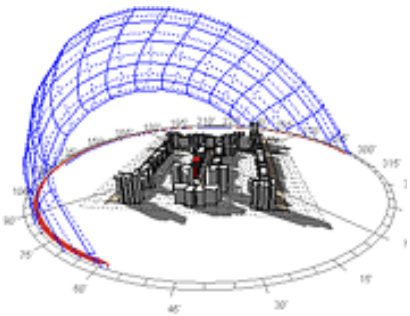
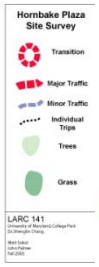
ARCH 5550 • Zero+DESIGN

Envisioning the Sustainable Campus

Integrating carbon, energy, and water management strategies toward zero- and net-positive design





Each building is a unique ecosystem within the larger ecosystems of landscape and region… Ecologically designed buildings and institutions afford a chance to make such relationships explicit, thereby becoming part of the educational process and research agenda organized around the study of local resource flows, energy use, and environmental opportunities.

David Orr, The Chronicle of Higher Education

Now there is one outstandingly important fact regarding Spaceship Earth, and that is that no instruction book came with it.

R. Buckminister Fuller, Operating Manual for Spaceship Earth (1963)

Exercise 2: Site Analysis, Massing Model, LCA of Construction Systems and "Shoebox" Energy Analysis

Due Dates

Step A: Due Wed. Mar. 30, 3:15 PM In-Studio Desk Crits

Steps B and C: Due Friday Apr. 1, 1:30PM: informal presentation; Room 71

Phase Grade weighting: 10% total grade (100 points); team grade

Reading: Read two of the following

OBJECTIVES

- To gain an understanding of the site characteristics that will shape the design for your project towards Zero+ Goals for performance and eco-effective design.
- To create a comprehensive site inventory for your site.
- To identify the key climactic influences that will shape the massing, orientation and other thermal envelope and daylighting design considerations for your project.
- To identify the ecological and life-cycle impacts of various structural systems and materials choices for your project calculate the necessary offsets to achieve a carbon neutral design goal.
- To continue to formulate an holistic approach to integrated living building design towards net-zero and zero+ performance goals.
- To create a preliminary massing and site layout concept for your design that considers the above analysis.

STEP A: RESEARCH AND SITE ANALYSIS

Continue gathering information on your project. As a team, investigate the site issues and how they impact the design. Complete a Site Inventory of assets and liabilities.
Consider the following:

1. Climate, Site, and Ecological Context: How do climate, site, and ecological aspects (environmental forces of sun, wind, weather, bioregion, etc.) shape the massing, orientation, circulation and other major design attributes at the site and neighborhood scales?

   • *Use weather data provided in Weather Tool and Ecotect or Solar Tool to prepare illustrative graphical analyses summary of the climate and site forces (e.g. prevailing winds, seasonal variations in temperature, solar irradiance and direction, wind, etc.)*

2. Massing and orientation strategies: What design massing and orientation (how are light, solar and thermal design integrated)?

   • *Present: graphic analysis of the site. Address building footprint, open space, access, massing, orientation, and topographic features such as paved surfaces, vegetation, drainage patterns, historical and cultural assets, habitat, tree canopies, ecological corridors, etc.*

3. Building (occupancy) type: How do the programmatic requirements of the project influence the massing and orientation, circulation, fenestration, materials, etc.?

   • *Present:* a brief written summary of building type considerations

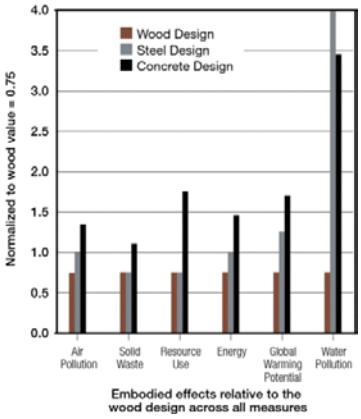
4. Envelope: How can the thermal envelope address changing sun, outdoor temperatures, and wind conditions – seasonally? …diurnally?

   Address window location, solar control, and shading.

   • *Present: description of preferred thermal envelope and fenestration, shading, orientation, etc.*

6. LCA of Structural systems and material choices: Using the Ecocalculator or a comparable LCA tool, analyze the life-cycle, durability, energy, carbon emissions and other ecological impacts of various materials choices?

   • *Present: graphic and/or written analysis of LCA/materials issues and observations regarding required offsets to achieve a carbon neutral result.*



STEP B: SITE MASSING MODEL: 1/16" Physical Models, Climatic Studies and Drawings

Due: Friday, April 1, 1:30 p.m. Rapson Room 71;
Informal Review
Develop 2 conceptual design proposals exploring the building siting and massing based on your "RESEARCH AND SITE ANALYSIS" from Step A. Keep in mind that these are conceptual massing models which are intended to open your design ideas and thinking. Start by working as a team to develop as many quick "rip & tear massing models" as possible using 1/16" scale physical models. After exploring a broad range of proposals, the team is asked to critique the studies and to select at least two proposals to develop further. *On Friday, April 1 you are asked to present your team's preliminary massing concepts (Note: one per team member, i.e., if there are 3 persons on your team, you should develop 3 massing concepts).*

NOTE ON PHYSICAL MODELS: Use balsa wood, cardboard, or other modeling materials. Include the entire site of your project as well as portions of the neighboring buildings and lots in your 1/16" base study model (use one base model of your site with alternative massing concepts). Be mindful of the impact of adjacent site features, uses, circulation and buildings (e.g. plan and sectional sketches are useful to explore relationships to adjacent buildings and spaces inside and outside). Remember these are study models.

For your informal review on *Friday, April 1* please include the following:

1. 1/16" Site/Building Massing Models: Prepare at least two different 1/16" massing models (one per team member). Please present your earlier "rip and tear" exploratory studies.
2. Site/Building Plan and Section Drawings: Develop annotated plans and section drawings (include the earth/site) at 1"=16' to illustrate your site and bioclimatic and passive design concepts related to energy and resource optimized design to illustrate your selected concepts (at least one per team member).
3. Design Critique: As a team you are asked to critique each of the design proposals. Consider the bioclimatic and passive strengths and weaknesses of each proposal. Use annotated drawings or diagrams to compare and contrast the design opportunities and constraints for each proposal.
4. Optional: Please add any additional images or studies that would be useful to explain your design investigations:
   - *Qualitative experience*: Include model photos, words, images, writing, etc. or other media that capture the quality of desired experience for each 1/16" proposal.
   - *Time Sequence Studies*: Photograph your 1/16" models outside to study the diurnal and seasonal transitions (e.g. use a 45ºNL sunpeg to photo models at June, Sept/Mar., and Dec. 21 at 9:00, noon, and 3:00).
   - *Solar Path Studies*: use the Solar Tool from Ecotect or a similar tool at the building massing scale (e.g. morning, noon, and afternoon for June, March/Sept, and Dec. 21).
5. Other relevant design and concept issues and images.

STEP C: INITIAL ENERGY SHOEBOX ANALYSIS

1. **Create a Shoebox Energy Model:** In Step C you will begin construction of a thermal model of your proposed design using ECOTECT, OpenStudio or IES VE Plug-in for Sketchup. Remember to simplify your model as much as possible (i.e., the model should be a plain rectangle in plan and the proposed number of floors with no detail. Windows should be repetitive and identical.) Follow the *Thermal Analysis* tutorials for the software tool you are using (see Course Moodle Website) to ensure that you have constructed the model correctly in order to do the prescribed thermal analysis.

   a. Develop a simple rectangular floor plan with a suitable number of identical windows and "extrude" or copy the plan up the required number of stories making each floor a complete thermal zone.

   b. Make corrections and/or simplify your thermal envelope model for better or quicker thermal simulation results.

   c. Set appropriate values for thermal envelope insulation values and glazing types or other object materials, HVAC system type (Full Air Conditioning), occupancy load and schedules, internal loads for lighting and equipment and establish the Set appropriate.

   d. Evaluate the resulting energy performance and compare to the average consumption for your building type (data provided by Energy Management group.)

2. **"Shoebox" Analysis Optimization studies to establish building energy perfromance Targets**

As a team, you will investigate the climate responsiveness and overall thermal performance for your initial thermal design and use the results as your performance *Baseline Case* for comparison as you proceed to

improve your design and work toward achieving a Net-zero energy, carbon neutral *Final Design Case*. Use your Energy Design Tool of choice to accomplish the following:

a. Heating and Cooling Loads Studies: Calculate the average monthly heating and cooling loads for your baseline case and create a table showing the monthly heating and cooling loads for your building for a typical year. Export (or copy) the data table showing the monthly heating and cooling loads values and the peak loads conditions to a table in Word or Excel or another suitable application.

b. Energy Consumption Breakdown for Fuel and Electric Use (include lighting, plug and equipment loads) in whatever format is most convenient based on tool capabilities and output options.

c. Run several iterative analyses with your "shoebox" model to optimize your thermal envelope insulation values, glazing type, HVAC systems parameters and any other options that can be quickly modeled and simulated with the tool you are using and create a "Low Energy" case that can be used to establish reasonable building performance targets.

d. Summarize the findings of your Shoebox Analysis as follows:

   i. Total annual Energy consumption for heating, cooling, electric (lighting and equip)

   ii. EUI in KBtu/SF

   iii. Monthly Heating and Cooling Loads

   iv. Peak Heating and Cooling Loads and dates

GRADING CRITERIA - Exercise Two: *10% total of ARCH 5550 grade (100 pts)*

• Depth and appropriateness of site analysis and research and relevance to project
• Clarity and accuracy of quantitative analysis charts, graphs and annotated drawings
• Craft and quality of Massing Models
• Clarity and accuracy of conclusions drawn