Lab Exercise #2

Designing for Site, Climate, and Performance

Group Members: Amanda Eller, Nate Henrie, Elizabeth Smythe

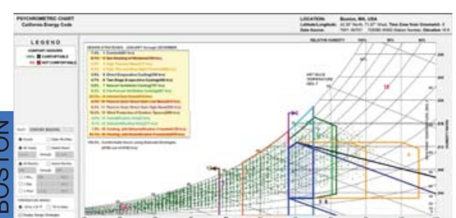
Cold city on the New England Coast – humid, windy, cold
Boston, MA
Library

Q A.1

Albion Public Library - Perkins + Will

- Toronto, Canada
- 2018 COTE Top 10
- 29,000 sqft
- Top 3 heating and cooling strategies were the same for Toronto and Boston
- 40% reduction in energy from previous library on adjacent site
    - Conventional systems paired with low glazing (40%) and a tight envelope (R40 walls)

BOSTON

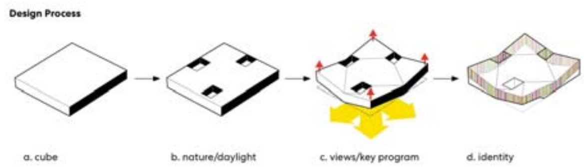


TORONTO

Q A.2

Albion Public Library - Perkins + Will

- Heating -
  - Internal heat gain - uses people, computers, and other tech from makerspace
  - Conventional Heating - predominantly used
  - Passive Solar Direct Gain Low Mass - not a lot of use; has tile flooring which heats up slightly from the sun



- Cooling-
  - Sun shading of windows - vertical slats used to help screen windows
  - Natural ventilation cooling - not purposely used, might get a cross breeze when entrance and courtyard doors are open at the same time
  - Fan forced ventilation cooling - predominantly used

Q B.1-2

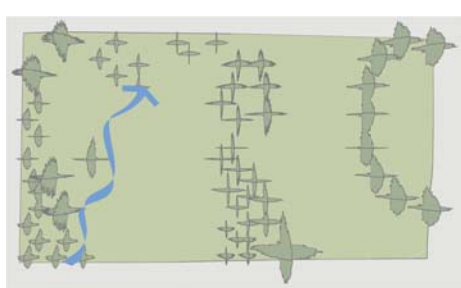
Target Goals & Initial Revisions

BUILDING SUMMARY

LOCATION	Boston, MA	02108
USES	Library	20,000 sq ft (100.0%)

RESULTS	BASELINE	TARGET	YOUR BUILDING
EUI % Reduction from Baseline	0%	80%	N/A
Zero Score	100	20	N/A
Site EUI (kBtu/ft²/yr)	157	32	N/A
Source EUI (kBtu/ft²/yr)	236	48	N/A
Total GHG Emissions (metric tons CO_2e/yr)	196	40	N/A

- The baseline EUI for our library (157 EUI) is higher than the national average (143.6 EUI) according to Energy Star Portfolio Manager and CBECS – Library.

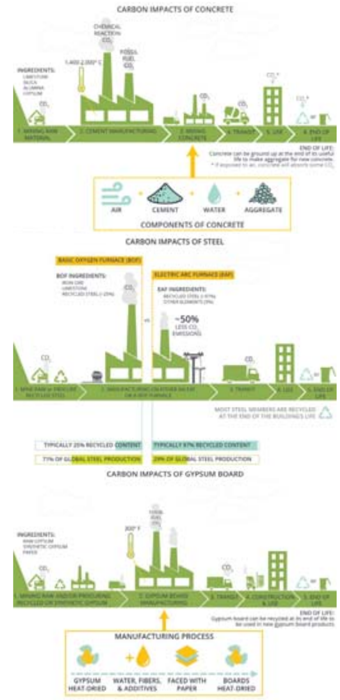


- Our initial design from lab 1 utilized the southern side to optimize heat gain as well as to provide natural lighting. Upon further review of the top psychometric strategies, this is still the best course of action, but our design will have to be careful to provide sun shading during summer months but provide the ability for passive solar gain the rest of the year and minimize any conventional heating. Additionally, the south side will be advantageous as a switch since that is the direction that summer winds blow in from and thus can further help to natural ventilate the building.

Q B.3-4

Material Use, Consequences, Substitutions

Our initial material palette included: concrete, steel, veneer brick, gypsum board, mineral wool insulation, glass and carpet. After looking at existing library's in Boston, we saw that a majority were made in a Colonial style. Because of that we chose to include brick veneers in our material palette as an exterior cladding that would be in harmony within the Boston library system.



Concrete – foundation; low walls
- Responsible for 6-10% of global emissions
- Most of emissions from processing

Substitution
- Replace low walls with stone blocks from local quarry
- Make foundation use clean, hard aggregate that is strong to help support loads; inject CO2

Steel – framing (walls, roof, beams, etc)

Substitution
- When needed, specify from an electric arc furnace plant
- Use reclaimed structural steel as needed

Veneer brick – siding/façade
- Under the same limitations as concrete as it just a different form of the material

Substitution
- Replace with bricks that have been injected with CO2 or made as a bioconcrete which helps to capture CO2 as part of its creation process

Gypsum board – interior cladding
- Energy intensive to produce
- Difficult to recycle

Substitution
- Replace with Ortech's Durra Panel – a straw based, fire resistant panel

Q B.3-4

Material Use, Consequences, Substitutions

Glass (double pane) – windows and doors

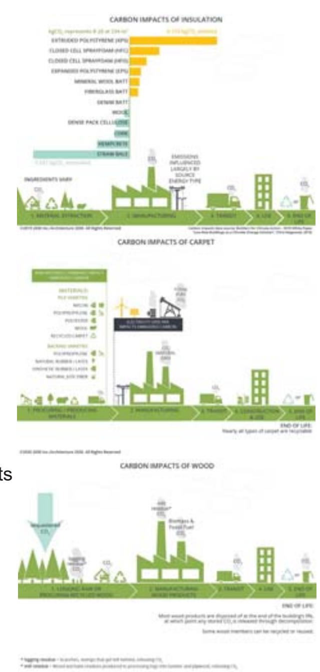
Insulation – MineralWool for insulation in walls and ceilings
- Emissions vary drastically depending on kind of insulation

Substitution
- Replace with denim matts as available (donations from community to save on cost) or with cork (can double as a roofing material)

Carpet – floors
- Responsible for most carbon of interior finishes generally

Substitution
- Specify for floors to be left unfinished (concrete) where possible, or use wood flooring or recycled fiber carpet

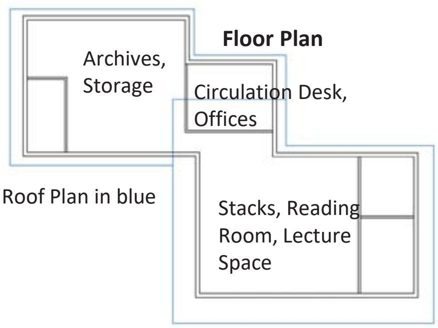
Wood – for finishes, flooring, and beams
- Use for beams if reclaimed structural steel is unavailable
- Use reclaimed or salvaged wood when possible
- Specify wood from sustainably managed, fast growth forests



- While our initial material palette was somewhat sustainable, we found that there were a lot of ways to make our selection smarter by choosing more natural materials, or materials which had more recycled products in them.
- Also we decided upon further review to include the use of wood to finishes (interior and exterior) and potentially as an alternative flooring finish to carpet or exposed concrete.

Q C.1

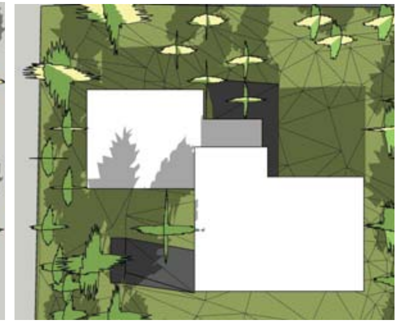
Schematic Design



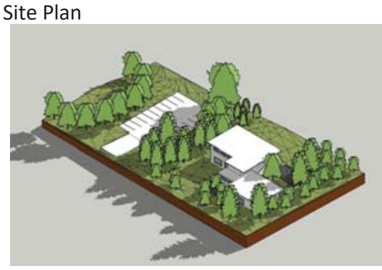
Roof Plan in blue

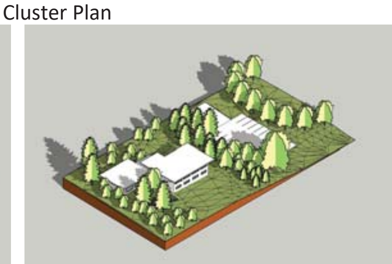
Roof overhangs are longest on the South façade to provide shade in the summer, but admit direct sun in the spring, fall, and winter. They are shorter on the East and West facades to admit sun in the shoulder seasons and Winter, but block harsh direct sun in the summer. Roof overhangs were not necessary on the North façade, but we included small ones for design continuity and language.

Site Plan



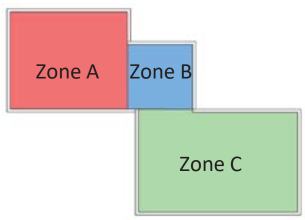
Cluster Plan





Axonometrics

Sections show scale of openings and roof overhang

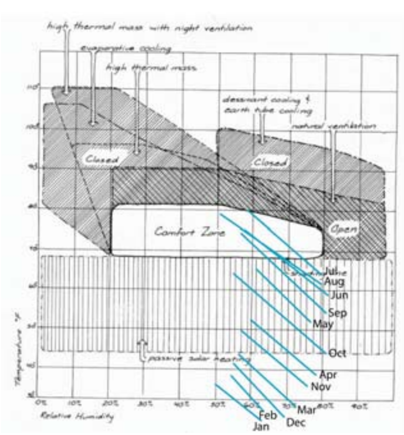


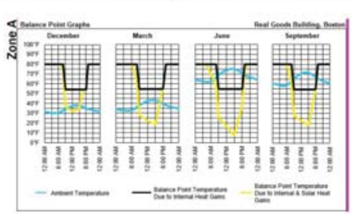
Zones A and B are shielded from cold winds by trees. Zone C gets lots of direct sunlight from southern exposure. Large apertures on the Southern façade help to passively heat the building. Clerestory windows on the N and S facades provide natural ventilation.

S Elevation

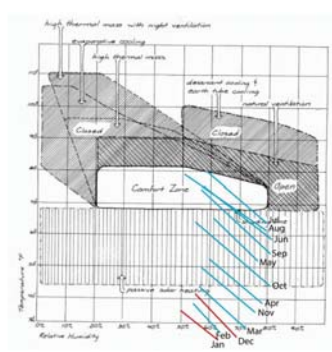
Q C.1

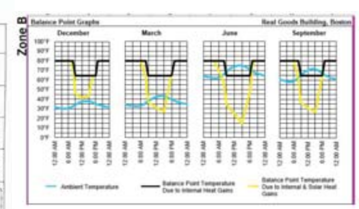
Bioclimatic Charts Thermal Strategies



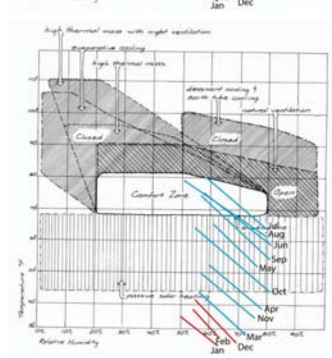


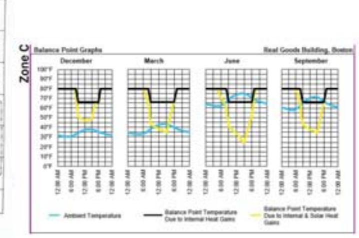
Zone A – NO heating required, passive solar heating and internal load gain is sufficient. Summer months still fall within the comfort zone.





Zones B & C: For most months, passive heating and internal load gain is sufficient, but heating is necessary in the coldest winter months.

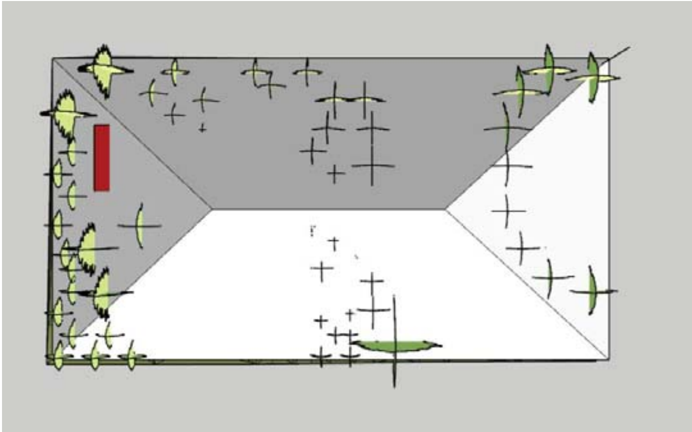




Q. C.2

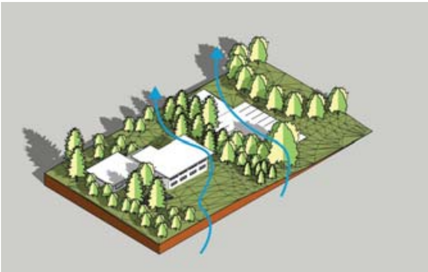
Solar Envelope

- The far west side of our building falls slightly above the solar envelope. But it is also notable that directly to the West and North of our site is the street – so shadows from this part of the building will not block any sun to the neighbors. We could possibly angle the roof planes so that this plane does not cross the solar envelope.

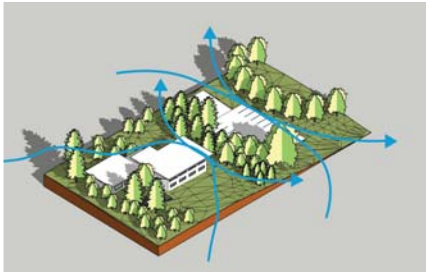


Q. C.2

Site Microclimate – Wind Flow

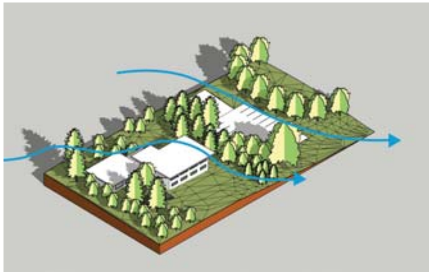


Summer Wind Flow – predominately from the SW

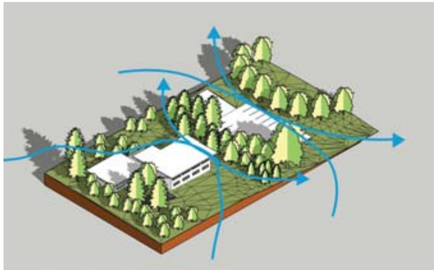


Spring Wind Flow – from the SW and NW

Primary outdoor spaces for summer will be at the Southern patio shown in the site plan, which is exposed to summer breezes but is shaded by trees to the S, as well as the Northern patio which will be fully shaded and more comfortable on a still, hot day. Outdoor spaces for the Winter will be the Southern patio, which is protected from cold winds coming from the North.



Winter Wind Flow – predominately from the NW

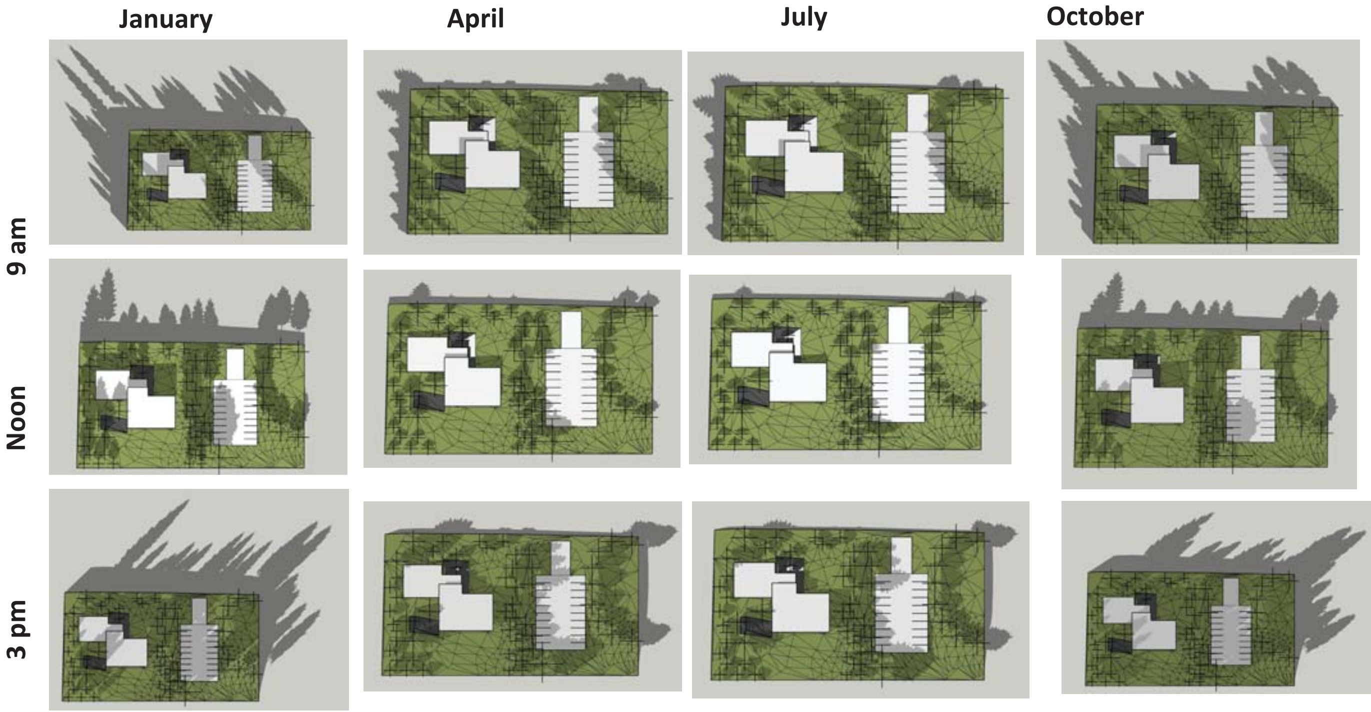


Fall Wind Flow – from the SW an NW

Q. C.2

Site Microclimate – Shade Study

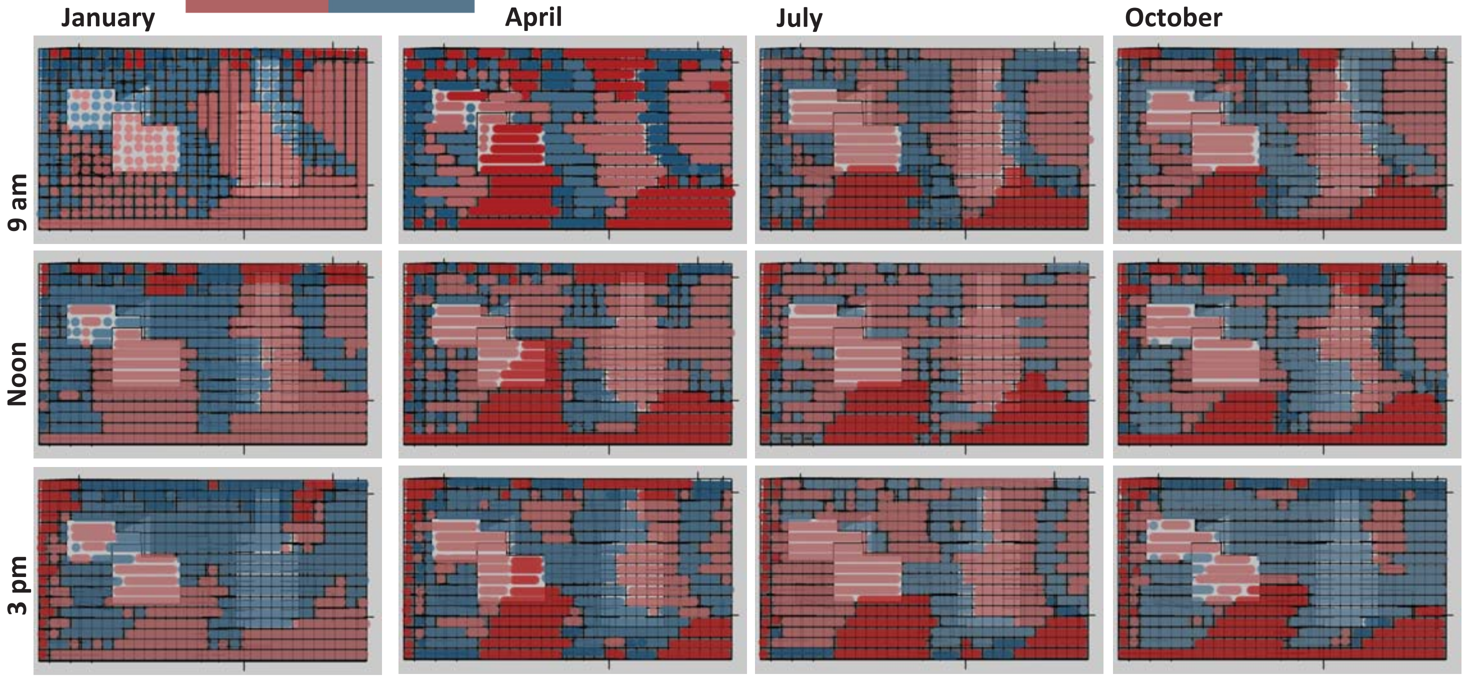
Our site gets lots of Southern exposure, which desireable in the Fall, Winter, and Spring. The Southern façade should have horizontal shading over the apertures to block the high sun in the summer but admit low direct sun in the winter.



Q. C.2

Climate Response Matrix

The climate response matrix shows that we are still getting direct sun with little wind from the South during Winter, but winds from the south pick up in the spring, so South facing windows should remain closed. In the summer we get lots of direct southern exposure, but breezes come from the south so we can take advantage of cross ventilation. Outdoor spaces on the SW corner of our building get direct sun in the winter but are protected from the wind by trees, so they would make good outdoor seating areas in the colder months.

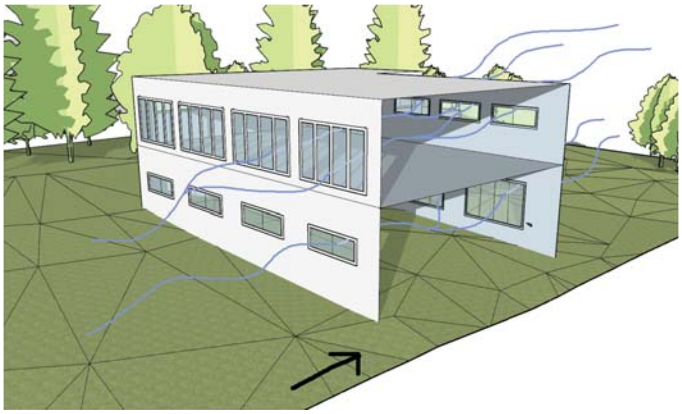


Q C.3

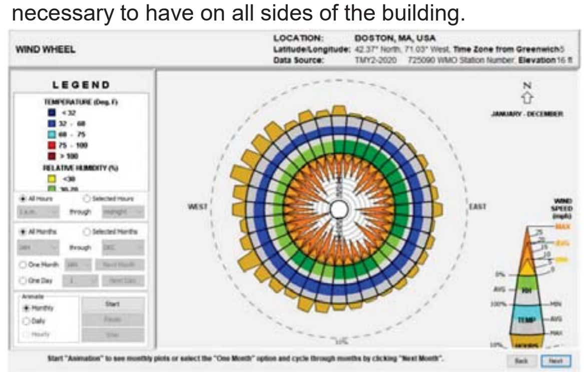
Ventilation Air Flow

Ventilation Aperture

Zone	Area (sqft)	Ventilation Strategy	Ventilation Method	Internal Heat Density (Btuh/sqft)	Wind Speed (mph)	Recommended Ventilation Aperture (sqft)
A	5,500 sqft	Mixed	cross	12	10	60
B	2,500 sqft	Mixed	cross	25	15	45
C	6,100 sqft	Open	cross	17	15	65



Boston's wind direction changes often, therefore operable windows for proper ventilation is necessary to have on all sides of the building.



Q C.3

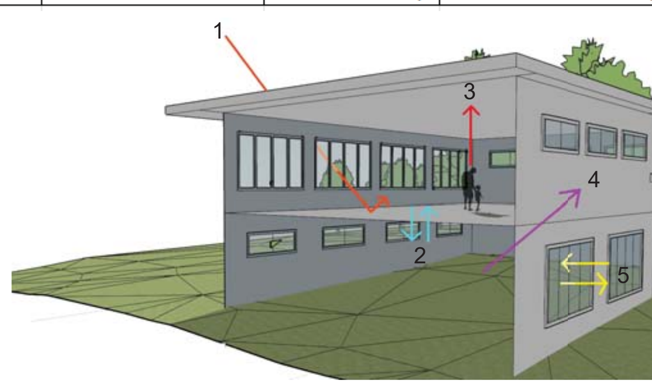
Solar-Glazing and Thermal Mass

Solar Aperture

Zone	Floor Area	Type of Strategy	Recommended Areas Glass/Mass	Heating Degree Days	Target NCL	Estimated NCL (C1.4)
A	5,500 sqft	Trombe wall w/ night insul	Glass = 2,200 sqft Mass = 6,600 sqft	5641	4.6 btu/DDF sqft	4.4 btu/DDF sqft
B	2,500 sqft	blue-green commercial low-e glazing	Glass = 1,000 sqft Mass = 3,000 sqft	5641	4.6 btu/DDF sqft	4.5 btu/DDF sqft
C	6,100 sqft	blue-green commercial low-e glazing	Glass = 2,440 sqft Mass = 7,320 sqft	5641	4.6 btu/DDF sqft	4.5 btu/DDF sqft

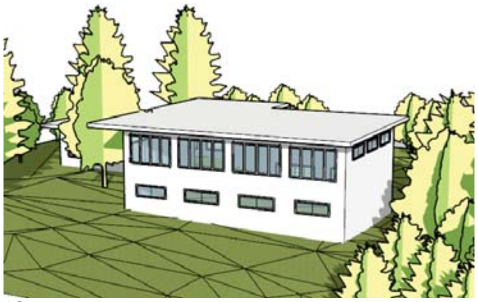
Zone A- NO heating required, only cooling.
Zone B & C- Heating required in December-January

1- Heat gain from sun
2- Heat trapped in mass (floor)
3- Internal heat gain
4- Heat conducted and/or insulated by walls
5- Heat gain and losses through ventilation



Q C.3

Window Shading (winter)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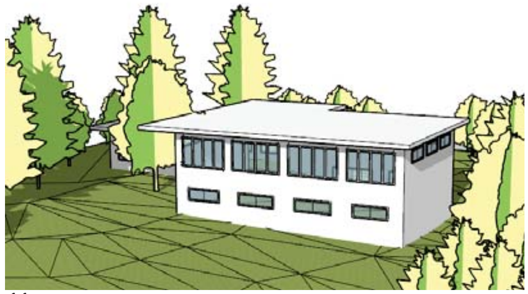
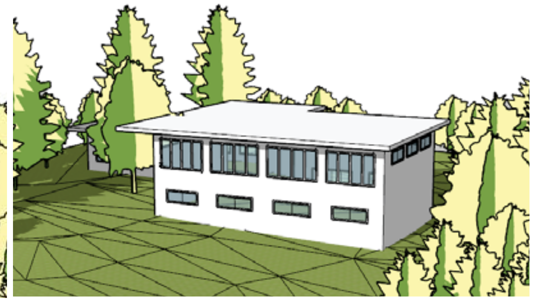
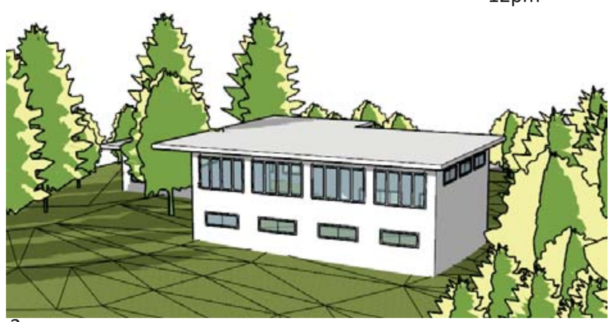

11am


12pm


1pm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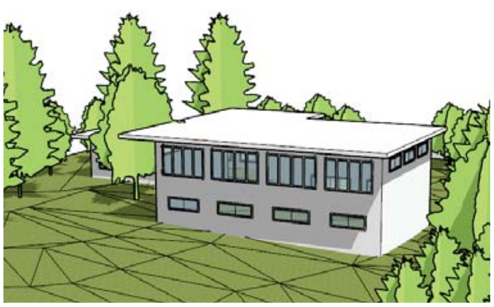
During the months where heating is needed for **zone B & C**, the south façade of the building is being hit with direct sun during the hottest times on a winter day.

Q C.3

Window Shading (Summer)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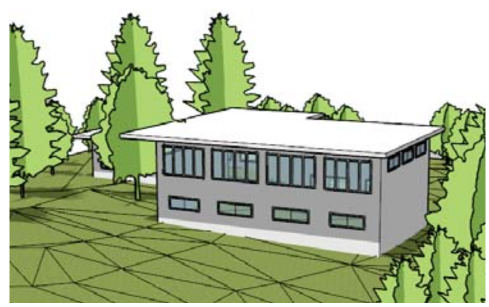
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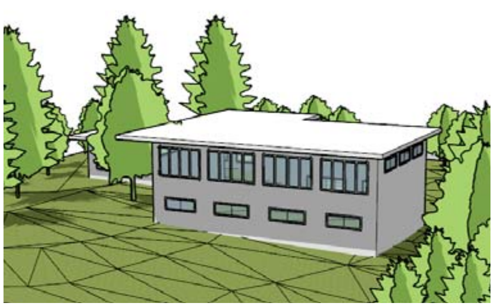
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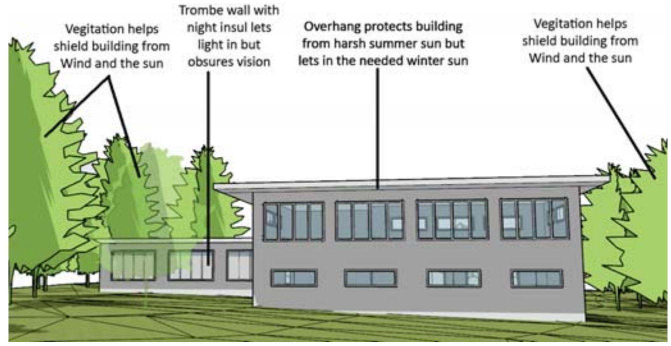
Zone A (far left hidden by trees) Is shaded by the trees and requires no additional shading devices. **Zone B and C** (large main building mass) are not shaded by trees on this south side, but due to the large roof overhang no additional shading is required.

Q D.1

Design Critique

- The initial heating and cooling recommendations asked for good shading, but with passive solar gain. This necessitated having overhangs to shade the structure during summer but then to help heat the building the rest of the year as the sun angle fell.
  - This made it a little more difficult to find an appropriate place for the controlled outdoor area that is a part of the program.
- In addition to wanting to use the strategies mentioned above, there was a desire for natural ventilation cooling. This usually involves the use of the wind. We tried to shield our building from the wind as much as possible as it is already so cold in Boston. This makes it hard to utilize the winds that are predominantly from the southwest, where we left the row of trees to protect the building from the wind. Whether or not the building is able to cross ventilate will depend upon the exact direct the wind is coming from.
- Our building design did well in terms of placement of programmatic elements due to their heating/cooling needs in conjuction with the user experience. Patrons desire a warm and pleasantly light environment to read and do other activites at a library, which is why placing those areas on the south side of the building works well to warm them through passive gain and internal loads in the cooler months, but to provide shade from the overhang in summer. On the northwest corner, there is no real need for heating as it can stay warm enough from passive gain and internal loads so placing it in an area of the site where the winds are less consistently hitting that side will minimize the amount of unwanted cooling.



Conclusion

- Overall, this lab went over well. We did struggle with understanding some of the InsideOut instructions and relied on the help from one another to comprehend them. We had to go over certain sections multiple times to fully grasp what was needed from us. Nevertheless, it was an excellent exercise to learn and execute a systematic design that is influenced by science.