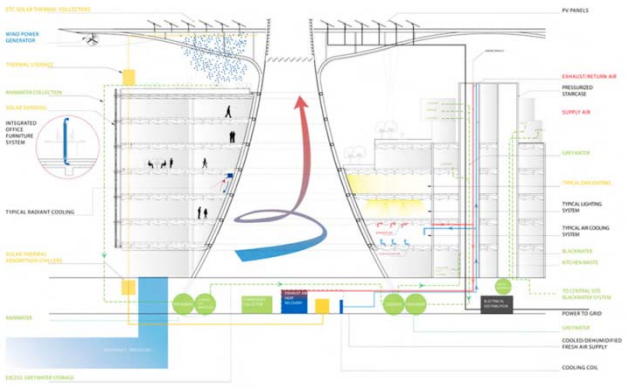
# ARCH 4150/5550 • Whole Building Analysis

# *Envisioning the Sustainable Campus*

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

Rendering of Masdar HQ. Copyrights: Adrian Smith+ Gordon Gill



Section drawing noting the different sustainability strategies.

## Exercise 6: Integrated Zero+ Design
## Holistic Integration and Performance Analysis

### Due Dates

Due Thurs. Dec.15, 12:30 PM, Formal presentation; Rapson Hall Courtyard

*Exercise 5.0 Grade weighting:* *50% total grade (500 points); as follows*
*25% total grade (250 points); individual grade (Phase 1)*
*25% total grade (250 points); team grade (Phase 2)*

### OBJECTIVES

- To learn to integrate various sustainable strategies and systems across boundaries of building and site.
- To learn to assess building performance metrics including energy use, renewable source energy, potable water use, rainwater harvesting and various water reclamation and life-cycle cost.
- To learn a methodology for "bundling" or combining of strategies – and creating several design cases for analysis and comparison to the baseline.
- To gain an understanding of preferred method of eco-effective design where conservation comes before application of renewable source energy strategies.
- To learn to evaluate a variety of renewable energy technologies for feasibility and cost life-cycle cost.
- To conclude development of your recommended project design towards net-zero and zero+ performance goals.

### OVERVIEW

For this final exercise you will complete the analysis for your project, by creating "bundles" of strategies organized in a logical fashion and including various energy conserving strategies, daylighting, water conservation and sustainable site BMP's as well as integration of innovative systems and renewable energy technologies. These "bundle" will represent Building 1 Building 2 and Building 3, where Building 3 will be the most aggressive combination of strategies aimed at achieving *net-zero energy, water and carbon emissions*. You will create these separate models and simulate them to the best of your ability in IES VE. You will then transfer the results of your various simulations into the *Zero+ Calculator* tool provided for further evaluation including addition of the strategies and systems you were not able to model in fully in IES. You will also use the tool for integration of Source energy, water, carbon emissions calculations and Life Cycle Cost Analysis of your 3 Proposed Building options compared to your baseline. You will be asked to create a written narrative of the results of your analysis up to this point and the findings and conclusions that you will use as you move into the next phase of design and whole building analysis. You will also be asked to present your findings and design recommendations as part of a larger group presentation for your project type.

You will work together as a team for all of the work, however **Phase 1** will be accomplished working in your smaller team of 2 or 3 individuals whereas for completion of **Phase 2** you will be asked to work in the larger

team consisting of all the individuals working on the same project for this class. As there are three projects, there are three teams. Each team will select from among themselves a project manager who will create a workplan containing the task assignments for the group. The final deliverable is a *powerpoint slide presentation (not in .pdf format)* that contains the following information:

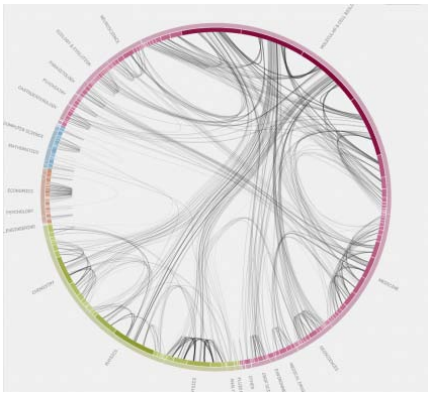
Presentation Contents:

1. Project Overview and Background Information
2. Descriptions of the 3 Building Cases (bundles) being explored
3. Detailed analysis results
4. Summary of Findings and Conclusions
5. Recommendations and Next Steps
6. Q & A and Comments

The presentation will be made to the prospective "client" representative and other expert guests on Thursday December, 15, 2011 at 12:00pm in a location to be announced. Each team will have 30 Minutes for their presentation including questions and comments from the "client" representatives and guests. Please allow at least 10 minutes for questions and comments.

## PHASE 1 REQUIREMENTS

### STEP A: SUSTAINABLE STRATEGY INTEGRATION AND BUNDLE DEFINITION



As a team, identify the linkages and synergies of the proposed sustainable strategies for your project.

1. Make a list of all strategies proposed for your project and your performance goals (e.g., Net-zero energy use, Net-zero water use, Net-zero carbon footprint, Zero waste during construction and operation, etc.)
2. After reviewing your performance goals, create an integration matrix or diagram of the sustainable strategies that address each of your performance goals.
   • *Note: Identify the relative strengths of the relationships between the strategies and all of the performance goals.*
3. Consider the strategies that address only one performance goal and evaluate whether they can be modified in some way to address multiple goals?

Create the Strategy Bundling matrix of the Building design cases to be studied.

1. Make a matrix consisting of the strategies from your integration exercise above and the three Building Three Building design cases to be studied. These are the bundles of strategies and systems you will analyze and compare with each other and to the Baseline case. (you may use the Bundle Worksheet Tool provided on the course Moodle site or create your own.
2. Organize the strategies in a logical way that allows for the best holistic systems integration. You might base the organization around performance level, initial costs, Life cycle cost or a particular design strategy. However they are organized, Building 3 should have the goal of achieving *Net-zero energy use, Net-zero water use and Net-zero carbon footprint.*

   • *Present: graphic analysis of the proposed strategy bundles for the three building design cases to be studied. Identify the inter-relationships and associated performance goals.*

### STEP B: HOLISTIC SYSTEMS INTEGRATION AND WHOLE BUILDING ANALYSIS

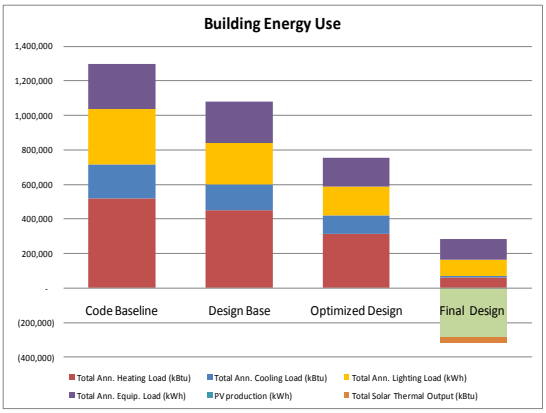
As a team, assess the task of assembling the three building design cases for analysis in IES.

1. Determine how the tasks relating to model creation and analysis in IES will be distributed among your team.
2. Create the three building design case models in Sketchup and/or using the IES ModelIt tool directly in IES VE Pro. Create your baseline model if you prefer (you have the option of using the baseline included in the Zero+ Calculator for your building.)

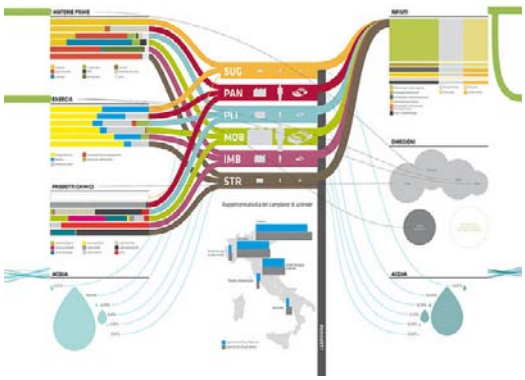
3. Set the energy cost parameters and import the "Prototype schedules and systems to allow the options needed for all your simulations.
4. Change the constructions, set up groups, adjust Apache Systems settings, set glazing properties, operating schedules and interior surface and shading surface definitions as appropriate to define your three building design cases. You may want to create building 1 and then make the necessary adjustments to Building 1 to create Building 2 building upon the work already done and then create Building 3 by building upon Building 2. Be sure to save your building design cases as separate IES models.
5. Add renewable energy systems as appropriate for each of the three building design cases.
6. Sequentially run Suncast, FlucsDL, Radiance and MacroFlow, etc. based on whether or not you are incorporating Daylighting or operable windows in the various Design Cases. At least one of your Design Cases must incorporate daylighting. After each simulation make corrections to your model settings as needed and adjust your strategies, optimizing various attributes as you see fit.
7. After you obtain the necessary interior studies using radiance, set up your daylight sensors and run the sensor dimming simulation for Apache. Then select your Daylight dimming method for the rooms you are daylighting.
8. Run your Apache dynamic simulations, linking to the results from Suncast, Macroflow, Radiance as needed. Don't link to Apache HVAC unless you are certain you have correctly set up custom HVAC systems using that tool.
9. If the results look suspect, check to see whether you have set up your model correctly. Make the necessary corrections and rerun your simulations until you are satisfied that the results are as accurate as possible.
10. Export the results from Vista into the Zero+ Calculator using the monthly output data required.
11. Combine. Can multiple systems be combined or can functions be shared in some way?.

## STEP C: COMPILE DATA, PERFORM SUPPLEMENTAL ANALYSES AND COMPARE RESULTS

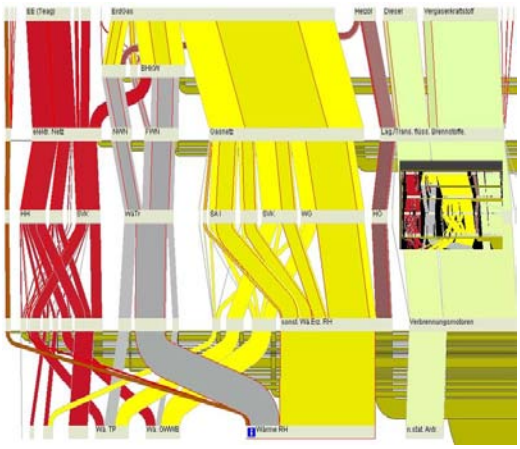
Enter the project data, IES simulation results and water usage and other performance enhancing parameters for the three Building Design cases into the Zero+ Calculator. Perform the following:




1. Enter information into the fields into the "Project Summary" Worksheet in the Zero+ Calculator as required.
2. Paste data from your various Building Design case simulations in IES Pro into the appropriate cells in the "Input Data" Worksheet in the Zero+ calculator.
3. Enter the Project floor area for each design case into the "Program" Worksheet in the Zero+ calculator as appropriate.
   Note: You may be able to leave the default data in the various cells, but if your program is different from that shown, simply replace the floor area data with the correct breakdown.
4. Return to the "Project Summary" Worksheet in the Zero+ Calculator. Enter the energy and other design strategies that you were unable to model in IES in the Energy Reduction Strategies Table. Not the data entered here must not be incorporated into your IES model for that case. Other wise you will be taking credit for the same strategy twice.




5. Using the Zero+ Calculator, compare the total estimated off-site energy generation requirements in KBtu/SF/Yr and the associated carbon emissions in Tons/Yr. for your various Design Cases as compared to the Baseline for your project.



## PHASE 2 REQUIREMENTS

### STEP A: COMBINE ANALYSIS RESULTS

Together with your teammates, you should review and compare all completed analysis and plan any other design conditions you wish to analyze and any further studies you would like to include in your final project presentation (see below).

a) Determine the strengths, abilities and specialties of your teammates and decide on task assignments for completion of the analysis, creation of output charts and graphics that show the design conditions modeled as well as the results.

b) Compile the results from the various teams into one set of IES Models for your 3 Building Design Options. Including Building 1, Building 2, and Building 3 Design Case. Make any further changes to each case that you wish to make to improve the results. Rerun the simulations and compile them into the Zero+ Calculator as before.


c) Assemble the best examples of FlucsDL and Radiance Studies that are associated with or similar to the building cases you are presenting and perform any additional Daylighting Studies to more fully assess lighting quality in your proposed designs. If more than one Building case includes daylighting, show the results side-by-side.

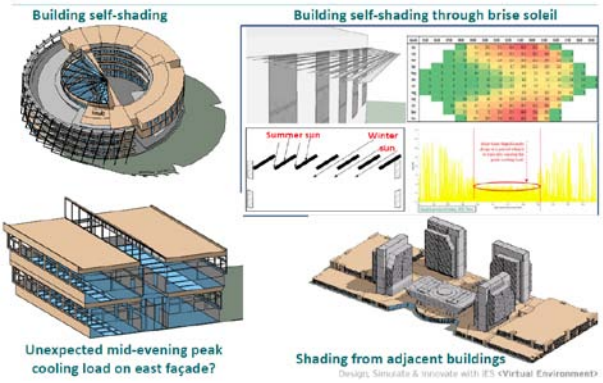
d) Performa any additional studies related to thermal Comfort (ASHRAE 55), natural ventilation strategies with operable windows using MacroFlo, renewable energy systems performance, or any other advanced analysis study of your choice.

### STEP B: DEVELOP PRESENTATION SLIDES.

Presentation Contents:

1. Project Overview and Background Information
2. Descriptions of the 3 Building Cases (bundles) being explored
3. Detailed analysis results
4. Summary of Findings and Conclusions
5. Recommendations and Next Steps
6. Q&A

Solar Shading Analysis



**Based on the strengths, abilities** and specialties of your teammates make task assignments for preparation of all necessary presentation slides (see presentation contents on page 1.) Plan to have no more than 15-20 slides.

a) Provide the following information:

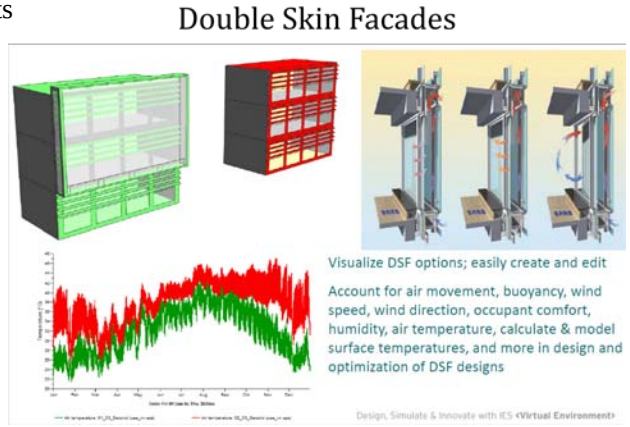
i. Project overview and background: include building type, use, floor area, number of building occupants modeled, hours of operation and baseline data including source of baseline energy usage. Review major objectives and design challenges.

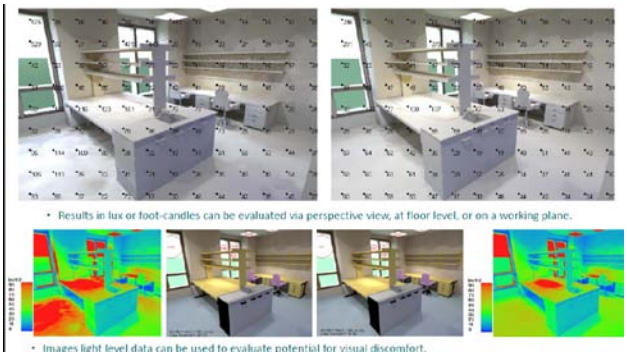
ii. Descriptions of the 3 Building Cases (bundles) being explored. Create plans, sections, exploded axons or other drawings to illustrate the strategies in each of your bundles.

iii. Detailed analysis results. Show the detailed results of the various studies that were completed for each of the Building Cases being presented. : Show the most important results from your combined analysis work, when possible the individual who performed the analysis should review it but you can also elect to have a spokesman for the various sub teams. Be sure to be brief and to the point using your graphical charts and drawings to "speak" for you. For each analysis, state the key conclusions that were reached including the overall savings in energy (MBtu or KWh or other metric) from the baseline, and also the percent of total energy use reduction resulting from that strategy.

iv. Summary of Findings and Conclusions: Present the summary comparison of energy use, energy cost, water use, source energy, carbon emissions and lifecycle cost analyses for the three Building Design cases as compared to the Baseline. Show a bullet list of the key findings and conclusions.

v. Recommendations and Next Steps: Based on your findings and conclusions enumerate your recommended strategies. State any problems encountered in the analysis that may affect the accuracy of your findings and any other caveats.




**Radiance Glare Studies**

b) Assemble your slides and review them as a team. Critique the presentation, determine where there are gaps, inconsistencies or information that is unclear. Decide on desired revisions and who will execute them. Be sure to add graphics that are needed to illustrate the conditions modeled, the results obtained and your findings and conclusions.

c) Set a date for a rehearsal.

d) Rehearse your presentation and make sure that the entire presentation can be made in 15 minutes or less. Fine tune any speaking and presenting assignments.

**STEP C: Deliverables:** Make final adjustments to your presentation. After giving your presentation upload your presentation file(s) to the ***Exercise6 Drop Box*** on the course Moodle Website by Friday. Nov. 16 at 4pm

## GRADING CRITERIA - Exercise Five: *50% total of ARCH 4150/5550 grade (500 pts)*

*25% Individual Grade and 25% Team Grade*

- Completeness of deliverables submitted
- Clarity and accuracy of quantitative analysis tables, charts, graphs and diagrams
- Craft and quality of annotated conceptual design drawings
- Depth of analysis and complexity of project and reasonableness of conclusions
- Clarity and accuracy of quantitative analysis charts and graphics
- Quality and craft of presentation - both verbal and graphical content