Columbia University

Graduate School of Architecture, Planning and Preservation

A4818X Sustainability + Existing Structures

Time:Fall, Monday 9:00AM-11:00AM

Location: Avery 115

Credits: 3pts

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Office Hours: by appointment

TA:none

Background

The built environment plays a critical role in society's environmental footprint. Buildings account for 39% of primary energy consumption and 72% of all electricity consumed domestically. Given the urgency to address Climate Change, owners, designers, and policy makers are therefore focusing on improvements to the built environment as a key mechanism to reduce greenhouse gas emissions. While much of this work in recent years has focused on efforts for new buildings, it is becoming increasingly clear that only improving new buildings will not result in the significant changes needed to avert catastrophic Climate Change. Currently New York City, under major DeBlasios' One City: Built to Last program, is investigating a comprehensive policy framework to address climate change and greenhouse gas emissions with a stated goal of reducing emissions by 80% by 2050 over a 2005 baseline.

Given average replacement rates of existing buildings of 1-2% per year and continued growth, these reduction levels can only be achieved through aggressive improvements in existing buildings. Furthermore, reusing or extending the use of existing structures reduces the amount of embodied energy when compared to building replacement. Taking a comprehensive approach to reducing environmental impacts will thus require a much more critical look at the opportunities in maintaining at least significant parts of existing buildings and balance them against potential future operational savings in a replacement scenario. This field of work will become an increasingly important aspect of the architectural profession and will go well beyond the current approaches to renovations, reuse, and historic preservation.

Improving the energy efficiency of existing buildings brings with it a complex interplay of different and often competing drivers. First and foremost are the technical challenges and opportunities to adapt a building and its systems to new performance levels. Depending on the original design this can allow for the re-discovery of environmental design strategies that had been inherent in buildings before the advent of active air-conditioning. For example buildings build in the early parts of the 20th century (e.g. the Woolworth building or the Flatiron building) all were designed for daylighting and natural ventilation. Given our modern expectations and understanding of air quality, thermal and visual comfort, as well as functional/programmatic requirements, some of the original strategies often need to be supported with advanced technical systems in the building enclosure, HVAC and energy systems. Buildings built after the advent of HVAC systems and mechanical cooling (e.g. Lever House or the UN Secretariat building) often were designed to be reliant on these new energy systems and thus provide a different set of challenges to improve their performance.

Additional challenges emerge in projects were historic preservation is a concern. Many of the buildings built in the early parts of the last century have aesthetic and cultural significance. An increasing number of midcentury modern buildings are now also considered part of our building heritage that is worth preserving. As a result, the degree to which building systems, like facades or lighting can be altered needs to be balanced with preservation concerns. At the same time, preservationists can provide important insights into the means and methods of construction of historic buildings and inform design and system decisions today in new and innovative ways.

Finally a key obstacle to the implementation of improvement programs is the potentially limited financial returns for the building owner. Given the current relatively low cost of energy, the payback on building improvements solely based on energy savings is often too low to justify significant upgrades. Relying on regulation to force owners to provide these upgrades to address climate change will put significant strain on the real estate market. As a result, the most successful solutions will not only reduce energy consumptions and emissions, but will add additional value to the building. This added value could be in improvements in comfort and occupant performance, improvements in resiliency and climate change adaptation, changes to the envelope or floor plate configuration to respond to current market demands, the addition of amenities or the change of use, and also an aesthetic upgrade to the buildings architecture and image, all of which could result in higher rents or resale values. It is in this added value proposition where architects can become driving creative innovators and where some of the most exciting work of the next decades will happen both architecturally and environmentally.

Educational Objectives

This course builds on the core environmental systems class (A4112/Tech2) and challenges students to apply the lessons from that class to the realm of existing building improvements. Students will learn how to survey building system concepts and create base documents of the project's architecture as well as the HVAC and energy systems. The course will provide a deeper understanding of building envelopes, energy systems and daylighting/lighting and will take energy modeling to a higher level.

Students will learn qualitative and quantitative approaches to analyzing technical and architectural problems and how to develop innovative integrated solutions. Sustainability will be a driving focus for the projects and students will learn how to critically evaluate current industry developments and benchmarks to their design process. The course will include guest lectures from engineers, architects and preservationists to show students how to approach the same building from different disciplines and to deepen their interdisciplinary communications skills.

While the course will be heavily grounded in technology, it is important to point out that a key focus of the course will be a semester long integrated design project. Each student will pick one existing building to analyze (both current condition and original design intent) and then propose different levels of modifications culminating in a final project that focuses on the added value of a radical design intervention. All projects will have to be multi-story buildings in New York City.

By combining design, technical thinking and presentation, the course will provide students with skills and knowledge to become leaders in integrated design processes. Especially the focus on presenting technical information in a rigorous but also compelling way at a concept level will teach students how to frame and support a design proposition and communicate it effectively.

Course Requirements

Attendance: Students are required to attend all classes and participate actively in the course discussion. The course format will be a highly interactive workshop format and students will need to be well prepared and engaged for each class. Class participation constitutes 30% of the final grade, Assignments: Throughout the semester students will develop one project from research of the existing building, through technical analysis to a final project. To structure the work progress a number of specific assignments/deliverables will be completed. These assignments will contribute 40% to the final grade.

Final Project: The class will cumulate in a final project of a significant design proposal by each student. This proposal will be presented in class and documented in a final project booklet. The final project will contribute 30% of the final grade of the class.

Grades: Class participation, the assignments and the final project will be graded on a point system and the final grade will depend on the total number of points achieved during the semester. Grades will be scored according to the following scale: >90% High Pass, 60-90% Pass, 50-60% Low Pass, <50% Fail..

Readings

The course has no required text book but the following books are recommended for additional reading:

Norbert Lechner. Heating Cooling Lighting. Design Methods for Architects.

Stein and Reynolds, Mechanical and Electrical Equipment for Buildings.

Daniels, The Technology of Ecological Building

Further reading will be recommended for specific classes throughout the semester.

Course Schedule

Every class will begin with a presentation and then switch to a workshop/discussion/presentation format to discuss the concepts introduced in the presentation, provide hands on software training, student presentations of assignments or discussion of work in progress.

9/12 Presentation: Course introduction; environmental concerns and existing buildings; case studies. Discussion: How to select the existing building to work on for the semester? What to look for and where to find it?

9/19 Presentation: Building systems refresher; thermal and visual comfort refresher; daylight modeling and climate analysis approaches; How to quantify performance; metrics and benchmarks? Discussion: Assignment 1: Student presentation of their selected project – design intent overview and current condition.

9/26 Presentation: Energy analysis and how to apply it at the concept level. How to establish energy targets and context? Definitions of Net Zero. Guest Lecture. Workshop: Energy analysis work session.

10/3 Presentation: The low hanging fruits: incremental upgrades to facades and energy systems. Life cycle cost analysis and the economic drivers for system improvements. Guest Lecture. Workshop: Assignment 2: Student presentation of their baseline energy model results.

10/10 Presentation: Historic preservation approaches and case studies. Guest Lecture. Discussion: discussion of design constraints (technical, architectural, economic, regulatory).

10/17 Pin-up: Assignment 3: Student presentation of original design intent, current performance and proposed improved performance under constraints.

10/24 Presentation: Adding value, how to change the value proposition in the renovation of existing buildings. Case study. Guest lecture. Discussion: Brainstorming session on architectural design improvements and how they can add value to existing buildings.

10/31 Presentation: Sustainability beyond energy and comfort (water, embodied energy, others). Overview of other environmental concerns and potential design strategies. Discussion: How does sustainability apply to projects; Opportunities and New York City specific constraints?

11/7 no class

11/14 Presentation: Presentation strategies and techniques. How to communicate technical content in a compelling way? How to contextualize results? Discussion: Final deliverables and booklet discussion.

11/24 Workshop: review of work in progress; design approach; how to get around problems on the home stretch.

11/28 Final Presentation – pin-up of final project; submission of design booklet.