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Future Forward: Skills, Talent Management, and Civil Engineering Growth in the 21st Century

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Understanding Civil Engineering Careers in Today's Changing Job Market

The US infrastructure is becoming functionally obsolete. According to the American Society of Civil Engineers (ASCE), the country must spend nearly \$4.5 trillion by 2025 to fix its roads, bridges, dams, and other infrastructure¹. The ASCE 2017 Infrastructure Report Card² notes that:

- More than 200,000 of the 614,387 bridges in the US are more than 50 years old and approaching the end of their design life.
- Many of the one million pipes in the water system are over 100 years old. Water main breaks result in the loss of two trillion gallons of treated water each year.
- Wastewater treatment plants will need an estimated \$271 billion of investment over the next 20 years to meet the demand of 56 million additional users. Most power lines in the US were built in the 1950s and 1960s and have a life expectancy of 50 years.
- The infrastructure that supports inland waterways is getting old and causing vessel delays.



Civil engineers will lead the charge in the assessment, rebuild, repair and upgrade of the country's decaying infrastructures and designing the civil structures of the future. Civil engineers will also rebuild water treatment plants and hazardous waste processing sites to support a cleaner earth.³

As the world becomes more environmentally conscious, today's civil engineers must also apply new sustainable approaches that respect the natural environment while controlling the depletion of natural resources. According to the ASCE, civil engineering in 2025 will include an added societal pressure to contribute to a sustainable world and improve the global quality of life. To this end, civil engineers play a bigger role in advocating and creating infrastructure-related public policy and communicating this vision to different audiences such as clients, investors, and the public.

The responsibilities of a civil engineer are diverse and challenging and play an important role in rebuilding our country's crumbling infrastructure.

What Does a Civil Engineer Do?

Civil engineers serve the industry and state/local government entities in the research, planning, design, construction management and maintenance of federal, public works and private infrastructure projects including roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, water and sewage systems, and waste disposal units. They work at smaller projects or larger assignments that include designing city layouts, sewage and water systems, and electrical grids.⁴

Depending on the assignment, the job responsibilities of the civil engineer may include:⁵

- Analysis of survey reports, maps, drawings, plans, aerial photography, and other topographical or geologic data to plan projects.
- Planning and design of systems and structures in accordance with construction and government standards and using design software and drawing tools.
- Transportation planning and traffic studies.
- Determining and managing schedules, budgets, and resources.
- Soil, materials, and geological testing to determine stable foundations.
- Schematic design development for a project or structure.
- Providing construction management and technical services.
- Utilizing technical software to model and develop designs.
- Proposing and presenting project work to clients and stakeholders.
- Determining and completing required project permitting.
- Managing teams that plan, design, and build projects.

Based on the project and industry, civil engineers may spend time both in the office and on the construction site. They may work in the office planning and designing projects and, then, in the field to conduct needs assessments and surveys and manage construction activities. Civil engineers typically collaborate project work with other teams or disciplines. They use sophisticated computer applications in all aspects of their work, to assist with, for planning, design, scheduling, cost estimating, quality control, and collaborating project information with internal and external stakeholders.

Educational Requirements

Typically, civil engineers in the US will need to have a bachelor's degree in civil engineering and may also benefit from obtaining a Professional Engineering (PE) license. Civil engineers in the US are licensed at the state level by professional licensing boards. Those wishing to pursue PE licensure need to meet a combination of requirements in education, experience, and must also pass a PE examination.⁶

A master's degree and work experience can advance a civil engineering career to management and leadership roles as well as specialized positions. The online Master of Civil Engineering (MCE) degree offered by Norwich University offers courses that teach advanced engineering principles and leadership best practices. Students choose from four concentrations that align with their civil engineering career goals:

- Construction management
- Geotechnical engineering
- Environmental/water resources engineering
- Structural engineering

The Norwich University MCE program also includes a capstone design project that requires students to anticipate the diverse impacts of a project before implementation. This provides graduates with firsthand experience in considering the social, economic, and environmental impacts of their projects.

Careers in Civil Engineering

Civil engineering includes a wide variety of specialized disciplines and career paths. Depending on the type and size of the organization where civil engineers work, they may find themselves headed toward either a growing management role or a more technical specialization. Different career paths allow civil engineers to concentrate in areas of greater interest and specific markets. The need for engineers with specialized skills has opened the market for civil engineers to explore a variety of careers as outlined below.

Structural Engineer

A structural engineer is involved with the planning, design, and development of structures such as bridges, dams, skyscrapers and buildings and plays a key role in the development of new infrastructures that can withstand the stresses of the environment while remaining safe and secure.⁷

From buildings and bridges to dams and pipelines, structural engineers are involved in all stages of a project's life cycle from preliminary design to final inspections. They often work with a team of engineers and architects and may serve as project managers, conducting regular meetings and site visits to ensure that a project is meeting environmental requirements, health and safety standards, and regulatory guidelines.

Structural engineers are highly trained professionals who have a deep knowledge of mathematics, science, and engineering mechanics, particularly when using different materials during the design and construction of new infrastructures. Certain states require a structural engineer's (SE's) license. The SE license is required for engineers who practice in states where structural engineers are licensed separately from other professional engineers.⁸

Structural engineers earn an average of about \$90,000 annually, according to the 2017 ASCE Salary Survey. The US Bureau of Labor Statistics (BLS) reports that demand for civil engineers, including structural engineers, is projected to grow by 11% from 2016 to 2026.

CareerBuilder.com outlines some of the skill requirements sought by companies when hiring civil engineers.

- Mathematics: to create and develop project designs.
- Physics: to understand and assess the mechanical properties associated with project designs.
- Project Management: to lead a project from initiation through closure.
- Finance: to apply the knowledge of cost analyses in keeping project materials and labor on budget.
- Communication: to effectively disseminate project information to project stakeholders.
- Leadership: to effectively create and ensure networks of people and relationships that ensure project completion in accordance with the organization's mission and vision.
- Attention to Detail: to focus on every minute detail of the entire construction of the building.
- Calmness Under Pressure: when approaching a tight deadline, the civil engineer needs to stay calm and focus on project completion.
- Organizational Skills: create a plan that co-workers can follow, and keep it on schedule.

Geotechnical Engineer

According to the ASCE, geotechnical engineers specialize in the science of soil and rock mechanics to investigate subsurface and geologic conditions. This work supports investigations to design and build foundations, earth structures, and pavement sub-grades. Many engineers in this field work on projects involving walls, tunnels, roadways, embankments, and building foundations. For example, in California which has significant seismic complication risks, a geotechnical engineer may report on seismic risks.

Taking specialized courses such as those offered by the Norwich University MCE program that explore earthquake engineering, soil mechanics, and soil stabilization can prepare future geotechnical engineers for the technical knowledge needed to analyze and design projects with complex geotechnical components.

Geotechnical engineers earn an average annual wage of about \$90,000, according to the 2017 ASCE Salary Survey. The BLS forecasts that demand for mining and geological engineers is expected to grow by 8% from 2016 to 2026.

Environmental Engineer

Environmental engineers apply engineering principles to improve and protect the environment for human health, to protect natural ecosystems, and for environmental-related enhancement of the quality of human health.⁹ Engineers in this field apply principles of engineering, biology, chemistry, and science to the areas of waste disposal, pollution control, contamination cleanup, recycling, and public health. They work with waste treatment, wastewater treatment, site remediation or pollution control technology.¹⁰

Environmental engineers produce environmental investigation reports, develop environmental protection practices, monitor and evaluate the effectiveness of environmental programs, and act as counsel for the design, planning, and execution of activities for environmental cleanup and remediation programs.

Engineers who specialize in environmental engineering must follow new and evolving environmental best practices. Due to the interdisciplinary nature of environmental engineering, expertise and advancement in the profession generally involves obtaining a graduate degree in environmental engineering. The Environmental/Water Resources concentration of Norwich University's MCE program includes the latest concepts in the areas of physiological and biological processes in water and wastewater and geoenvironmental engineering, including groundwater flow and waste containment. Upon completion of these courses, students can be prepared for a successful future as an environmental engineer.

According to the 2017 ASCE Salary Survey, environmental engineers earned a median annual wage of \$99,000. The BLS forecasts that employment of environmental engineers will rise 8% from 2016 to 2026.

Marine Engineer

Marine engineers apply their civil engineering skills to the design, construction, and maintenance of marine facilities such as ships, submarines, tankers and aircraft carriers. Marine engineers are typically responsible for internal systems such as propulsion, electrical refrigeration, and steering.¹¹ They may inspect equipment, prepare system layouts, conduct environmental, operational or performance tests, monitor repairs, and prepare technical reports and cost estimates.

The BLS reports that marine engineers can earn a median salary of \$92,560, with the job outlook in this field expected to increase by 12% between 2016 and 2026. The positive career outlook is driven by the need for environmentally-friendly ships and systems.



Engineering Manager

Civil engineers with experience and advanced skill sets often attain leadership positions such as engineering manager who often manage dozens of projects simultaneously. Responsibilities include supervising several teams, reviewing projects for technical accuracy, and ensuring projects proceed on schedule and align with organizational goals and strategy.

As leaders, engineering managers must develop an acumen of core business functions such as finance and accounting principles, contracts, and insurance requirements. The position also includes a human resources component regarding staff supervision and training and managing personnel budgets. The Norwich University MCE program focuses on advanced technical knowledge to help students gain the leadership skills necessary to lead a team of engineers.

The BLS reports that the median salary for architectural and engineering managers was \$140,760 in 2018 and that the employment of these professionals will increase by 13% from 2016 to 2026.

Design Engineer

Design engineers work with engineering software to create schematics, plans, and prototypes of products, equipment and structures. They confirm designs with collaborative teams, perform physical testing on engineering prototypes and ensure components and assemblies are compliant with industry standards and regulations.¹²

Knowing the latest software programs and possessing project management skills are critical requirements for design engineers. The Norwich University MCE program offers courses on the latest virtual design and construction software programs as well as project management that help prepare civil engineers to advance. The degree program also helps refine soft skills such as problem-solving, time management and communications.

The average annual compensation of a design engineer is about \$78,000, according to Indeed Salary. The BLS reports that demand for civil engineers, including design engineers, is projected to grow by 11% from 2016 to 2026.



Water Resource Engineer

Water resource engineers plan, design, and oversee construction and maintenance of equipment and systems for water resource facilities such as wastewater treatment plants, drainage canals, irrigation systems as well as hydraulic structures such as reservoirs, dams, and floodways. Through their services, these engineers help ensure clean, uncontaminated water is available to the masses.¹³



Typical tasks performed by water resource engineers include hydrologic and/or hydraulic analyses, design work, as well as project management in coordinating teams related to water resource projects. To be successful in this field, water resource engineers must understand fluid mechanics and the physicochemical and biological processes for water and water treatment. The Norwich University MCE program offers an environmental and water resources concentration that includes specialized coursework covering the principles of physical, chemical, and biological concepts of water and wastewater treatment, stormwater management, Geographic Information Systems (GIS) for water resources, and geoenvironmental groundwater flow and how to apply these principles in their career.

Water resource engineers earn an average of about \$98,000 per year according to the 2017 ASCE Salary Survey. The

BLS reports the employment of environmental engineering professionals is forecast to grow by 8% from 2016 to 2026, stimulated by the continuous need for clean water by a growing population.

Sustainability Engineer

Driven by the need to preserve the world, sustainability engineers design or operate systems without compromising the natural environment. They initiate, evaluate, and manage sustainability activities and projects focused on energy efficiency, water conservation, and waste management. Taking environmental engineering to the next level, sustainability engineers evaluate the interactions among technical, ecological, social and economic systems.

According to Indeed.com, the average salary of a sustainability engineer in the United States is \$84,129 annual but fluctuates based on experience. Grouping sustainability engineers with their environmental counterparts, the job outlook shows a 5% growth from 2018 to 2028 according to the BLS.

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