degree is not in engineering, I'm not eligible for promotion to a higher position. This kind of problem is

common in civil service or government work, and in some large corporations.

My work is different every day. It's similar to city planning, plus county planning, plus duties unique to military communities and many other duties as assigned. I'm responsible for the master plans of several military installations (Army posts, Naval stations). This is similar to the Comprehensive Plan of a city or county and guides the future physical development. The largest community I have worked on has been an Army post of 40,000 people, the largest area about 350,000 acres, and the newest, a new Naval station in Washington State. In addition, I've managed up to 40 major (over $1,000,000) construction projects at the same time.

Work on a single project may extend about five to 10 years, beginning with planning and estimating the construction. I then develop a proposal which goes through channels for an act of Congress to approve funding for each. I then manage and coordinate design and construction and finally, occupation and utilization.

In existing facilities, I perform many of the functions that IEs do in manufacturing or other positions, planning and managing facility utilization. My job during Desert Storm was to help provide accommodations and facilities for the troops as they assembled from active duty, reserve and National Guard call-ups and moved in their units (groups of hundreds or thousands of men and women) from place to place to arrive when and where they were needed.

In creating a plan, I have to know everything about the community, the people, their jobs, their home, school and recreation needs, and the operation and interactions of all military, civilian and commercial organizations. I have to interact with everyone – generals, admirals, senators, school administrators, public works employees, recreation center directors, mayors (one for each housing area), local city and county planners and councils, Indian tribes, you name it.

Although it's a huge job and there is stress and responsibility, it's really fascinating. When the new Naval station needed cable TV and Internet connections for family housing, military

operations and the troops on the aircraft carrier USS Abraham Lincoln, I was assigned to get it installed and up and working. It was a year-long project involving all the possibilities – build it from scratch, franchise a cable company, contract it out, try new technologies, etc. And as a military installation, we were in effect a city, having authority to franchise and charge a cable company for the privilege of doing the installation if we chose to. In the end, I convinced two companies to provide different pieces of the service, and wrote and negotiated the contracts myself.

When the Secretary of Defense was coming to our Army installation, I stood in for him in a dress rehearsal and tried out the HMMV (the vehicle sometimes called a 'hummer') with all the latest weapons and technology on board. When aerial photos of the Navy base were needed, I arranged the use of an Army Reserve helicopter and borrowed two professional cameras. You never know what a planner – or an Industrial Engineering Technician – will be called on to do next!"

PERSONAL QUALIFICATIONS

IN A POLL CONDUCTED BY THE INSTITUTE OF INDUSTRIAL ENGINEERS (IIE), THE main personal attribute that respondents felt was important for these professionals was excellent communications skills. This was followed by reasoning and logic. Professionals felt that communications and integrity are critical in dealing with diverse people in every department, and in keeping trust and good working relationships with them all. Your interest in making things function better is what will make this career rewarding for you.

The traits that you'll put to use in this work are organization, determination and dedication. You like systems and you see a similarity between different production systems. You may even see everything as a production system. You should have a good systems thinking approach, as well as quantitative thinking.

You're curious about how things are made and what makes things happen. You have an aptitude for analysis, and a strong desire to solve problems, as well as problem solving skills. In your work, chances are that you won't use a lot of higher mathematics, but your education in it trains your brain to think through problems and consider all the parts, analytically and logically.

Another response to the IIE poll credited "unrestricted logic." This relates to creativity – you need to be able to see all the possibilities, not just the ideas that fit the conventional solution or current industry standards and practices.

You're detail oriented and pay attention to details. You should have an aptitude for math and science, be good at selling your ideas, and be good with people. IEs are called "people engineers" because they study how people interact with production systems. You'll need to work with people and listen to them, draw out their ideas and their concerns, encourage and motivate them to try doing things differently. It will be very helpful if you value teamwork and can understand different departments' needs.

Industrial engineers also do a lot of work with upper management to sell the whole solution. Excellent written and oral communication skills are needed. You must be able to sell your ideas and proposals, combining confidence with the facts. Good management skills are also among the best qualifications you can have. Always be willing to learn. Be open to new concepts and fresh ideas.

Being able to see the big picture, and look at systems, methods and practices as a whole rather than as individual activities, will help you to integrate quality improvement and increased productivity throughout. Fixing a problem somewhere can just cause a logjam down the line, just as changing something at your point in a river can affect everyone downstream. Comprehensive thinking is a major part of anything creative, and the purpose of industrial engineering is to apply your creativity to overall improvement.

You should be comfortable with working on a variety of things, rather than a daily routine. Then too, industrial engineering is something like inventing, in that it helps some to be a bit easy going and open minded. That's because you're generally trying to find imaginative ways to get things done easier and cheaper. Let the other kinds of engineers get carried away with grand ideas, bells and whistles!

ATTRACTIVE FEATURES

YOU CAN DO THIS WORK IN ALMOST ANY FIELD, IN ALMOST ANY CITY OR COUNTRY. You are well paid. Because you're involved in making things work better, people generally respond positively to you. If you enjoy being versatile, your job will be interesting and fun for you.

The opportunities are growing in industries other than manufacturing, such as information technology, computer applications and Internet business models. There will be more need in the future for health and safety engineers with increased environmental awareness.

You get to work on a variety of challenging problems, typically in a team environment. You have the satisfaction of knowing that you're making a difference in the workers' quality of life, as well as in the financial well-being of a company.

The industrial engineering discipline prepares you for professional positions of all kinds, including CEO, administrator, lawyer, or any number of upper-level, management and executive stations in companies.

UNATTRACTIVE FEATURES

THE FIELD IS NOT WELL UNDERSTOOD BY THE GENERAL PUBLIC. FOR EXAMPLE, the heroine in Michael Crichton's novel *Air Frame* was doing a typical industrial engineer's job but the author describes her as an "MBA." You might just get frustrated if you want people to understand just what it is you do. Says one IE, "If they have any clue at all, they usually assume that you're 'the guy with the stop watch.' " This can be a problem when you're trying to move into a new job or another type of position.

Some sources indicate that there may be fewer employment opportunities in the future than in other fields due to automation. This is offset, however, by new possibilities opened in the applications of automation, such as computer-aided design, computerized machinery and robotics. The ups and downs of the economy can also directly affect these positions.

There's a potential for emotional stress due to the responsibilities. Industrial engineers' recommendations are used by management for major decisions, affecting profits and costs, labor relations, and employment – affecting the success of the company in critical ways. The work must be accurate and timely. There are everyday pressures in making things happen within an organization.

You may find yourself in the middle between the front line workers and management. The managers may be out of touch with what's actually going on out there, and not take seroiusly the issues you bring up, or their magnitude. You may be asked to sell something to the front lines that you're skeptical about yourself.

It can be a very technical field for some people and a lot of businesses that use IEs don't allow room for creative talents. It takes a lot of motivation and confidence to challenge the system, even when that is what needs to be done to reach the optimal solution. Some companies restrict engineers to certain areas, which can be frustrating because of limitations imposed and the tendency of most systems to have interrelated parts.

The job often requires presence in work areas which may be noisy, hazardous, or dirty. Overtime is expected of industrial engineers when it's deemed necessary. The work can also be very detailed and tedious, especially entry-level work measurement, such as time studies.

Industrial engineering involves skills that are not really taught in school. They are picked up on the job, because each job is somewhat unique and none exactly fits a general "industrial engineering" job description.

EDUCATION AND TRAINING

A BACHELOR OF SCIENCE DEGREE IN INDUSTRIAL ENGINEERING (BS IE) OR IE Technology from an accredited program is considered a basic requirement for employment as an industrial engineer. Many jobs also require at least two years of experience. However, some employers will still consider applicants without this kind of background.

Jobs in analytical areas, operations research, simulation, human factors (ergonomics) and college teaching positions often require a graduate master's level degree – Master of Industrial Engineering or Systems Analysis, or a Master of Business Administration (MBA), for example, or even a PhD. For government work, a master's in Public Administration is appropriate.

Generally, government employment or work that "affects the public welfare" requires state registration. Registration requires passing an Engineer-In-Training (EIT) exam and two years experience with a BS IE degree, or with six years experience without a bachelor's degree, plus passing the professional industrial engineering exam. Even in careers where registration isn't required, it can give you more credibility for a job or advancement.

Education for Technicians

Between the professional engineer and the craftsperson or tradesperson are those individuals known as subprofessionals or paraprofessionals, who apply scientific and engineering skills to technical problems. These include engineering aides, technicians, inspectors, draftsmen, and others.

A career as an industrial engineering technician generally requires an Associate Degree in Engineering. There are jobs requiring no more than a Certificate of Proficiency in Design Drafting from an accredited technical school or community college, or even a high school education, but the pay is lower and the potential for career advancement limited.

Passing the EIT is a boost at this point, and can, with experience, lead to full registration as an Industrial Engineer even without a bachelor's degree. An associate degree usually takes two years to complete, and a bachelor's degree four to five years.

Courses that are important to take include mathematics and physical, social and computer sciences, starting in high school with advanced classes. Your interests can lead you into other classes, such

as electronics, shop, auto mechanics, business, and computer classes. Drafting and drawing are good technical communications skills to have. If you want to work outside of manufacturing especially, or hope to reach management positions, it will help to have a background in financial subjects, such as accounting and financial management.

Communications skills are said to be critically important, as you'll need to work closely with employees, whether in the shops, administration, or the front office; with outside people such as equipment and material suppliers or transporters; and with your company's customers.

A very important skill that is sadly overlooked in the education of many engineers is the ability to write well. Learning how to write – not merely to structure a sentence correctly, but to express yourself clearly and forcefully in writing – is absolutely necessary for success in industrial engineering.

EARNINGS POTENTIAL

STARTING SALARIES WITH AN UNDERGRADUATE BACHELOR OF SCIENCE IN Industrial Engineering average around $50,000 per year. The average is about $60,000 with a master's degree, and almost $65,000 for PhD graduates. Experience, even in school work-study, cooperative or internship programs, can make a difference in your starting salary.

Your degree just gets you started. Your future earnings depend on how much you put into improving yourself over time. Keeping a portfolio or résumé of your results on the job also greatly improves your value in the eyes of employers in the future.

The potential for progression, or advancement, is also very good. Overall, industrial engineers average around $70,000 a year. Those with health engineer or safety Engineer job titles earn less – $60,000 on average.

Senior industrial engineers with 10 years of experience, administrators, department heads and plant managers make $75,000 to $100,000 and more.

Technicians earn lower salaries than engineers, more like $25,000, up to $40,000 with several years experience. Salaries vary as wildly as the different job titles, job descriptions and actual work of the many positions open in the field of industrial engineering.

OPPORTUNITIES

THE OPPORTUNITIES IN INDUSTRIAL ENGINEERING ARE PRACTICALLY UNLIMITED. IT'S a growing field, offering flexibility to work in many different surroundings. If you want travel, try consulting. If you're a homebody, a local manufacturing or health facility will probably be your best initial bet. The breadth of the IE college curriculum helps IEs find more opportunities than other engineering graduates. Even in a slow economy, companies know that they need IEs to help control costs and increase productivity.

A field that's grown over the past several years is the implementation of high performance work systems. The ideas of these programs are to share information between management and workers; develop everyone's knowledge; give workers a say in decision making and work processes; link rewards to performance; and equalize everyone's role. This is an example of the systems approach that is the industrial engineer's role.

There are jobs to be found through less traditional paths today, such as writing, publications and media, and auditing. No longer just financial, auditing now includes factors like "performance auditing" and "internal consulting." Government agencies are good examples of this. Even Congress has the General Accounting Office, which can investigate and analyze just about any subject. The Base Closure Commission was established without even Congress to answer to, so that they could review every aspect of maintaining or closing military installations – exactly what both auditors and industrial engineers do.

Consider these examples and get a better idea of how broad this field is and where it can lead you. All of these people were trained as industrial engineers:

Rich Barton, CEO of Expedia

Pete Coors, Chairman and CEO of Coors Brewing Co.

Nancy Currie, astronaut

John Dasburg, Chairman, President, and CEO of Burger King Corp.

Mike Eskew, CEO of UPS

Timothy Fields, Jr., Assistant Administrator of the US Environmental Protection Agency

A. Ernest Fitzgerald, Management Systems Deputy of the Office of the Assistant Secretary of the Air Force

Carlos Roberto Flores, President of Honduras

Joe Forehand, CEO of Accenture

Jack Guynn, President of the Federal Reserve Bank of Atlanta

Gordon Harton, President of Lee Jeans Co.

Homer Hickam, best-selling author (*Rocket Boys, October Sky*) and former astronaut

Chad Holliday, CEO of DuPont

C. Robert Kidder, CEO of Borden Inc.

Dick Kovacevich, CEO of Wells Fargo

Michael Massimino, astronaut

Jim McCaslin, President of Harley-Davidson

Deborah Nash Willingham, Vice President of Microsoft Corp.

Jorge F. Quiroga Ramirez, President of Bolivia

Tom Usher, CEO of U.S. Steel

Rex Walheim, astronaut

Jong-Yong Yun, President and CEO of Samsung Electronics

GETTING STARTED

START RESEARCHING THE PROFESSION YOU'RE INTERESTED IN. LEARN ABOUT ALL OF the engineering disciplines if you're interested in engineering in general, to begin with. The Internet is a great resource for information of all kinds. Use it to learn about different industries, and to search for jobs. Go to your school or public library career center and look into the resources they have for you.

You can prepare by taking advanced high school physical sciences and math courses. Take algebra, trigonometry, physics and chemistry, as well as calculus in your senior year. You'll find that business subjects such as accounting, statistics and economics can help you in your career. Work on communications with English, writing and speech classes.

Join a club, such as your school's math or science club. At many schools, there are competitions in engineering design, such as solar powered cars. It's a way to have fun while you find out whether engineering is right for you.

Try to get a summer internship to see what it's like doing this work in a place that interests you. Search out cooperative programs that your school has with corporations.

Develop a personal mission statement; define your personal goals in life.

Write a good résumé with a keyword section. List keywords in this section that employers' automated systems will pick up on, so that your résumé gets chosen for reading by a real, live person.

Attend local chapter meetings of the Institute of Industrial Engineers. Check their Web site at www.iienet.org for the location of the nearest chapter. Become a member of the IEE, and join the local chapter. Consider joining the Institute for Operations Research, as well. You'll not only become familiar with what people are doing in various industrial engineering roles, but you can make valuable contacts through these associations for future networking.

Talk to people in the industry about their jobs, and the pros and cons of their careers. Tell people you're interested so that they can help you find information and network. Now as much as ever, it never hurts to know someone inside the company you want to work for.

All industries have trade magazines. These are periodicals that are read by professionals in a particular industry, in contrast to consumer magazines, which are for the general public. Reading these will help you learn about those industries and how industrial engineers work in them, and what the trends are in both the industry and the employment opportunities.

Industrial engineering is a fascinating, rewarding career field. Start exploring now!

ASSOCIATIONS

- **Institute of Industrial Engineers**
  The IE professional association
  www.iienet.org
- **Future Scientists & Engineers of America**
  After school technology clubs in K-12 schools
  www.fsea.org
- **Society of Manufacturing Engineers**
  Student Summit Contact:
  Kathy Carter, Education Department
  email: cartkat@sme.org
  www.sme.org
- **American Association of Engineering Societies**
  www.aaes.org
- **Institute for Operations Research**
  Communication with professionals, conferences, and journals
  www.informs.org/
- **American Society of Safety Engineers**
  www.asse.org
- **Society of Automotive Engineers**
  "The Engineering Society For Advancing Mobility in Land, Sea, Air and Space"
  http://www.sae.org/servlets/index

PERIODICALS

- ***IIE Solutions Magazine***
  What Industrial Engineers do, and the kinds of jobs available
  www.solutions.iienet.org/magazine/

- ***Interfaces***
  For managers and professionals and the academic community in Operations Research and Management Sciences.
  silmaril.smeal.psu.edu/interfaces/

WEBSITES

- **Institute of Industrial Engineers**
  Information, networking, and job help
  www.iienet.org

- **IIE Career Center**
  www.iienet.org/CareerCenter/

- **INFORMS**
  Student Union for students and grads in Operations Research and Management Sciences
  Resources include free tutoring.
  www.isr.umd.edu/~jwh2/iol/

- **Malcolm Baldrige National Quality Award**
  Who's got a passion for excellence and a commitment to people?
  www.quality.nist.gov

- **The Gilbreth Network**
  An extensive book list and a newsletter, as well as more about Frank and Lillian Gilbreth
  gilbrethnetwork.tripod.com/front.html