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Research Project: Built Environment and Sustainability

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Project Overview

Built environment provides the critical foundation and shape generations of civilization for livable communities. They are the fabric that connects the spatial, social and economic structure of cities and provides critical services for the public health, economic well-being, and security of urban communities. Stress in the built environment is reflected in structural deterioration and interruption of service from increased exposure to both natural and anthropogenic hazards. Physical infrastructure and interdependent social and economic systems are also stressed by population growth; social inequities; and the institutional barriers to integrated management of built environment. Natural resources and environmental quality have also been increasingly impacted by built environment, posing tremendous challenges which individual communities and nations must confront. Global transportation infrastructure, for instance, has evolved to an enormous scale - nearly a billion cars and trucks move people and goods along the world's roadways - and consumers spend trillions of dollars each year on personally owned vehicles to enable personal mobility. In the meantime, transportation-related air pollution (e.g., ground-level ozone and particulate matter (PM) pollution) is an issue of significant importance in the U.S. and across the world (Fig. 1).

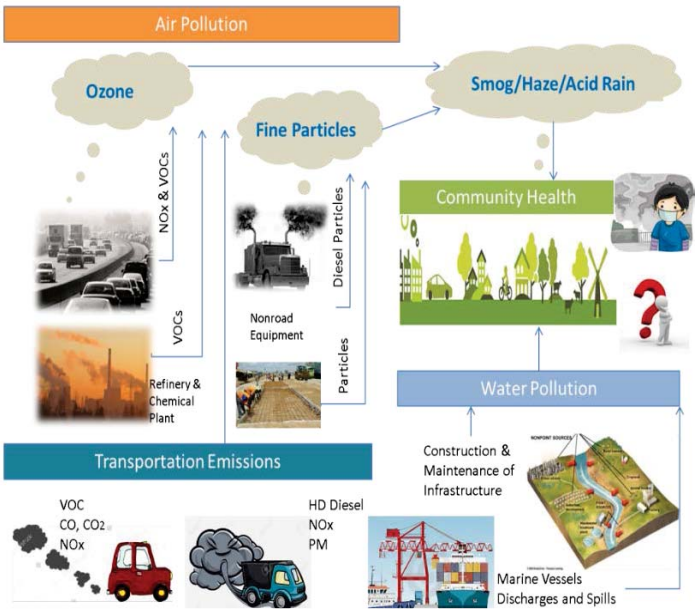


Figure 1. Built environment, natural environment, and health

In the 2017 CATALYST Academy project, Built Environment and Sustainability, CTECH will expose students to a wide spectrum of lab topics from human behavior/decision to structure design/testing. The students will study the concept and management of built environment, natural environment, and community health. Specific topics of built environment and sustainability may include 1) planning, design and management of multimodal transportation systems in which engineers can contribute to addressing a wide variety of challenges, ranging from congestion to security to environmental impact; 2) Analysis, design, and construction of

built environment such as buildings, bridges, concrete dams, tanks, and towers, as well as a great diversity of other structures; and 3) Programs in water systems such as the the AguaClara program to address the need for sustainable municipal scale water treatment in resource poor communities.

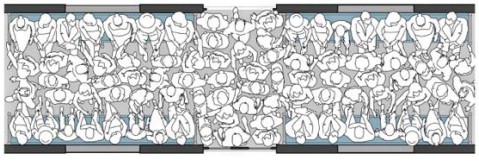
Laboratory Topics

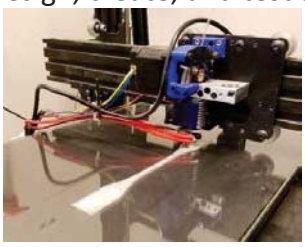
Labs and topics include:

- Sustainability in your hand—Human Behavior: Surveying Consumers: Decisions of Economically and Environmentally Informed Travelers in Urban Networks
- Transit network design
- Transportation Management in Practice
- Transportation, Air pollution, and Public Exposure
- Vibrations in Structures
- AquaClara
- 3-D print your own canoe and test it

Lesson Plan

Each day, students will have a short lecture on a different aspect of built environment and then do a design or discovery-oriented activity. The students will work in teams to explore all different aspects of built environment: conducting surveys and experiments on the topic of crowding; competing in planning, design and management of transit systems; learning transportation emissions and monitoring real time exposure to air pollution; 3-D printing of a concrete canoe and testing it in a wave tank; Seismic design and testing; and the AquaClara program.

Monday, July 17	Overview: Built Environment and Sustainability **Lab #1: Human behavior, Crowding, and Transit Design (366, and computer lab, Hollister Hall)** In this lab session, students will get introduced to the diverse and interdisciplinary elements that are considered in the design of transit systems. The first part of this lab will highlight the importance of considering human behavior – including perceptions – in engineering effective public transportation. We will discuss how one can measure **quality-of-service**, with a special focus on passenger crowding as a comfort indicator that affects affect perceptions of travel time. Students will actively experience different crowding levels to then answer a choice experiment. 

	  The second part of the lab will discuss the problem of transit system design through both some high level concepts of transit planning and an interactive design game in which students will compete to build the best subway system improvements for NYC. We will also discuss how new ride-hailing services can help and/or hurt transit services.
Tue	**Lab #2: Transportation in Practice, Emissions, and Air Pollution (366, Hollister Hall, and Campus).**  How is the real transportation system operated and managed in practice? In the first part of this lab session, Veronica from Washington DC will talk about transit management in real practice. While providing critical service for the mobility needs, transportation-related air pollution constitutes important risk factor for cardiopulmonary disease, increases children's asthma rates and premature death, lung cancer death, and substantial loss of average life expectancy. In the second part of this lab session, students will first learn systems thinking about the complexity of transportation, emissions, air pollution, and public health problems. After this, we'll conduct real time measurement of respiratory exposures at different places/facilities (e.g., walking, on a bus, near a stop sign, on a parking lot, etc.) on Cornell campus in Ithaca, NY. With the collected exposure data, the students will then come back to the lab to analyze the data and discuss the results.
Wed	**Lab #3: Lab #3: 3-D Printing Load Bearing Structures** Additive Manufacturing (AM), popularly known as 3D Printing, has the potential to be a truly disruptive technology. AM technology presents the capability to create customized parts rapidly, economically, and with a geometric complexity beyond what is possible with traditional manufacturing. This ability will significantly impact the biomedical, aerospace, and construction enterprises. In this module, students will be introduced to the concept of AM, with a focus on creating load bearing parts and structures. As a demonstration, students will use AM technology to design, create, and test a small boat in a wave tank.  

Thu	**Lab #4: AquaClara(B60 Hollister Hall, and outdoors)** Conduct research with the student team that is inventing the technologies to make the water coming out of your tap safer. Roll the dice to see how infrastructure influences how we get our water. Learn how Cornell students invent new water treatment technologies using science, creativity, and real world experience. Compare methods to convert river water into drinking water. Ask Cornell students how they connect engineering, love, community, meaning, social justice, and their careers. 
Fri	**Lab #5: Vibrations in Structures** (366 Hollister Hall, computer lab, and engineering quadrangle) In this lab session, students will be introduced to vibrations in structures ranging from the Earth to buildings and bridges to electric guitars. Students will learn about resonant frequencies of vibration, modal shapes, and how to measure those vibrations with sensors, and visualize the vibration measurements with computer software. Students will then participate in a field test involving the vibrations of the Duffield Hall stairs on the engineering quadrangle. 
Sat	**Final Presentations by Students**