

MCCormick

Northwestern Engineering

Civil and Environmental Engineering at Northwestern University

Building and Preserving Sustainable Cities
and Protecting and Restoring the Natural Environment
through Analysis and Design



Civil and environmental engineers *build, preserve, protect, and restore* to support human activities in cities and to minimize the human footprint on nature. They play an essential role in solving many of the most pressing problems facing human societies and work in almost every aspect of modern life, from health, shelter, food, and energy, to air, water, movement, commerce, and recreation.

Build + Preserve

Civil and environmental engineers **build**—not only buildings and bridges but also materials to harvest sunlight to make solar fuels and electricity, networks by which we travel and transport goods and information, and processes and systems that ensure the safety of people, places, and natural resources.

To build complex life-sustaining systems, civil and environmental engineers must plan and anticipate social and economic change. They must design systems that satisfy and reconcile competing requirements and aspirations—for economic growth and development, for environmental sustainability, and for efficient operation. They must master hardware and software to deliver human-scale services in mega-scale systems. Increasingly, their designs must go well beyond the physical infrastructure to consider the complex dynamics of real-time operation in transportation, water resources, electric generation, and other increasingly interconnected systems.

Future generations of civil and environmental engineers must also **preserve** aging infrastructure to meet new demands and build the sustainable cities of the future. Faced with a dramatically urbanizing planet and an unstable climate system, civil and environmental engineers must transform almost every dimension of the way humans live, work, eat, and move.

Protect + Restore

Civil and environmental engineers have the responsibility to **protect** the health and safety of human and natural systems. A key challenge is to analyze, design, and build structures to withstand human-made and natural hazards, such as blasts, landslides, earthquakes, hurricanes, and floods and to figure out how to do this under the uncertain conditions of a rapidly changing climate that is causing more extreme events and rising sea levels.

More and more, the job of civil and environmental engineers is to **restore** ecosystems to their full function. They restore streams and wetlands to provide wildlife habitats, flood control, nutrient uptake, water quality enhancement, carbon storage, and recreational opportunities. They study how invasive species restructure food webs and how legacy contaminants are transferred through these evolving food webs—knowledge necessary to direct cleanup and lift limits, such as fish consumption advisories.

Imagine a world where automobiles drive themselves, where waste is considered a resource, where clean water is available to everyone. The exciting innovations and inventions of civil and environmental engineering will make this happen.

Methods + Techniques

In order to build, civil and environmental engineers must develop tools to **analyze** problems. With innovative mathematical techniques, civil and environmental engineers at Northwestern:

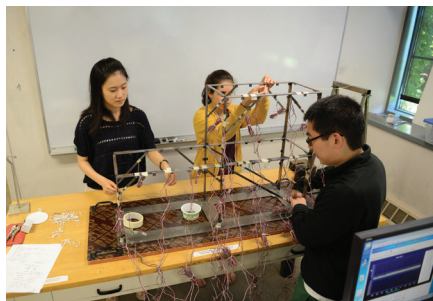
- Develop revolutionary methods to non-destructively test the integrity of structures, such as airplane wings, to reveal tiny cracks early before a catastrophic failure occurs.
- Use cutting-edge DNA sequencing techniques to identify new biotechnology strategies to generate energy from wastes.
- Analyze coral reefs to understand the effects of a warming ocean and why bleaching occurs.
- Analyze the formation of biofilms not only to adapt them to convert wastes into useful chemicals in electrochemical synthesis, but also to control their growth in pipes, where they can cause corrosion, or on the surfaces of medical instruments, where they can cause disease.
- Develop genetic techniques to discover what microorganisms are present and what they are doing in a particular system.
- Develop new ways to monitor specific chemicals in complicated mixtures and to tease out precise structures that can be harmful or beneficial to human and ecological health.
- Devise testing techniques for the effective extraction of shale gas that promises to provide the United States with energy independence in the near future.

Using the sophisticated analytical tools of their trade, civil and environmental engineers **design** new materials and systems. Civil and environmental engineers at Northwestern:

- Design taller, more resilient and sustainable structures made up of strong, tough, lightweight materials.
- Create membranes inspired by the ion and water channels of cells that purify drinking water and capture industrial wastes prior to release.
- Design fuel cells using special communities of microorganisms that can degrade organic material and donate electrons to external circuits.
- Design artificial photosynthetic processes by developing multi-functional, nano-structured catalysts to convert CO₂ into fuels using the energy of the sun.
- Create stretchable and flexible electronic materials that can be used in solar cells and medical devices such as catheters and cardiac monitors.
- Design the transit systems of communities to be walkable and bikeable.

Creating The Future

In short, civil and environmental engineers create the future. Imagine a world where automobiles drive themselves and produce energy while they are parked, where waste is considered a resource from which raw materials are recovered and energy is generated. Imagine a world where biologically inspired materials are extremely light, can sense changes in conditions, and can then adapt to maintain high performance. Imagine a world where clean water is available to everyone and an equitable standard of living is assured to all. The exciting innovations and inventions of civil and environmental engineering will make this happen.



Students trained in civil and environmental engineering at Northwestern have a broad, fluid base in science and engineering that enables them to work across disciplines and to tackle the grand challenges of improving our living conditions in harmony with nature. Trained with both project and policy courses, students can find study and work opportunities on almost every continent of the world and pursue careers in business, consulting, and technology-driven industry; in government, policy, and law; in public health, environmental protection, and ecological restoration; in small and large scale construction, and material and structural analysis and design; in managing air, water, and land transit of goods and people.

The work of civil and environmental engineers spans many scales, from the molecular and nano to the mega-scale; from the virtual to the physical. Yet, common to all pursuits of civil and environmental engineering are the goals of improving the quality of life and preserving the life support system of the Earth.

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