Olin Living Lab Project

Program Summary

Summer 2014

DRAFT

Olin College of Engineering

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"One planet, one experiment."

-Edward O. Wilson

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The Living Lab project is a student-driven effort to design and construct a green building on Olin's campus.

This document outlines our approach to launching Olin toward a more sustainable future.

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WHY A LIVING LAB?

If we are to transition society to a sustainable footing, then our colleges and universities need living curricula, i.e., ones that have courses, projects and facilities where living things, ecosystems, nature, the sun, enter directly into students' studies.

If we are to graduate students that will engage in and contribute to a transition to a deeply sustainable society, our students need opportunities to participate in creating sustainable systems, to experience and identify with shared efforts to create change.

We seek to redefine engineering education to incorporate sustainability in an integral way. Olin is committed to developing new approaches and serving as a model for others to promote change.

GOALS

Incorporate deep environmental and sustainability practice into engineering curricula.

Provide a visible destination to attract ecologically minded students to Olin College.

Provide a facility for living projects related to sustainability and the environment.

Create a community space that can serve to transform, express, and share our values around sustainability.

Gain experience with a small, net-zero pilot building to prepare for a more substantial green building on campus.

Achieve Living Building Challenge certification.

BUILDING PROGRAM

The Living Lab will be a self sufficient building demonstrating true sustainability as defined by the Living Building Challenge.

The Living Lab will provide nominally 1200 square feet of beautiful wet lab and greenhouse space combined with a multipurpose room for receptions, presentations and meetings capable of comfortably housing 25 students.

Example curricular projects ideated by the community include algae biofuels production, microbial fuel cell research, biomaterials development, biomimetic organism analysis.

We anticipate the space to be used to educate members of the community and campus visitors on the topics of sustainability and the environment.

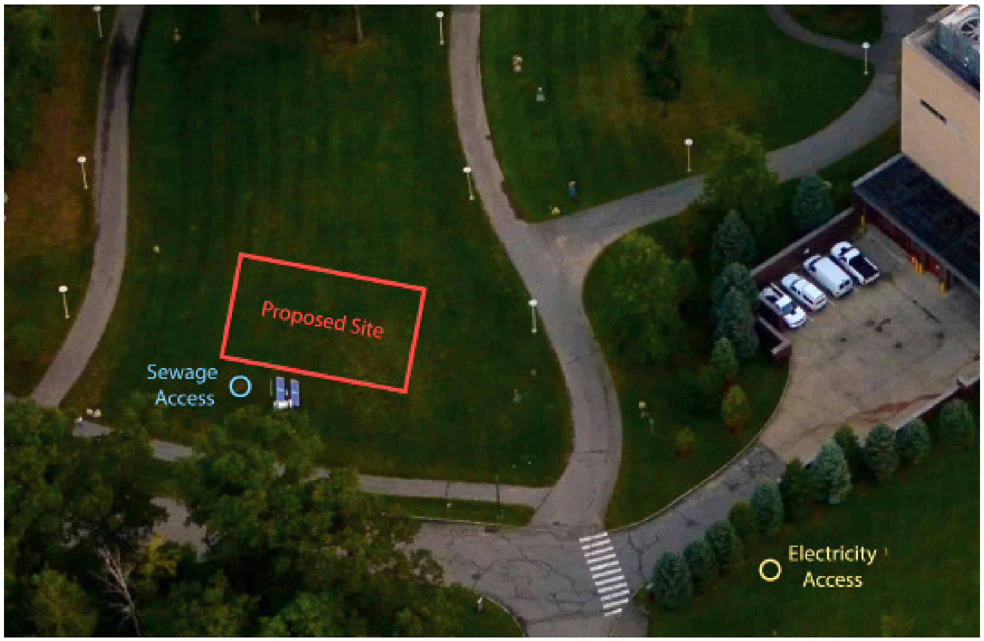
PROPOSED SITE

The site is located on the north end of Olin's campus behind both campus dormitories.

The area outlined in red encompasses both the building and the immediate surrounding hardscape and landscape.

There are currently no plans for other campus buildings at this site (Kossuth, 2013).

SITE CONDITIONS



Locations are approximate.

Sewage and electricity access are depicted on the picture to the left (Zacharias, 2014).

Potential disruption has been identified in frisbee golf course.

SCHEDULE

We expect to take a Design-Build approach which will allow for more efficient cost and time management.

PROPOSAL	Ongoing.
APPROVAL -Administration Approval -Board Approval	6 months.
DESIGN / FUNDRAISING -Hire Architect -Community Charrette -Bid Construction	6-12 months.
BUILD -Construction Drawings -City Permitting -Construction -Inspections	9 months.
OCCUPANCY -Certificate of Occupancy -LBC 12 Month Occupancy Data	12 months.
LBC CERTIFICATION	3 months.

TOTAL COST OF OWNERSHIP

CONSTRUCTION COSTS

Based on the RSMeans Building Construction Cost Data 2013 edition, the estimated mean and upper limit costs per square foot for “Research Laboratories and Facilities” are outlined below.

Mean: $212/sqft x 1200sqft = $254,400
Upper Limit: $310/sqft x 1200 sqft = $372,000

Additional budget considerations must be taken into account in order to achieve Living Building Challenge certification. These include the one-time carbon offset purchase, habitat exchange, and additional cost of materials free of toxic chemicals on the redlist.

OPERATIONAL COSTS

FACILITIES: Minimal additional cleaning and maintenance expenses given the limited size and complexity of the building. (Zacharias, 2013)

CURRICULUM: Equipment and materials covered by existing curricular budgets. No additional staffing required.

EVENTS: Covered by existing program, course and department budgets.

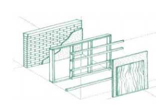
TRUE SUSTAINABILITY


SITE

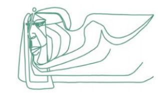

WATER


ENERGY


HEALTH


MATERIALS


EQUITY


BEAUTY

The Living Building Challenge provides a rigourus defintion of sustainability that is essential to focus, inspire and challenge our community to be successful.

The Living Building Challenge is a rigorous green building certification process that requires a project to meet all set criteria, and certification is based upon actual performance data and not anticipated or modeled results. There are seven petals (Site, Water, Energy, Health, Materials, Equity, and Beauty) and a total of 20 imperatives associated with these petals. See Appendix A to learn more about the LBC imperatives and see Appendix D to learn about potential building systems.

For more information check out livingbuildingchallenge.org

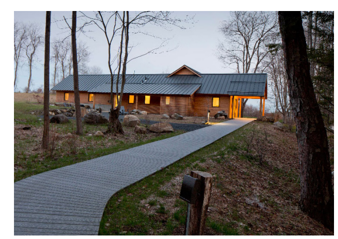
There are currently only five Living Building Challenge certified buildings in the world. However, over 200 projects are currently pursuing certification.


Oct 2010


July 2010


April 2011


April 2013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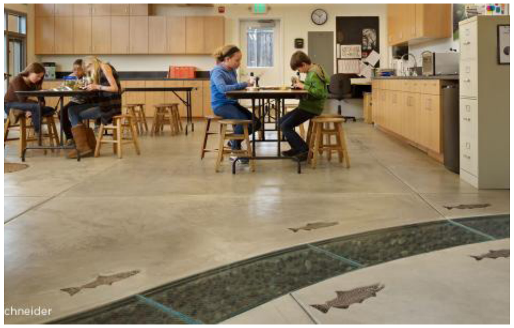
LBC DESIGN ELEMENTS

To maximize natural light within the building, cover the interior with light materials. Bring wild surroundings inside with plenty of natural design elements.

Explore using a green wall to both enhance natural beauty of the building and treat gray water.

To create a warm facade and seamlessly integrate the building into nature, use wood facing.



Use beautiful and educational design elements within the building, such as this stream, to reveal inner workings of the building's systems.

Include an all-glass greenhouse to provide both project space and a warm and inviting environment to building occupants.

Use simple design elements, like these laser-cut salamanders, to hint at the natural surroundings of the building.

BUILDING DESIGN INSPIRATION



Solar Umbrella House, Los Angeles, CA


Springfield Literacy Center, Springfield, PA.


RainShine House, Decatur, GA.


Knox Innovation, Opportunity and Sustainability Center, Victoria, Australia

Drawing inspiration from existing green buildings

Abedian School of Architecture, Queensland, Austraila.

Center for Sustainable Landscapes, Phipps Conservatory and Botanical Gardens, Pittsburg, PA.

Packard Foundation Headquarters, Los Altos, CA

Lumen Building Greenhouse, Wageningen University, Netherlands

SITE

01 Limits to Growth, 02 Urban Agriculture, 03 Habitat Exchange, 04 Car Free Living

“Restoring a Healthy Relationship with Nature”

“The intent of the Site Petal is to clearly articulate where it is acceptable for people to build, how to protect and restore a place once it has been developed, and to encourage the creation of communities that are once again based on the pedestrian rather than the automobile. Such communities should, in turn, be supported by local and regional agriculture, since no truly ‘sustainable’ community can exist that relies on globally-sourced food production.”

01 Limits to Growth

Projects can be built on greyfields or brownfields, but not on sensitive ecological habitats such as wetlands.

Potential Approaches

-Site potentially in protected wetland zone, however site is near developed zone, potential to apply for educational facility exemption.

02 Urban Agriculture

Projects must include opportunities for on-sight agriculture.

Potential Approaches

-Adjacent greenhouse
-Green Roof
-Vertical green wall

03 Habitat Exchange

Projects must set aside an equal amount of land as part of a habitat exchange.

Potential Approaches

-Community design charrette to find a habitat exchange that Olin students and greater community are passionate about.

04 Car Free Living

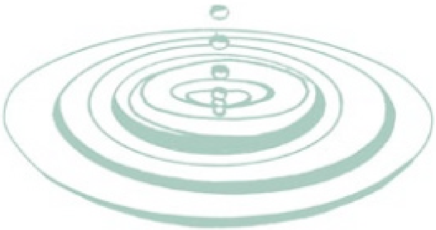
Projects must contribute to walkable, pedestrian-oriented communities.

Potential Approaches

-Should not be an issue given our transect falls under L3 (campus zone). However design should strive to mitigate traffic onto site which could be an issue if members of the community are driving in to see the lab space. Possible connection to parcel B walking trails to encourage community engagement with nature.

"Creating Water Independent Sites"

"The intent of the Water Petal is to realign how people use water and redefine 'waste' in the built environment, so that water is respected as a precious resource. Scarcity of potable water is quickly becoming a serious issue as many countries around the world face severe shortages and compromised water quality. Even regions that have avoided the majority of these problems to-date due to a historical presence of abundant fresh water are at risk: the impacts of climate change, highly unsustainable water use patterns and the continued drawdown of major aquifers portent significant problems ahead."



05 Net Zero Water

All water used on sight must be collected on sight and purified without the use of chemicals.

Potential Approaches

-Rain water catchment/tank storage with filtration

06 Ecological Waterflow

Storm water and building waste water must be managed on sight.

Potential Approaches

-Rain water collection
-Composting Toilets
-Living Machine (Usage cycle will play huge role in feasibility of such system)
-Facultative Lagoon
-Traditional Septic Field

LBC Petal Imperatives

"Relying Only on Current Solar Income"

"The intent of the Energy Petal is to signal a new age of design, wherein the built environment relies solely on renewable forms of energy and operates year round in a pollution-free manner. In addition, it aims to prioritize reductions and optimization before technological solutions are applied to eliminate wasteful spending - of energy, resources and dollars. The majority of energy generated today is from highly unsustainable sources including coal, gas, oil and nuclear power. Large-scale hydro, while inherently cleaner, results in widespread damage to ecosystems. Burning, wood, trash or pellets releases particulates and carbon dioxide (CO2) into the atmosphere and often strains local supplies of sustainably harvested biomass. The effects of these energy sources on regional and planetary health are becoming increasingly evident through climate change, the most worrisome major global trend attributed to human activity."

07 Net Zero Energy

All energy must be collected on site from renewable sources on a net annual basis.

Potential Approaches

-Solar PV for electricity needs
-Diurnal heating and cooling
-Seasonal heating and cooling
-Ground Sourced Heat Pump for reservoir heating and cooling

Health

08 Civilized Environment, 09 Healthy Air, 10 Biophilia

"Maximizing Physical and Psychological Health and Well Being"

"The intent of the Health Petal is to focus on the major conditions that must be present to create robust, healthy spaces, rather than to address all of the potential ways that an interior environment could be compromised. Most buildings provide substandard conditions for health and productivity. There is a direct correlation between decreased comfort and increased environmental impacts, since solutions in the physical environment to improve well-being are often inefficient and wasteful."

08 Civilized Environment

All occupiable space must have operable windows to provide fresh air and daylight.

Potential Approaches

-Extensive simulations to maximize daylighting will be done
-Wind simulations done to examine fresh air flow through building
-Active recovery of passive adjustments

09 Healthy Air

Air quality testing pre-occupancy and 9 months after occupancy will measure levels of Respirable Suspended Particles (RSP) and Total Volatile Organic Compounds (TVOC).

Potential Approaches

-Recuperative ventilators
-Fresh air exchange for most seasons

10 Biophilia

Projects must be designed to include elements that nurture the innate human attraction to natural systems and processes. These include environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships.

Potential Approaches

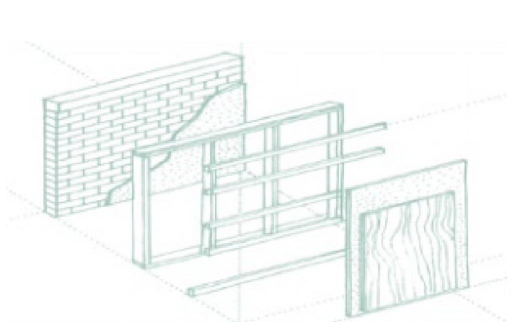
-Community Design Charrette to discuss how biophilia can be implemented into the design of the space.

Materials

11 Red List, 12 Embodied Carbon Footprint, 13 Responsible Industry,
14 Appropriate Sourcing, 15 Conservation/Reuse

"Safe, Renewable, and Responsible for all Species Through Time"

"The intent of the Materials Petal is to induce a successful materials economy that is non-toxic, transparent and socially equitable. Throughout their lifecycle, materials are responsible for many adverse environmental issues including illness, squandered embodied energy, pollution and resource depletion. The Imperatives in this section aim to remove the worst known offending materials and practices. When impacts can be reduced but not eliminated, there is an obligation not only to offset the damaging consequences associated with the construction process, but also to strive for corrections in the industry. At the present time, it is impossible to gauge the true environmental impact and toxicity of the built environment due to a lack of product-level information."



11 Red List

Building materials cannot contain any materials found on the red list of chemicals that have been identified as carcinogens, endocrine disruptors, ... This includes asbestos, cadmium, chlorinated polyethylene and chlorosulfonated polyethylene, chloroflurocarbons (CFCs), chloroprene (neoprene), formaldehyde (added), halogenated flame retardants, hydrochloroflurocarbons (HCFCs), lead (added), mercury, petrochemical fertilizers and pesticides, polyvinyl chloride (PVC), pthalates, wood treatments containing creosote, arsenic, or pentchlorophenol.

Potential Approaches

-Work with Declare materials
-Work with designers who have experience in sourcing red-list-free materials.

12 Embodied Carbon Footprint

Project must take accountability for all carbon associated with construction, occupancy, and projected replacement parts for the building by purchasing a one time carbon offset.

Potential Approaches

-Student project to calculate embodied carbon footprint

13 Responsible Industry

Wood must be Forest Stewardship Council (FSC) certified or from salvaged sources. The project must advocate for the creation and adoption of third-party certified standards for sustainable resource extraction and fair labor practices

Potential Approaches

-Letter templates available to advocate for sustainable research extraction and fair labor practices. Letters should be sent out to local vendors to advocate in our community.

14 Appropriate Sourcing

Source locations for materials and services must adhere to a zoning map where denser materials must be sourced closer.

Potential Approaches

-Work with New England based designers who have experience meeting these requirements.

15 Conservation/Reuse

All projects teams must strive to reduce or eliminate the production of waste during design, construction and operation in order to conserve natural resources. They must also create a material conservation management plan that explains how materials will be managed in the design phase, construction phase, operation phase, and end of life phase.

Potential Approaches

-Student group to create material conservation management plan

Equity

16 Human Scale + Human Places, 17 Democracy + Social Justice, 18 Rights to Nature

"Supporting a Just, Equitable World."

"The intent of the Equity Petal is to correlate the impacts of design and development to its ability to foster a true sense of community. A society that embraces all sectors of humanity and allows the dignity of equal access is a civilization in the best position to make decisions that protect and restore the natural environment.

We need to aggressively challenge the notion that property ownership somehow implies that we can do whatever we like, even externalize the negative environmental impacts of our actions onto others. For example, consider these situations: when a polluting factory is placed next to a residential community, the environmental burdens of its operation are placed on the individuals who live in those houses. The factory is diminishing its neighbors' rights to clean air, water and soil. When a building towers over another structure, its shadow diminishes that structure's ability to generate clean and renewable energy, thereby impeding the rights to energy independence. We all deserve access to sunlight and clean air, water and soil."

16 Human Scale + Humane Places

The project must be designed at a human scaled rather than an automobile scale to promote culture and interaction.

Potential Approaches

-Not an anticipated issue

17 Democracy + Social Justice

Projects must be compliant with the Americans with Disabilities Act (ADA). In addition, street furniture must be provided and accessible to all members of society.

Potential Approaches

-Design for full ADA compliance
-Outdoor meeting space accessible to community.

18 Rights to Nature

The project may not block access to, nor diminish the quality of, fresh air, sunlight and natural waterways for any member of society or adjacent developments.

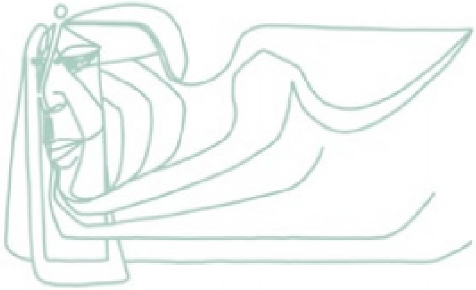
Potential Approaches

-Fresh Air: Biocompatible project station
-Sunlight: not expecting issues as surrounding buildings are a decent distance away
-Waterways: not expecting issues as project is not located near water ways, wetlands?

LBC Petal Imperatives

"Celebrating Design that Creates Transformative Change"

"The intent of the Beauty Petal is to recognize the need for beauty as a precursor to caring enough to preserve, conserve and serve the greater good. As a society we are often surrounded by ugly and inhumane physical environments. If we do not care for our homes, streets, offices and neighborhoods then why should we extend care outward to our farms, forests and fields?"



19 Beauty and Spirit

The project must contain design features intended solely for human delight and the celebration of culture, spirit and place appropriate to its function.

Potential Approaches

-Community design charrette to determine beauty and spirit aspects of the design

20 Inspiration + Education

Educational materials about the performance and operation of the project must be provided to the public to share successful solutions and to motivate others to make change.

Potential Approaches

-Tours to educate members of community
-Technical specifications published to allow others to follow, especially in thermal domain

Hawaii Preparatory Academy

LBC Certified, Similar Program

Project Details

- Located in Kamuela, Hawaii
- Start of construction: September 2008
- Start of Occupancy Period: January 2010
- Living Building Challenge Certified in April 2011
- Building Area: 5,902 square feet

The building's proximity to Mauna Kea optimizes wind-energy collection. Additionally, the building's south-facing orientation maximizes solar collection from its panels.

The Energy Lab collects approximately 6,000-7,000 gallons of water per year, which is filtered through advanced soil-percolation methods.

As an alternative to traditional air conditioning, the Energy Lab uses a radiant cooling system to cool the building. They collect water and allow the evening air to cool it and then the water circulates throughout the day to keep the building cold.

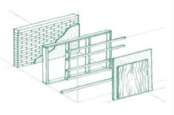
Bertschi Living Building Science Wing

LBC Certified, Similar Program, Similar Aesthetic

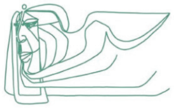
Project Details

- Located in Seattle, Washington
- Start of construction: June 2010
- Start of Occupancy Period: February 2011
- Living Building Challenge Certified in April 2013
- Building Area: 3,380 square feet

The Bertschi Living Building Science Wing is located in an urban area, meaning that the design and architecture teams had to utilize every square foot very effectively. They created many outdoor spaces to stimulate inspiration and learning.



The Bertschi Living Building Science Wing is consciously constructed with sustainable materials, and was designed in such a way that it can be deconstructed and reused if necessary in the future.



The Bertschi Living Building Science Wing included both a biowall and a continuously-running stream that runs through and under the classrooms as a very beautiful addition to the water treatment system.

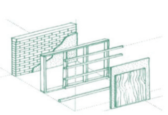
Case Studies

The Omega Center for Sustainable Living

LBC Certified, Similar Aesthetic

Project Details

- Located in Rhinebeck, New York
- Start of construction: November 2007
- Start of Occupancy Period: May 2009
- Living Building Challenge Certified in October 2010
- Building Area: 6,246 square feet



Throughout the duration of the project, 99% of all scrap metal, wood, cardboard, and rigid foam scraps were recycled, shredded or reused. 100% of food and glass, paper, and plastic packaging was composted or recycled.

The Omega Center for Sustainable Living built the EcoMachine™, a chemical-free water reclamation system that mimics the Earth's natural water filtration processes.

After building the EcoMachine™, the Omega Institute then decided to construct housing for it that would follow the highest green building certification standards, LEED Platinum and the Living Building Challenge. They were able to power the entire water reclamation system using electricity generated by the building, giving the whole building a 0 carbon footprint.

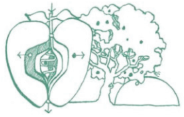
The Living Learning Center at Tyson Research Center

LBC Certified, Similar Program

Project Details

- Located in Eureka, Missouri
- Start of construction: December 2008
- Start of Occupancy Period: May 2009
- Building Area:2,968 square feet

The project was built upon an old, degraded asphalt parking lot, and now is a man-made extension to the nearby Shaw Nature Reserve. Previously a developed area, the Living Learning Center project reintroduced wildlife through its construction of their rain garden and through their landscaping efforts.



In order to create a connected indoor/outdoor experience, every occupied space has at least one operable window, letting in natural light. In addition, there are permanent walk-off mats at each entrance, and chemical-less cleaners to reduce air contamination in the building.

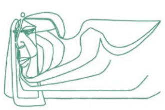
The power-generation system that the Tyson Research Center chose for the Living Learning Center was a powerful solar panel system. The south-facing sloped roof was integral to the efficient collection of solar power.

Smith College Bechtel Environmental Classroom

LBC Certified, Similar Program, Similar Aesthetic

Project Details

- Located in Northampton, MA on Smith College's campus
- Start of Construction: 2011
- Start of Occupancy Period: October 2012
- Building Footprint: 2,500 square feet



Embedded in the floor of the Bechtel Environmental Classroom is a timeline of 1 billion years of geologic history of the area. Also included in the outside of the building are hints of species in the area through laser-cut salamander shapes in the facade.

Smith College is committed to allowing its student body plentiful access to the natural surroundings of the area. The Smith Bechtel Environmental Classroom is nestled against the woods. The classroom holds up to the highest ADA standards.

Interestingly, a method Smith College's team used to collect water was to drill a well on-site and lift and pressurize it using an electrical pump.

Oberlin College Minimum LEED Silver Standard

Similar Aesthetic, Similar Program

Project Details

- Located in Oberlin, OH, on Oberlin College's campus
- Renovation Timeline: Ongoing
- To-Date LEED Certification Building Tally: 4

- The Adam Joseph Lewis Center for Environmental Studies (pictured above) was one of Oberlin College's very first green buildings and was named the top green building since 1990 in "Architect Magazine." It's "grid interconnected," meaning that its surplus energy is sent to the town of Oberlin, and uses both conventional and very biological methods to treat its wastewater.
- The Kohl Building, pictured opposite, is the first LEED Gold Certified building to be utilized for music. It uses a sensor-activated plumbing system, landscaped roofs to avoid runoff waste, was built with sustainable materials, and has a Building Management System that tracks and accounts for all energy usage of the building.
- SEED House, a sustainable living themed house, was a project completed by students of Oberlin College. It now houses 8 students and was built on a relatively constricted timeline, much like that of Olin's Living Lab.

Wellesley College Whitin Observatory

Similar Program

Project Details

- Located in Wellesley, MA, on Wellesley College's campus
- Renovation Completion: 2011
- Usage: Astronomical Observatory
- Building Area:9,950 square feet

- An interesting aspect to the site of the Whitin Observatory was that the building itself was considered part of the site. designLAB had to keep that in consideration when designing the surrounding aspects of the project.
- Keeping in mind the scientific and educational usages of this building, the architecture firm had to decide what original aspects of the building to keep, which to update, and what amount of building flow and natural lighting was most conducive to inspiration in this setting.
- designLAB was careful to update this building in a sustainable way. From integrating Wellesley's steam/cool water AC system to seamlessly extending the building and letting it "disappear" into the natural woodsy backdrop, one of the main goals of the refurbished Whitin Observatory was to serve as a real-life exhibit of sustainability.

MIT Brain and Cognitive Sciences Complex

Similar Program, Similar Aesthetic

Project Details

- Located in Boston, MA on MIT's campus
- Completion date: 2005
- Footprint: 411,000 gross square feet
- LEED Silver Certification: 2008

- The largest neuroscience center in the world, the Brain and Cognitive Science Complex is home to incredible facilities, including classrooms and offices that surround a 5-floor atrium, wet and dry laboratories, an auditorium, and conference rooms. In addition to these facilities, the building is LEED Silver Certified, and holds and incredibly high standard for sustainable buildings everywhere.
- This building achieved a 70% reduction in potable water use, and houses gray water processing methods for toilet use and storm water management systems.
- Other sustainable architectural features include a heat recovery system, daylight balanced lighting, a corridor for an active rail way, and pile foundation system to protect internal lab equipment from train (and other) vibrations.

We asked faculty how they would use Living Lab space as part of their existing courses. Here's what they said.

SOURCE: Jean Huang

TITLE: Microbial Fuel cells

DESCRIPTION: The generation of energy using microoganisms is an exciting area of study that requires and integrates knowledge from multiple disciplines from biology to electrical engineering to physics. In this laboratory module, students will develop and experimentally test conditions that optimize electricity generation from microbial samples that students collect from the environment. Measurement and comparison of the energy generated will feedback to system design as students consider ways to optimize this potentially valuable process.

SPACE REQUIREMENTS: A large wet lab space; there will be mud involved in the project from freshwater or marine environments and student groups should have dedicated places to work and leave their materials during the term.

COURSE: SCI1210 Modern Biology or SCI2214: Microbial Diversity

FACULTY INVOLVED: Jean Huang and advising from or collaboration with colleagues from physics and electrical engineering

SOURCE: Jean Huang

TITLE: Study of algal growth and processing for biodiesel production

DESCRIPTION: Photosynthetic micoorganisms are fascinating for study of basic biology and can play an important role in sustainable energy generation for the future. In this laboratory module, students will design experiments to examine the factors that influence the growth of algae and experimentally test methods for extraction of hydrocarbons (biodiesel) from the algae.
Space Requirements: Students will need sunny space for cultivation of the algae, and space for both storage of the cultures during growth experiments and processing of the algal cultures for biodiesel extraction.

COURSE: ENGRXXX Energy Systems

FACULTY INVOLVED: Jean Huang and Abigail Mechtenberg and possibly collaboration with Arizona State University, which has an algal strain they may like us to test

RESEARCH: The Living Lab space is additionally an important resource that may be used for biological research where experiments with photosynthetic organisms for larger scale experiments may be performed using natural environmental conditions and sunlight.

Curriculum Modules from Faculty

SOURCE: Benjamin Linder

TITLE: Biomimetic Organism Analysis

DESCRIPTION: Plants, bacteria, insects, animals, elements of the natural world have much to teach us about the design and engineering of products and systems that are remarkable and fascinating, at once high performing and environmentally benign. Relatively little exploration has been made of the vast array of organisms that exist, with numerous candidates readily available all around us, meaning students would have an opportunity to make meaningful, new discoveries. In this module, teams of students choose a locally available organism and an aspect to explore such as material properties, physical behavior, or system dynamics and endeavor to generalize biomimetic insights from measurements and observations that can be vetted and shared with others. Most but not all teams will collect and maintain living specimens for study in the lab as well as dissect and prepare samples in the space. The lab will allow some specimens to live beyond their normal season for extended study. The experience will be paired with material on the process of translation and abstraction and case studies on biomimetic insights.

SPACE REQUIREMENTS: For cultivation, students will need sun-lit bench space to hold and cultivate specimens over time in trays, pots, terrariums, and aquariums, totaling about 2 5 ft benches (25 sq ft). Specimens will be limited to organisms that do not require IRB review and review protocols to work with. Electricity will be needed for heat lamps or heating pads and aquarium pumps. Access to water will be needed as well as the ability to work with soil. Insects could get free and get lost in the building.

For measurement and exploration, students will need well lit bench space for preparing and studying samples including space for microscopes and cutting boards, totaling about 2 5 ft benches (25 sq ft), which can be shared with others. Most sophisticated data collection will be done in other labs on existing equipment. Students would not all have to work in the space at the same time.

Ideally, class of about 25 students could meet in the room for periods of up to 2 hrs. Students would present their projects to the class in turn without having to move everything to another room in another building. This would require the ability to make the space dark in order to project images.

COURSE: ENGR 3210 Sustainable Design
Project could either be required of all students, run as an option from a short list from which students choose.

FACULTY INVOLVED: Benjamin Linder. Lightweight advising from biology, chemistry, material science, mechanics, controls, systems, and energy faculty members would be very desirable.

SOURCE: Jon Stolk

TITLE: High Performance Synthetic and Natural Materials

DESCRIPTION: Over the past few decades, materials science research has focused much attention on understanding the properties and structures of high performance natural materials, and on developing synthetic materials products whose microstructures mimic natural designs. Our synthetic designs, however, seldom stack up to their natural counterparts, particularly with regard to environmental and societal impacts. Modern synthetic composites, for example, require high processing energies and produce toxic chemical waste streams, and demand high costs for recycling; while natural composites make use of benign chemical inputs and produce inert end-of-lifewaste. In this project students will explore the processing, properties, and microstructure of both synthetic and natural high-performance materials. Teams will select a consumer product or engineering component that employs a synthetic high-performance material, e.g., a carbon fiber bicycle frame or a Gore-Tex® fabric. Through a self-designed process of hands-on experimentation, teams will develop an understanding of how the modern materials are produced, how they behave, and how their microstructure dictates their performance characteristics. At the same time, teams will identify bio-based counterparts that share similar properties to, and that may be considered as more environmentally benign replacements for, the modern synthetic materials. Students will weigh the trade-offs among material performance, processing requirements, design and manufacturing challenges, and environmental and societal impacts.

COURSE: SCI 1410 Materials Science and Solid State Chemistry

SPACE REQUIREMENTS: Many of the property measurements and microstructural characterizations for this project could be completed in the existing materials science laboratories. To support the examination of end-of-life impacts of natural and synthetic materials, we would ideally expand our current selection of testing equipment to include materials degradation chambers (e.g., UV, sunlight, temperature/humidity cycling), and equipment for measuring the toxicity of waste streams from materials processing and disposal.

FACULTY INVOLVED: Jonathan Stolk, with advising from design, biomaterials, bioengineering, and chemistry

APPENDIX D Building Systems

WATER

Given a roof footprint of 1200 square feet, and a data set for average rain fall in Needham, Ma, we estimated that we would be able to collect between 2000 and 2500 gallons of water per month. In order to account for differences in frequency, and duration of rainfall events, a 5000 to 10,000 gallon tank would be optimal.

SANITATION

The building will meet all of its onsite sanitation needs through sinks, drains, and toilets. A grey water system will likely be used to recycle primary water for secondary use. Building code will require the presence of two toilets, one for males and one for females. Sewage treatment will be handled onsite either by composting toilets, a facultative lagoon, a traditional septic tank and field, or a combination of these technologies (Walker, 2013).

ELECTRICITY

We anticipate having varying electricity demands depending on the season and Olin's college schedule. As a result, daily electricity demand could range from 1kWh to 10kWh, possibly peaking as high as 20kWh. We expect that 25 solar panels rated at 100 Watt peak generation should be enough to meet this demand.

HEATING AND COOLING

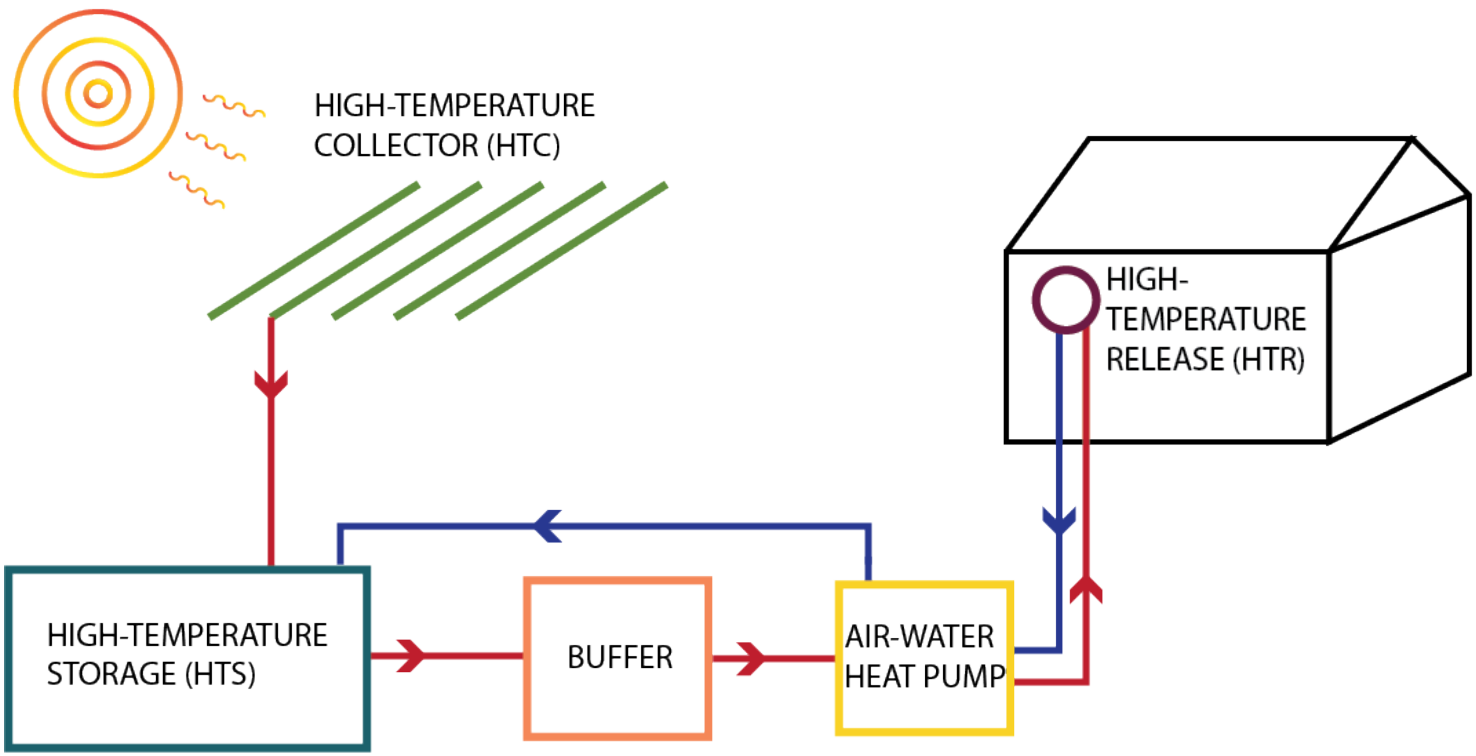
The Boston area annual heating degree days (HDD) average 5,641, while cooling degree days (CDD) average at just 678. As a result, heating becomes the main challenge.

Conversations with the community will be key in determining final building systems.

HEATING AND COOLING SCENARIO

To heat the Living Lab, we are leaning towards a high-temperature system that uses seasonal heat storage, and is augmented by daily strategies. Though a low-temperature reservoir system is elegant, simple, and inexpensive, it may be unrealistic to assume that it will be capable of fully heating the space.

This diagram shows a high temperature heating and cooling system. A solar collector concentrates heat from the sun which is moved into a high temperature storage before passing into a buffer. Liquid that passes through the buffer then goes through a water-to-air heat pump in which heated air is passed through ducts in a building. In order to cool this building, hot air is drawn out of the building, the heat passes through the heat exchanger, and moves directly back into the storage system.



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APPENDIX C:
Benjamin Linder

Jean Huang

Jon Stolk

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