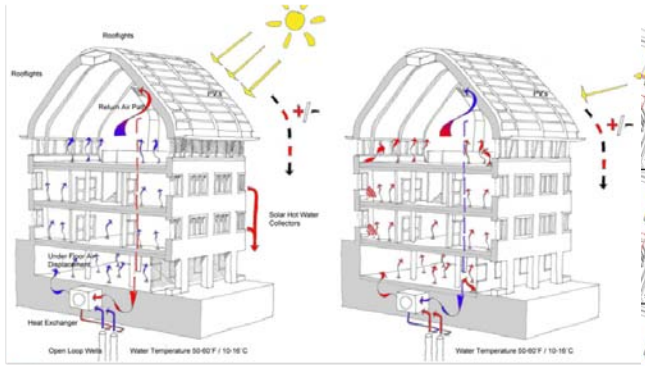
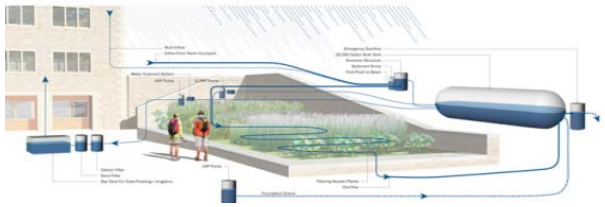
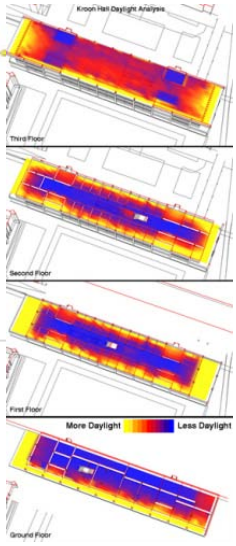
ARCH 5516•LUMINOUS AND THERMAL DESIGN
ECOLOGICAL DESIGN FOR THE 21ST CENTURY







Project: Kroon Hall, Yale School of Forestry and Environmental Studies
Location: New Haven, CT
Architect: Hopkins Architects
Building Type: Higher Education, Library

PROJECT THREE
Phase 2.0: Final Integrated Design
Holistic Systems Integration and Analysis

Phase 2.0: Grading Weighting: 70% of Project Three (280 points of 400 points)

- **In-process team critique:** Friday February 25, 10:00 am-12:00 p: Optional Desk-Crit - sign-up for one 30 minute team critique;
- **In-process team critique:** Monday, February 28, 10:00 am-12:00 pm**:** Informal 30 minute balcony pin-up;
- **Phase 2.0 Due**: Friday, March 4, 10:00 am-12:00 noon**;** Final review - all teams please pin-up by 9:45 in Rapson Hall Courtyard

Reading
Lechner, Norbert; Heating, Cooling, Lighting. New York: John Wiley & Sons (2nd or 3rd ed.)
Please Read: Chapter 8: Photovoltaics and Active Solar; and Chapter 16: Mechanical Equipment

Introduction
In the final phase of Project Three, teams will complete the design and evaluation of their project. You will propose your final recommended design solution for the mnZED Lab Addition to Rapson Hall and compare the performance to the Baseline Case. This Baseline Case should be the initial concept that was presented in Project One and analyzed as the Baseline Case in Project Two. Your final design should be informed by the analysis of your incremental design improvements made during Project Two and in Project Three, Phase 1.0. In Phase 2.0 you will integrate passive thermal and luminous design considerations as well as the key building systems including *Lighting, Heating, Cooling, Ventilation and Renewable Energy Systems.* The building solution should respond adequately to the program provided at the outset and it should meet the energy, daylighting and other relevant goals set by your team.

You will analyze the final design and compare the results to the original *Baseline Case* showing the estimated improvements in energy use, greenhouse gas (carbon dioxide) emissions, thermal comfort, daylighting performance and other metrics (performance measurement) of your choice. To do this you will make the necessary modifications to your ECOTECT thermal model, and perform the necessary analysis to determine the resulting change in performance. Your daylighting analysis will be accomplished using ECOTECT (Radiance and Daysim are optional). In order to estimate and compare the total energy consumption and of your building including any renewable energy systems you have added, a renewable energy/carbon calculator (filename: 2011-5516_Carbon-RE-Calculator_v.3.0.xlsx) has been provided. You will present your findings through charts, graphs and narratives and convey your proposed design solution through the use of annotated plans, sections or axonometric diagrams and models as appropriate and as outlined in the *Presentation Checklist* at the end of this assignment. In addition you will also be asked to show graphically how the various design strategies and related systems are integrated into your design.

Step 1: DESIGN REFINEMENT

i Design Integration: Incorporate the preferred explorations from Project Three - Phase 1.0: The Room and Envelope into your final design for Phase 2.0. You should ask questions such as:

- *Consider the overall design concepts and intentions: Does the design, as a whole, integrate effective daylighting, heating, cooling and ventilation with other ecological opportunities?*
- *Does it indicate a holistc systems integration approach to the project?*
- *Does the design balance poetics and pragmatics?*
- *Does the design positively impact the existing Rapson Hall facility in terms of visual and thermal comfort, environmental quality,energy use and aesthetics?*

ii Problem Resolution: address potential problems or unresolved design issues in your design (e.g., unresolved circulation issues, building infrastructure connectivity and alignment, excessive floor area values with respect to program requirements, etc.).

iii Systems Integration: Holistically integrate all major systems including daylighting, passive and active heating, passive and active cooling, passive and active ventilation, renewable energy systems and related controls strategies.

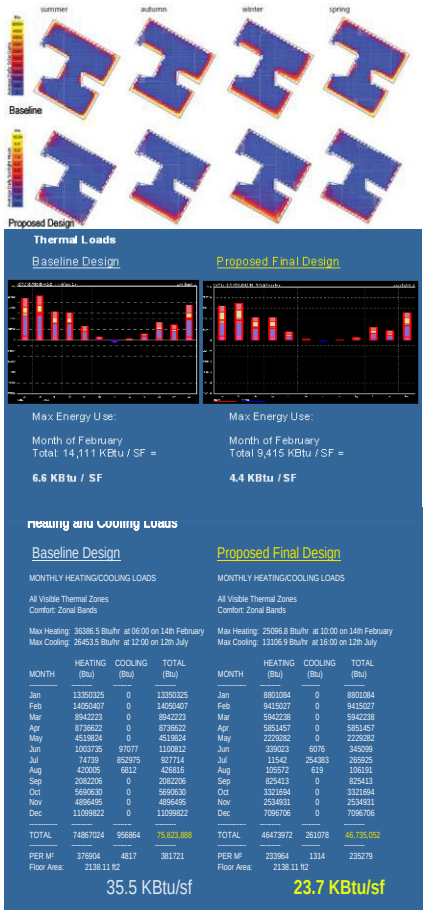
iv Eco-effective Design: Using an *eco-effective* approach, optimize benefits resulting from your design proposal not only to the immediate building occupants, but also to external communities and ecosystems. (e.g., urban heat island effect, wildlife habitat, carbon emissions, etc.)

Step 2: ECOTECT MODEL REFINEMENT: UPDATE YOUR FINAL ECOTECT MODEL

i Incorporate the necessary modifications reflecting all possible proposed design refinements from "Step 1: Design Refinement" into your ECOTECT model and save it as a "Final Design Case" for comparison to your preliminary design "Baseline Case" from Project Two.

ii Investigate problems and troubleshoot simulation errors and model construction problems (e.g., see "Error Messages" topic in the ECOTECT HELP!)

iii Check to see that all appropriate values for object materials, HVAC system mode, occupancy load and schedules, internal loads for lighting and equipment and establish the appropriate operating schedules are included. Remember to make changes to the internal loads settings for lighting, plug loads and air infiltration with respect to the "Baseline Case" in order to allow for energy conservation measures (ECM's) such as tightening the envelope, using more energy efficient lighting, occupancy sensors, daylight control of lighting, energy efficient equipment, etc.



Step 3: PERFORMANCE ANALYSIS: Final design case

Simulate your "Final Design Case" using ECOTECT. Use the same times and seasons for all daylight and thermal studies as used in past studies (e.g. 9am, noon and 3pm for three days - summer solstice - June 21, winter solstice - Dec 21 and Equinox (Mar/Sep21).

i <u>Daylight Studies</u>:

a) Required: Daylight illuminance analysis *(in fc)* of your final building proposal illustrating the diurnal and seasonal light levels. The studies may be shown in plan or axonometric (3D) view. Use either Ecotect or Radiance to create these studies. (Radiance is preferred)

b) Recommended: Using Radiance, create perspective renderings of aselected space showing spot illuminance values, contour lines or both.

c) Optional: Using Daysim, generate Daylight Autonomy and/or Daylight Utilization (UDI) studies that help to substantiate your daylighting design performance (convert to footcandles from lux as needed).

ii <u>Thermal Studies</u>:

a) Required: Average Monthly Heating and Cooling Loads for all zones – include a loads Chart. It is recommended that a Data Table also be provided. Indicate the thermal performance (EUI) of your proposed final design in KBtu/sf as compared to the Baseline case?

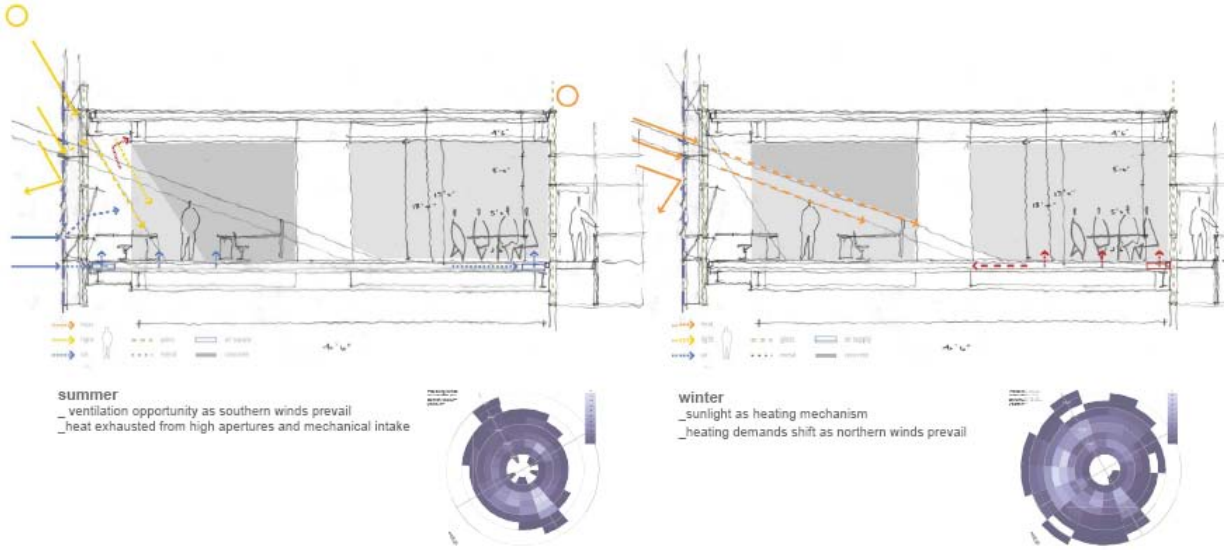
b) Required: Perform thermal analysis of your choice to assess the thermal comfort performance of your design, e.g., Hourly Temperature Profiles,

Temperature Distribution, Thermal Discomfort, Solar Gains, Fabric Gains, Temp/Loads Comparison, etc. Indicate the thermal comfort performance of your proposed final design compared to the Baseline.

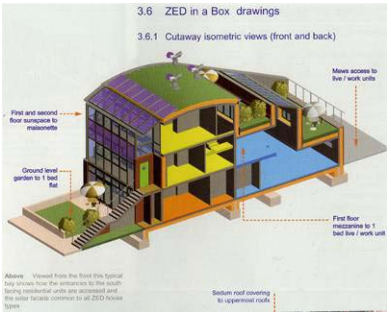
c) Recommended: Passive Gains breakdown, preferably for selected zones where passive strategies are being employed or for all zones to evaluate the improved effectiveness of your passive design approach. Include numeric breakdowns by percent.

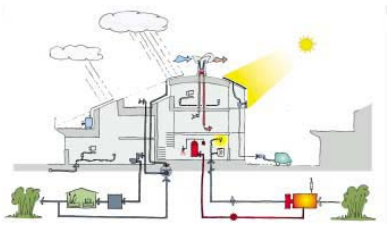
d) Optional: Perform a resource consumption/load matching analysis showing the production of your renewable energy systems vs. your building energy use. This may be displayed in either KWh or CO^2 Emissions.

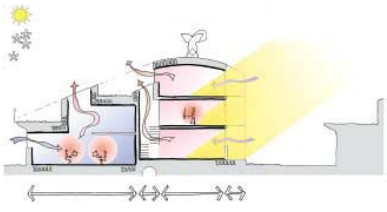
Note: You are asked to also include your original "Baseline Case" for daylighting and thermal in your final presentation.



Step 4: MODEL and Graphic INTEGRATION STUDIES







i <u>1/16" Massing Model</u>: Develop a physical model of your final design project at 1/16 scale. You may update the massing mode from an earlier project based on your final design or you may fabricate a new model, whichever is more expedient.

ii <u>Graphical Systems Integration Sections and studies</u>: Use sections or sectional axonometric drawings to illustrate your approach to the following systems integration:

a) Daylight, electric lighting, and solar control systems integration. Include conceptual electric and control strategies.

b) Passive/active solar and conventional heating systems integration.

c) Passive/active cooling and ventilation systems integration.

d) Renewable energy systems and proposed building integration concepts.

iii <u>Plans, Elevations and Other Renderings</u>: Provide drawings representing how your design meets the program requirements:

a) Concept and Site: Provide a site plan and area map for your project at an appropriate scale (see Bioclimate studies as appropriate); include concept diagrams as appropriate to introduce overall design intentions

b) Floor Plans – 1/16" scale (recommended) or scale of your choice (consider including room labels and area in s.f. Indicate zoning and circulation paths, etc.).

c) Elevations – 1/16" scale (recommended) or scale of your choice (consider including materials and equipment annotation, etc.)

d) Provide perspective renderings of your building in full and/or partial views graphically representing the design details, materials and integration with the existing.

iv <u>Optional: 1/16" windflow model section studies</u> of your passive ventilation schemes, illustrating both the new and old sections (north-south section).

Step 5: WRITTEN FINDINGS AND CONCLUSIONS

Develop a brief written summary of the findings and conclusions of your analysis and your design explorations. Please include the following in your presentation:

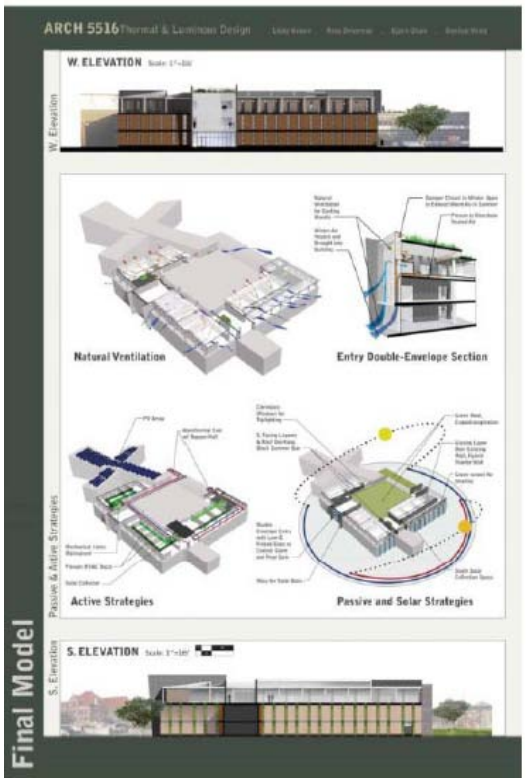
i. Design Intentions, Concepts, and Strategies: Summarize the critical design intentions, concepts, and strategies related to daylight, thermal, and zero-energy design.

ii. ZED Performance: State clearly how well your final design meets your ZERO energy performance goal using written and/or graphic means.

iii. Carbon Emissions: State clearly how well your final design performs in terms of annual carbon emissions using written and/or graphic means.

iv. Ecological Impacts/Benefits Summary: Summarize the Eco-effective benefits of your final design to the community and surrounding eco-systems.

v. Strengths and Weaknesses and Lessons: List the major strengths and weaknesses of your design proposal? Lessons?



PRESENTATION CHECKLIST: PROJECT THREE

FINAL REVIEW: FRIDAY, MARCH 4; 10:00-12:00; Pin up completed by 9:45 a.m.

Required format: 4-6 boards at 24"x 36" (vertical format). *Label all charts, tables, graphs, plans, elevations, sections and other diagrams.*

1. ***Overview: Design Intentions, Concepts, and Strategies:*** Include an introductory board illustrating your overall design intentions (consider site and bioclimate studies).

2. ***Project Three: Phase 1.0: THE ROOM & ENVELOPE: Experiencing Sustainability***
   Updated daylight program, room and envelope study models and Ecotect room analysis studies: See " "Submission Checklist" on page 3 of Project Three – Phase 1 handout.

3. ***Project Three: Phase 2.0: Final Integrated Design*** *Holistic Systems Integration and Analysis*

   a) ***ECOTECT Comparative Analyses – Proposed Final Design compared to the Baseline Case from Project Two:***

   i.) *Daylight Illuminance Studies for final design (noon for June 21, Dec. 21, and March/Sept. 21)*

   ii.) *Thermal Studies for final design*

   - Required: Average Monthly Heating and Cooling Loads Charts
   - Required: Selected Thermal Comfort Analysis Study
   - Recommended: Monthly Heating and Cooling Loads Data Table including peak load conditions
   - Optional Passive Gains Breakdown Charts and Data
   - Optional Resource Consumption/Load Matching Chart for Renewable Energy Systems production compared to Building Consumption (Final Design Only)

   iii.) *Baseline Cases for Daylight and Thermal from Projects One and Two: include the same or similar daylighting and thermal studies from your previous analysis of your "Baseline Case" to compare to your "Final Design Case."*

   iv.) *Comparative Site Energy Use Intensity(EUI) in KBtu/Ft^2*

b) ***<u>Models, Drawings and Graphical Systems Integration Studies:</u>***

i) *<u>Updated Massing Model at 1/16" = 1'-0" scale (recommended)</u>*

ii) *<u>Floor Plans at 1/16" = 1'-0" scale (recommended)</u>*

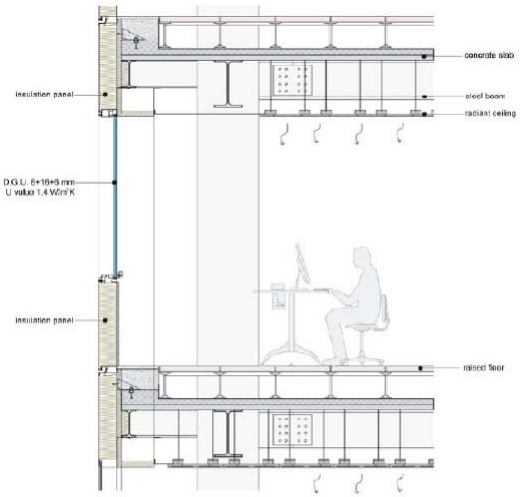
iii) *<u>Elevations at 1/16" = 1'-0" scale (recommended)</u>*

iv) *<u>Graphical Systems Integration Sections and Studies (building section or cutaway axonometric)</u>*

- Annotated study explaining your daylight, solar control, and electric lighting systems integration.Annotated study explaining your passive and/or active solar heating systems integration.
- Annotated study explaining your passive and active mechanical cooling and ventilation systems integration.
- Annotated study explaining your renewable energy systems integration.

v) *<u>Updated Windflow Model Studies (optional)</u>*

c) ***<u>Written Findings and Conclusions</u>***: Include a brief written summary (Step 5 above)



NOTE: Please also submit (2 copies) 11"x17" color copies of your boards and upload PDFs of all of your boards as well as your final design case and baseline case Ecotect models to the course website on Moodle.

GRADING CRITERIA: Project Three: 40% (400 points total)

Phase 1.0 and 2.0 Final due for grading on Friday, March 4

Phase 1.0: Grading Criteria: 30% of Project Three (120 points of 400 points)

- Clarity and craft of revised daylight program and coded plan (for the full building addition)
- Clarity and execution of design intentions demonstrated in the physical models and photo-documentation
- Accuracy of Ecotect quantitative daylighting and thermal studies
- Clarity of summary of findings and craft of *Phase 1.0 Project Three* presentation board(s)

Phase 2.0: Grading Criteria: 70% (280 points of 400 points)

Phase 2.0 Final due for grading on Friday, March : integrate with Final Project Three Presentation

- Clarity and execution of design intention demonstrated in plans, sections, elevations and diagrams
- Clarity and execution of design intentions demonstrated in the physical model
- Clarity and accuracy of Ecotect (optional Radiance/Daysim) quantitative daylighting and thermal studies
- Clarity of summary of findings and craft of Phase 2.0 Project Three presentation board(s)
- Clarity of Written Narrative and Carbon Calculations