INTRODUCTION TO CIVIL ENGINEERING

INTRODUCTION

Civil engineering affects many of our daily activities: the buildings we live in and work in, the transportation facilities we use, the water we drink, and the drainage and sewage systems that are necessary to our health and well-being. Civil engineers:

• Measure and map the earth's surface.

• Design and supervise the construction of bridges, tunnels, large buildings, dams, and coastal structures.

• Plan, layout, construct, and maintain railroads, highways, and airports.

• Devise systems for the control and efficient flow of traffic.

• Plan and build river navigation and flood control projects.

• Provide plants and systems for water supply and sewage and refuse disposal.

To build may be a primal urge. Our constructions, while they may be simply for shelter or transportation, often include aesthetic touches that are there to make us feel good about what we have built. Thus, bridges have geometrical designs intended to support weight, but they also have an artistic detailing and a "look" that defines the era in which they were built. In constructing buildings, highways, and bridges, civil engineers work with architects to develop the appearance of the structure. Ugly buildings represent a failed communication between the two professionals; a building that falls down, or cannot be maintained, also represents a failure, but one that the civil engineer could possibly have prevented.

Civil engineering is much more than erecting skyscrapers or bridges. Civil engineers are trained in the interactions among structures, the earth, and water, with applications ranging from highways to dams and water reservoirs. Deeply involved with specifying appropriate construction materials, many civil engineers and others are also employed by the manufacturers of those materials. Since constructing a large building or public-works project can involve elaborate planning, civil engineers can be outstanding project managers. They sometimes oversee thousands of workers and develop advanced computerization and planning policies.

Most significantly, many civil engineers are involved with preserving, protecting, or restoring the environment. Most water treatment and water purification projects are designed and constructed by civil engineers (in these two areas, many of them are known as environmental engineers). A growing number of civil engineers are involved in billion-dollar projects to clean up toxic industrial or municipal wastes at abandoned dump sites. Civil engineers engage in such diverse projects as preserving wetlands or beaches, maintaining national forest parks, and restoring the land around mines, oil wells, or factories.

There are about 186,000 civil engineers at work today, according to federal data. This total is expected to rise by approximately 17 percent - slightly above the average for all professions – by the year 2000.

HISTORY

Construction is one of humanity's earliest organized activities. Therefore, it is no accident that civil engineering was one of the very first to be formally organized (in the early 1700s in France).

In the United States, the American Society of Civil Engineers was organized in 1852 - the first national engineering society in the country.

In the mid-1800s, and through to this day, one of the central tasks of civil engineers was the design of roads and bridges. The history of American technology can be traced in the bridges around the country, with wood being replaced by iron and steel. Those beams or girders were then replaced by steel cables in such landmark structures as the Brooklyn Bridge (completed in 1883). In this century, new forms of concrete and steel-reinforced concrete are the most common bridge-building material. The advent of the automobile set off an avalanche of highway construction, culminating in the legislation that set up a national highway trust fund in the 1950s.

Over the past forty years, thousands of miles of interstate highways have been built, redefining the landscape of America and its cities. The key theme in the civil engineering Canon of Ethics is the "protection of the welfare and safety of the public". Indeed, the "civil" in civil engineering refers to the discipline's involvement in public works, including government buildings, military bases, water treatment works, mass transit systems, airports, shipping ports, and parks. Because of this involvement, many civil engineers find themselves employees of, or suppliers for, local government. This relationship, combined with the requirements for public safety, translates into a high degree of professionalism. Civil engineers with professional engineer (P.E.) licenses are fairly common, and if a civil engineer expects to perform work on public facilities, getting the P.E. license should be a priority.

A key word that arose in the 1980s and will remain important for civil engineers for many years to come is "infrastructure". This term refers to the facilities that local, state, and federal governments provide in order for private industry to expand , or for improving the services for private citizens.

THE CURRENT SCENE

Construction is a key part of the overall American economy. Data from the U.S. Department of Commerce show that more than $400 billion is spent each year on new construction, and about another $100 billion is spent on repair and maintenance of existing structures. To this half-trillion-dollar total can be added the $50 billion or so that is paid for construction materials.

Many civil engineers specialize in the development and production of new construction materials. Infrastructure demands will be a big element of civil engineering for the next several years. Federal, state, and city budgets for construction suffered in the early 1980s, but as the economy grew in later years and tax dollars became available, the pace of construction activity increased. In a recent New York Times article entitled "Cashing in on a Construction Boom", one construction executive was quoted as saying that his company's "biggest concern is whether they can find enough engineers to handle all the work they should be getting."

Civil engineering also comes to the fore when social changes foster new development. In the 1950s and 1960s, much business growth was created by the construction of the interstate highway system. In the 1970s, the prominence of the Sunbelt became apparent, northern states began losing population, while southern and western states gained dramatically. Such population swings require new construction for roads, schools, water systems, and housing.

Overall, however, the civil engineering field in the United States is not as dynamic as it was two or three decades ago when the interstate highways were being constructed, when new communities were popping up all over the land, and when public funds were more available. The United States economy was also growing at a faster rate during the 1950s and 1960s, resulting in a higher demand for new factories. Today, the reduced demand for civil engineers can be seen in the slightly lower salaries that civil engineers earn coming out of school. Most salary surveys indicate that B.S.C.E.s get 10-20 percent less than other engineering majors. It is still, however, a very healthy salary.

This is not to say that one cannot have a very successful career in civil engineering. Perhaps more than in most engineering professions, civil engineers work as partners in privately held firms. These firms are set up the same way a law firm is, with several senior partners sharing the profits and junior partners and associates earning salaries until they move up to senior status. The business is what you can make of it. At the same time, saying that there is less growth in the American economy is not the same as saying there is no growth. New factories are being built, new skyscrapers and bridges are going up across the land, and more environmental work is being scheduled.

JOB TITLES

Over the past couple of decades, the broad field of civil engineering has been specialized in a number of areas. Civil engineers with one type of experience are able to shift to another area, but the real career growth occurs as one becomes an expert in one of these specialties:

1) Structural engineer: This is the classic civil engineer, concerned with designing walls, towers, bridge spans, dams, or foundations. A knowledge of construction materials and methods is combined with analytical techniques that determine how much weight or mass a structure is carrying, what forces it must withstand (such as wind or water) and, in cases where an architect is involved, how best to accomplish the architect's vision.

2) Construction engineer: This engineer works at the construction site, transforming blueprints and drawings into concrete and steel reality. Besides understanding the principles by which a structure was designed, the construction engineer must manage the actual work. This can involve elaborate scheduling and planning so that materials and workers are brought to the site to complete their purpose in the proper order. Time pressures and an awareness of the financial elements of a project are constant objectives. Because the work is done outdoors, sometimes in very remote areas, one must be prepared for a life-style of "camping out" in temporary quarters for long stretches of time.

3) Surveying and mapping engineer: Even before a design is completed, and as construction progresses, teams of surveying and mapping engineers are at work. They use electronic instruments and even satellites (which provide detailed overhead views) to measure the dimensions of the project. Some construction projects can cover dozens of square miles of territory. Elevations must be determined, calculations made regarding how much earth needs to be moved, and the exact location of structure(s) must be determined.

4) Transportation engineer: Do you prefer to travel by plane, train, auto, or bus? Transportation engineering has provided the wealth of travelling options we enjoy today. Highway design is constantly being improved by making roads safer, and, in urban areas, making plans for handling increased traffic. Transportation engineers also oversee the design and construction of mass transit systems, such as subways, which require tunnelling, railway construction, and research on commuting plans. A subspecialty within transportation engineering is the pipeline engineer, who determines the movement of water, oil, or gas through pipelines. In certain aspects, this field is comparable to highway design, with the distinction that a liquid is being conveyed, rather than vehicles.

5) Environmental (sanitary) engineer: These engineers specialize in water and wastewater projects, land remediation, aqueducts, and solid waste disposal. This field is currently one of the fastest growing of all engineering specialties. Billions of dollars are being allocated for water and wastewater treatment, for methods of processing solid wastes, and for cleaning up hazardous waste dumping sites.

6) Hydraulic and irrigation engineer: Utility companies, factories, farms, and river barges depend on a steady source of water. These engineers perform the planning, design, construction, and maintenance to keep supplies available. Dam design and construction, flood control, and the design and construction of reservoirs, wells, and aqueducts are all common projects. It used to be that hydraulic engineers were concerned with draining swamps and straightening waterways. These days, they are as likely to be constructing swamps and estuaries to preserve the environment and provide reserves for fish and wildlife.

7) Geotechnical engineer: Along with geological engineers, these engineers help determine the underlying rock strata and soil conditions that affect roadways, water reservoirs, bridges, and other large structures. Earthquake planning and preparation also fall into this category.

EDUCATION

In addition to the core courses that nearly all engineering students attend, civil engineers choose from an extensive list of civil engineering classes. Some students make selections based on the specialty they desire to follow, others, not having any specialty in mind, try to fit in as many of the civil engineering courses as possible. The list of civil engineering topics includes:

- **Surveying**
- **Design graphics**
- **Hydrology and hydraulics**
- **Geology and soil mechanics**
- **Structural analysis**
- **Environmental engineering**
- **Transportation engineering**
- **Construction materials**
- **Concrete and steel structural design**

About one third of the students earning a B.S. degree go on to take a Master's, in which specialization in one of the civil engineering programs is intensified. In addition, a proportionately higher number of civil engineering students take the time to qualify for a professional engineer's (P.E.) license by passing an initial test to become an engineering intern (EI). The P.E. license is often a requirement for becoming involved in public works or for buildings, so many civil engineers need the license in order to practice.

CAREER OPTIONS

Civil Engineers have a wide range of career options from which to choose. Civil engineers work with construction companies, manufacturing companies, power companies, and with consulting engineering firms. Many opportunities for civil engineering employment exist in city, county, state, and federal government agencies.

SALARIES AND THE INTANGIBLE REWARDS

Here's the good news initially, engineering graduates earn the highest pay of any college graduates. Over the long term, however, salaries tend to level off, but are still very high relative to all professionals—but not the highest. An attractive aspect of a career in civil engineering is that employment can be found in or tailored to any setting, whether "at a desk", "in the field", or any combination of the two.