CHRIS THEIS

Louisiana State University

Comprehensive Architectural Design Studio

Fall 2007 Arch. 5001 (UG)

The studio work I have illustrated is from a fifth year "comprehensive design" studio in our Bachelor of Architecture program. The students work on one project for the entire semester. It is divided into four phases: research, schematic design, design development, and final documentation. Students are evaluated after each phase. There is a specific focus on sustainable design. It is always a project with a real site that can easily be visited and it is often a "real" project.

PROGRAM STATEMENT

The existing Visitors Center for the Gulf Islands National Seashore was severely damaged in Hurricane Katrina. This provided us with an opportunity to assess the damage and propose a structure that might hold up better, while analyzing the existing building to determine what could be done to make the new structure more efficient. Also the National Park Service is anxious to create more sustainable facilities and has indicated that all new facilities should serve as models of sustainable building practices. The exact amount of conditioned space varied because some students decided that several functions could be accommodated in unconditioned spaces. The example shown is approximately 14,000 square feet.

Climate + type PROFILE

Small- climate dominated building/ large - interior load dominated building. (Approximately half of the programmatic space is assembly.)

Hot/ humid- Ocean Springs, MS

Special Topic: Energy Simulation

Do you use software in studio to study CND or energy related issues in general? If so, which software? Please comment on pros and cons of this choice

The following software was utilized in this project:

ComCheck (It is easy to use, free, and very helpful. Also, it was designed, in part, to validate the Optimize Energy Performance criteria in the LEED checklist.)

eQuest (Again, it's free and relatively easy to use. It's modeling tool is cumbersome and primitive compared to Ecotect or Energy Design Plug-in for SketchUp.)

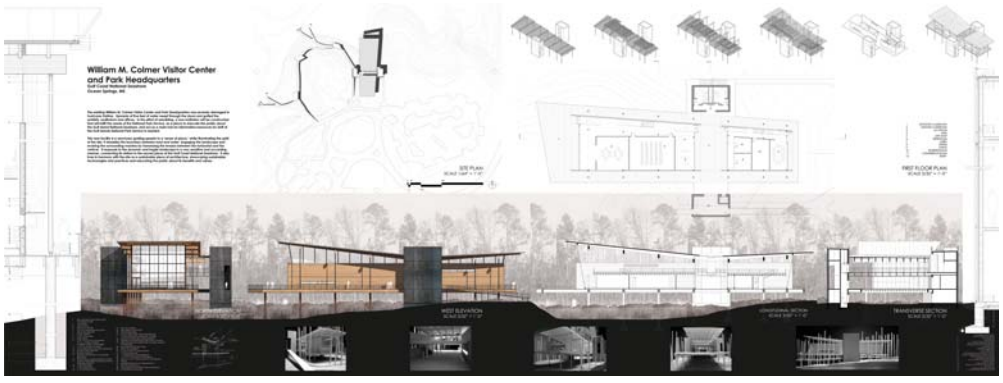
Parallel Course Description

David Bertolini, PhD

"This course might be called Architectural Communication. Drawing upon your knowledge and experience in architecture this class will explore the complex relationships between theoretical, political and practical forces that hold currency in offices today to see how they influence documenting architecture. This class is the connection between architectural concepts, as manifested in your studio, and architectural practice; where ideas become reality. The goal is to understand how architecture is communicated to builders using the protocols and methods of construction drawings. At the center of this class is the detail where we will investigate, using your design work, how various concepts, philosophies, and materials are assembled together to complete one's architectural vision."

This course is independent of the studio for the first half of the semester. During that time the students are introduced to the general issues of the contemporary production of construction documents. In the second half of the semester the course is closely tied to the studio.

William M. Colmer Visitors' Center and Park Headquarters, Gulf Islands National Seashore
Amy Fruge



Studio Teaching Topic KEY

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TEACHING TOPICS PROFILED

1. Site Analysis _ Senses

Produce a written program document with a problem statement and statement of intent, a written and graphic site analysis/interpretation, and an analysis of appropriate precedents... Develop an understanding of the relationship between the building program and the site that would serve to facilitate the realization of the designer's intentions as the design process unfolded.

2. Site Analysis _ Topography/Vegetation

Develop an understanding of the relationship between the building program and the site that would serve to facilitate the realization of the designer's intentions as the design process unfolded.

3. Site Analysis _ Climate

The investigation of relationship between possible design strategies and the climate and microclimate, and the quantitative physical properties of the site.

4. Site Analysis _ Site Visit

The investigation of relationship between possible design strategies and the climate and microclimate, and the quantitative physical properties of the site.

5. Design Strategy _ Sustainable Elements

LEED checklist and descriptions of individual credits, "GreenBuilding Suite", etc.

6. Schematic Design _ Resource Consumption

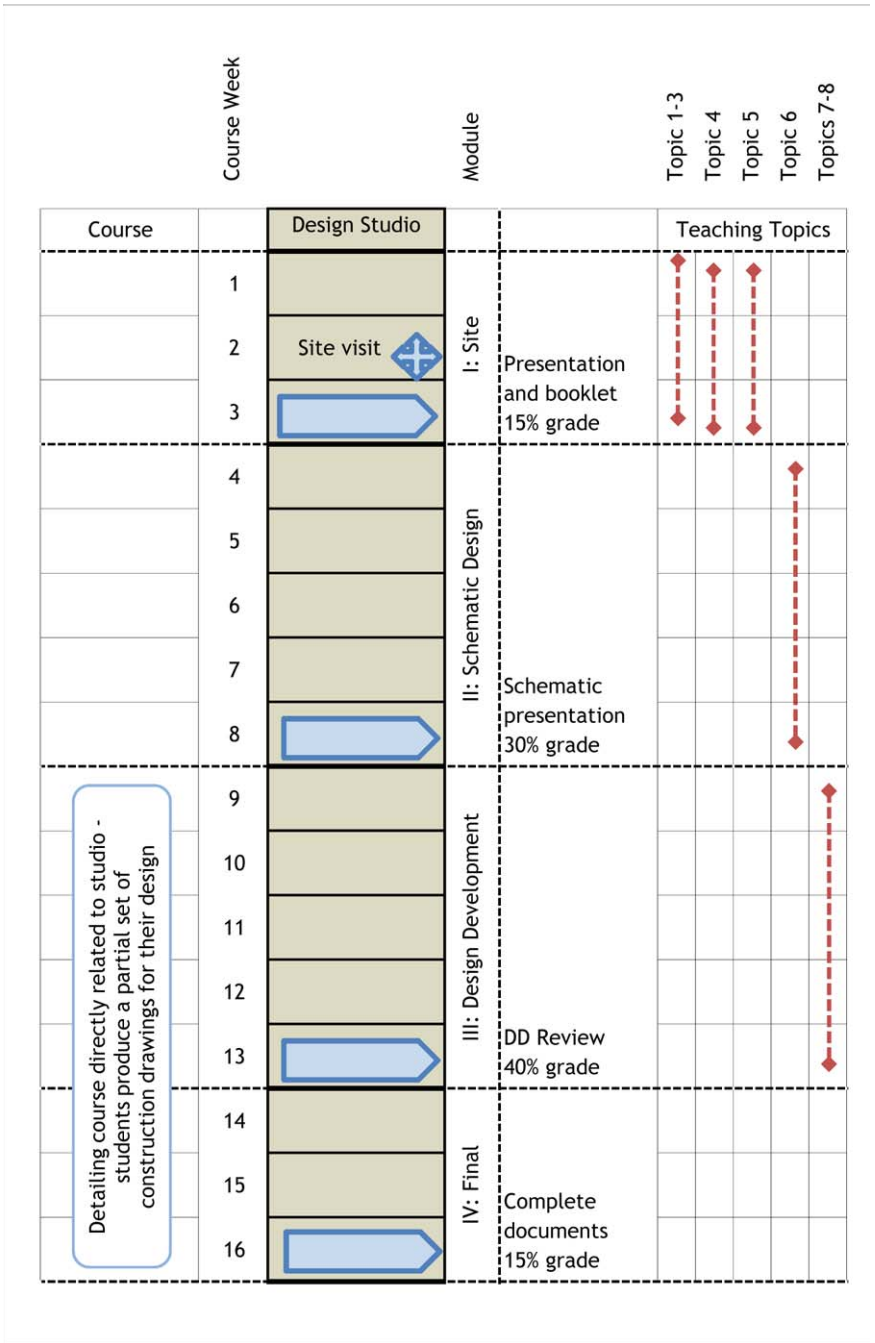
Use the LEED checklist and the eQuest computer program to monitor building performance throughout the schematic design phase.

7. Design Development _ Envelope

Use *COMcheck* and *BuildingGreen Suite* in the design and detailing of the building envelope.

8. Design Development _ Details

Use *COMcheck* and *BuildingGreen Suite* in the design and detailing of the building envelope.



Philosophy of CND Studio Instruction

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The studio work I have illustrated is from a fifth year "comprehensive design" studio in our Bachelor of Architecture program. The students work on one project for the entire semester. It is divided into four phases: research, schematic design, design development, and final documentation. Students are evaluated after each phase. There is a specific focus on sustainable design. It is always a project with a real site that can easily be visited and it is often a "real" project.

In the research phase the focus is on analysis and interpretation of both quantitative and qualitative data. The students are encouraged to see the site and program as interdependent entities. Climate and microclimate data are transformed into specific design criteria. Both the physical and the cultural contexts are investigated. Appropriate precedents are studied and often visited if possible. Of course the site is carefully surveyed and both the quantitative and the qualitative (experiential) aspects of the site are studied. I consider this to be one of the most important phases of the project. The outcomes are individual student Program Documents that serve as a record of the students' understanding of the relationship between the building program; the site, climate, and microclimate; and the specific sustainable design strategies that have been identified. This document serves to facilitate the realization of the designer's intentions as the design process unfolds.

The schematic design phase is really not much different than any design studio, with the exception that the strategies identified in phase one are emphasized from the beginning. Also we utilize a variety of simulation tools (such as "ComCheck", "eQuest", "Ecotect", and/or "Energy Design Plug-in for SketchUp") to assist us in this process. The emphasis is on a reiterative design process that (hopefully) is holistic and inclusive. This phase ends with a formal presentation at mid-semester. I try to get reviewers who are familiar with the project and with sustainable design practices. This review is by far the most important one of the semester. After the review the students are given a week or so to respond to the critiques, after which they enter into the design development phase.

In this phase we try to get into as much detail as possible with a specific focus on systems integration and the building envelope. During this phase we rely heavily on "BuildingGreen Suite" and "ComCheck." The students are expected to go into as much detail as possible in the selection of materials and assemblies, as well as any "green" technologies they might employ. As an example, if a student is employing a rainwater collection system he or she would be expected to calculate the average rate of collection and the projected average usage and size the storage tanks accordingly. Of course, he or she would also be expected to have carefully integrated the storage tanks into the design instead of simply adding them on at the end. The outcome of this phase is a partial set of construction documents.

The final two weeks of the semester are spent putting together a final presentation that includes all of the pertinent material from the first three phases. These presentations are mounted in the halls of the school and faculty, local practitioners, alumni, parents and friends are invited to participate in a "gallery review." The students also submit a complete digital record of the project. Throughout the project the students are reminded that just because their designs might be "sustainable", that doesn't automatically mean that they have designed "good" architecture. On the other hand, if a student ignores the sustainable goals and strategies that were identified in phase one he or she will be evaluated accordingly.

As indicated above, I consider the first phase to be critically important to the success of the project. Considerable emphasis is placed on the importance of this phase and the students are evaluated accordingly. It has become abundantly clear to me that there is a direct correlation between the amount and quality of work produced in phase one and the overall quality of the final product.

And lastly, I emphasize the importance of recognizing that the goal is not to design a building that is close to carbon neutral and zero-energy. The goal is to design a building that is a physical manifestation of the mission of the institution it will house, that meets or exceeds the programmatic requirements of both the client and the users, that respects the physical and cultural context in which it resides, that conserves water, that utilizes materials and finishes that are renewable and non-toxic, and that requires little or no fossil fuel energy and creates little or no greenhouse gas emissions. In other words, the goal is to create good architecture.

10 Critical Issues / 10 Common Mistakes

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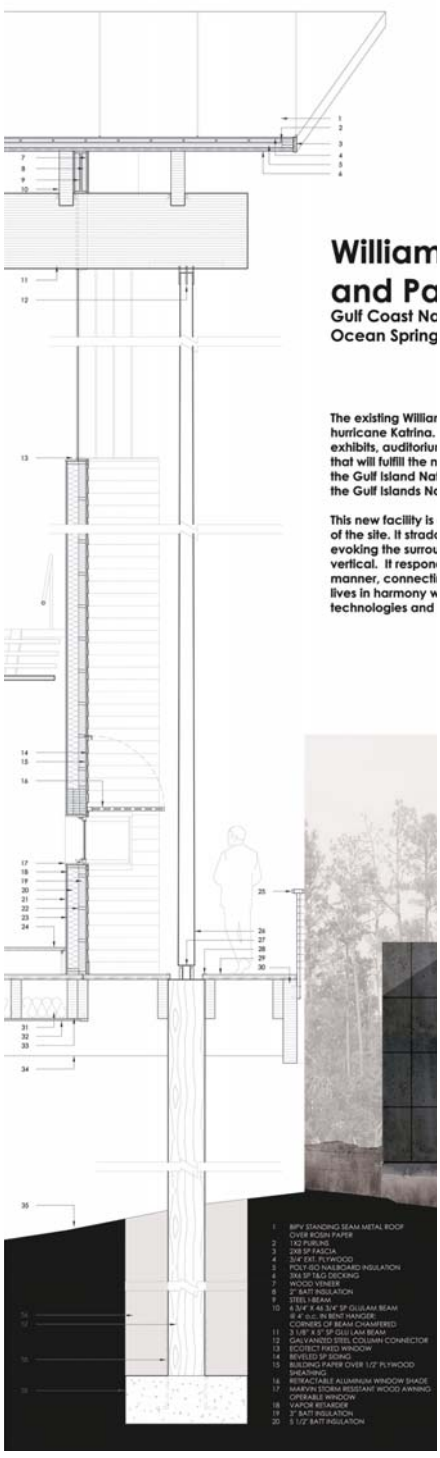
Fall 2007 Arch. 5001 (UG) Comprehensive Architectural Design Studio

10 critical issues in THE teaching of Carbon Neutral Design

1. *Careful program analysis and interpretation with equal attention paid to user needs and client requirements.*
2. *Thoughtful site analysis and interpretation in relation to the specific programmatic requirements.*
3. *Climate and microclimate analysis with specific implications for design strategies.*
4. *Analysis of appropriate precedents with specific reasons why they where chosen.*
5. *Utilization of appropriate tools early in the design process (i.e. LEED checklist, "Climate Consultant", Sun, Wind and Light, The Green Studio Handbook, etc.).*
6. *Insist that the beginning stages of schematic design be done freehand and with physical study models before moving to digital media.*
7. *Utilize "ComCheck" as soon as an initial schematic design has been realized to confirm that the envelope is well conceived.*
8. *Utilize "eQuest", "Ecotect", and/or "Energy Design Plug-in for SketchUp" to refine the schematic design.*
9. *Utilize "ComCheck" and "BuildingGreen Suite" to further refine the envelope in design development.*
10. *Remember that just because a building might be sustainable doesn't mean that it's good architecture. As Glenn Murcutt said, "…When ecology becomes the major issue, you're left with a scientific box that does nothing for the spirit. I cannot separate the idea of the poetic and the rational. If there's not a junction, we've got merchandise, not architecture."*



10 student design mistakes that undermine the goal of Carbon Neutral Design

1. *They overcomplicate everything.*
2. *They don't understand the relationship between insulation and envelope thickness.*
3. *They think they've got it right the first time.*
4. *They don't know when to let an idea go when it's clear that it's just hindering progress.*
5. *They don't understand the concept and practice of a reiterative design process.*
6. *They rely far too much on AutoCad or other primarily production programs in schematic design.*
7. *They get hung up on one strategy and ignore others that might be more appropriate.*
8. *They don't use precedents to their full advantage.*
9. *They suffer from "analysis paralysis."*
10. *They forget point 10 above.*

Supporting Material

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Fall 2007 Arch. 5001 (UG) Comprehensive Architectural Design Studio

William M. Colmer Visitors' Center and Park Headquarters, Gulf Islands National Seashore
Amy Fruge

COURSE MATERIALS

(PDF) Theis. CND Course Materials Compilation

1. Course Syllabus with clearly articulated learning objectives
2. Phase 1: Research – Site Analysis, Precedents, Programming handouts
3. Phase 1: Research - Evaluation Form
4. Phase 2: Schematic Design handouts
5. Phase 2: Evaluation Form
6. Phase 3: Design Development handouts
7. Phase 3: Evaluation Form
8. Phase 4: Final Presentation and Project Documentation
9. Phase 4: Evaluation Form
10. Phase 4: Final Presentation Instructions
11. COURSE EVALUATION FORM
12. ARCH 5005: Advance Architectural Techniques David Bertolini, PhD Course Description and Objectives, Assignments

STUDENT WORK

(PDF) Amy Fruge Phase I Research Booklet

"Phase I Research- Site Analysis, Precedents, Programming for the William M. Colmer Visitors' Center and Park Headquarters, Gulf Islands National Seashore, Ocean Springs MS.

(PDF) Amy Fruge (Final Boards)

Site Analysis_Senses

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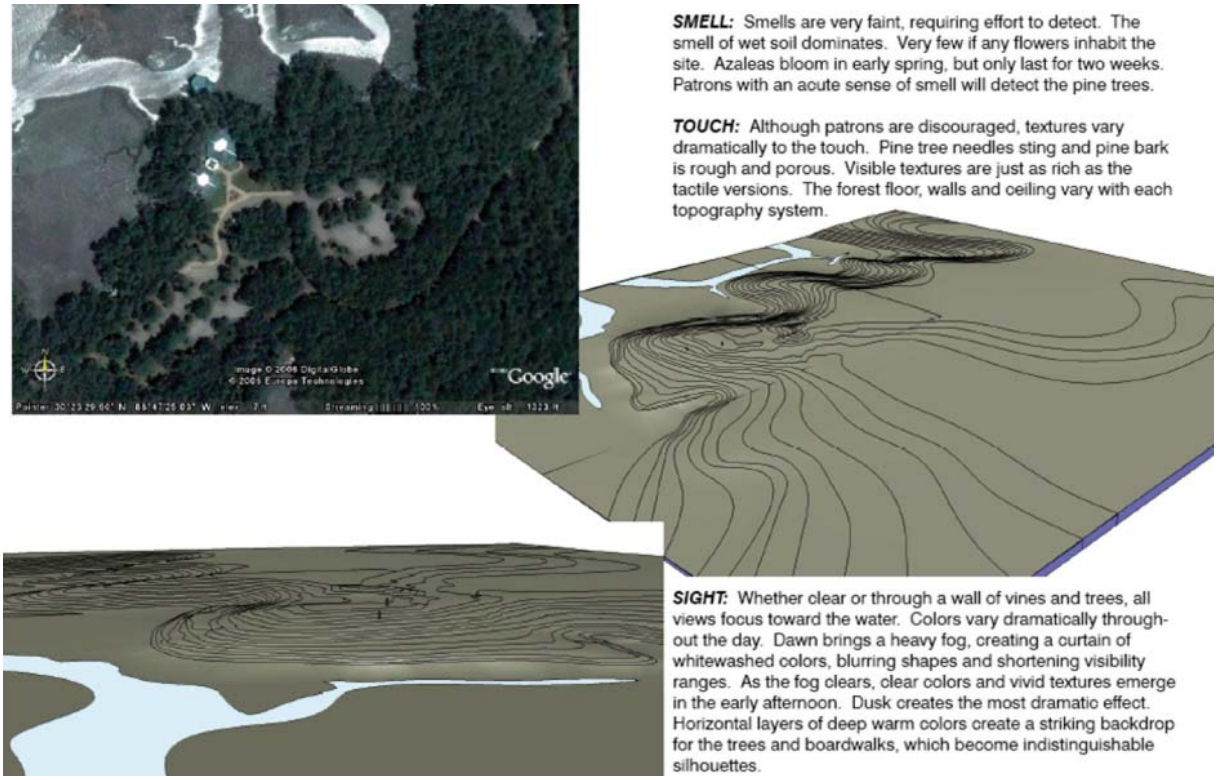

Site Analysis
Student: *Amy Fruge*

Design/Performance Objective

In the first phase of the project the students were instructed to produce a written program document with a problem statement and statement of intent, a written and graphic site analysis/interpretation, and an analysis of appropriate precedents. These two images illustrate a few of these. The objective of these exercises was to develop an understanding of the relationship between the building program and the site that would serve to facilitate the realization of the designer's intentions as the design process unfolded.

Investigative Strategy

Field measurements and observations, client and user interviews, "Google Earth", sensory perceptions, etc.

Evaluation Process

Individual documents were evaluated based on the following: document form (appearance, layout, spelling, grammar, readability); graphic representations; understanding and analysis of basic site, precedent, and program information; interpretation of this information; statement of design intentions; and active participation on research teams and in on-site exercises.

Evaluative Criteria

Document form (appearance, layout, spelling, grammar, readability), graphic representations, quality of observations.

Cautions- Possible Confusions

None

Duration of Exercise

Approximately three weeks for the Site Analysis Phase.
Two days on site required as a group.
Additional site visits as required by individual students and small groups.

Degree of Difficulty

Easy for some, challenging for others. Depends on their perceptual skills.

References

Hinchman, Hannah. *A Trail Through Leaves: The Journal as a Path to Place*. (esp. "The World as Events")
Lynch, Kevin. *Site Planning*. (esp. Chapter 6 "The Sensed Landscape and It's Materials")
Norberg-Schulz, Christian. "The Phenomenon of Place." From *Theorizing a New Agenda for Architecture*, Kate Nesbitt, ed.
Potteiger, M. and Purinton, J. *Landscape Narratives*. (esp. "The Nature of Landscape Narratives")
Sewall, Laura. *Sight and Sensibility*. (esp. Chapter 1 "Vaeieties of Visual Experience")

Site Analysis_Topography/Vegetation

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Fall 2007 Arch. 5001 (UG) Comprehensive Architectural Design Studio

Site Analysis
Student: *Amy Fruge*

The diagram illustrated above is one of several in this exercise. The others included site sections; soil types; site wildlife, habitats, and vegetation; and views.

Design/Performance Objective

In the first phase of the project the students were instructed to produce a written program document with a problem statement and statement of intent, a written and graphic site analysis/interpretation, and an analysis of appropriate precedents. These two images illustrate a few of these. The objective of these exercises was to develop an understanding of the relationship between the building program and the site that would serve to facilitate the realization of the designer's intentions as the design process unfolded.

Investigative Strategy

Field measurements and observations, client and user interviews, "Google Earth", sensory perceptions, etc.

Evaluation Process

Individual documents were evaluated based on the following: document form (appearance, layout, spelling, grammar, readability); graphic representations; understanding and analysis of basic site, precedent, and program information; interpretation of this information; statement of design intentions; and active participation on research teams and in on-site exercises.

Evaluative Criteria

Accuracy and appearance.

Cautions- Possible Confusions

Requires a good topo map.
We typically spot check the topo map in the field with transit and pole.
Correlating vegetation can be confusing on densely vegetated sites.

Duration of Exercise

Approximately three weeks for the Site Analysis Phase.
Two days on site required as a group.
Additional site visits as required by individual students and small groups.

Degree of Difficulty

Depends on specific site

References

LaGro, Jr., James A. *Site Analysis: A Contextual Approach to Sustainable Land Planning and Site Design*.
Lynch, Kevin. *Site Planning*.
McHarg, Ian L. *Design with Nature*.
Rubenstein, Harvey M. *A Guide to Site Planning and Lanscape Construction.*

Site Analysis_Climate

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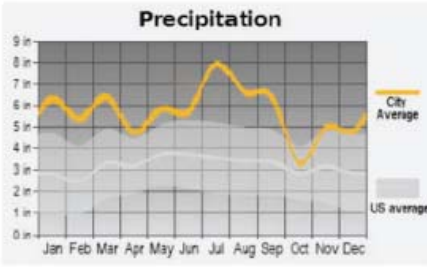

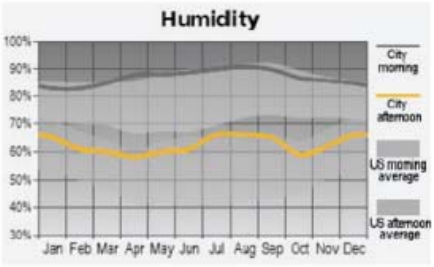

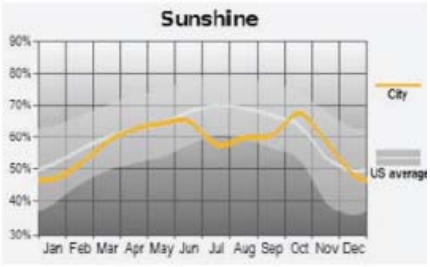

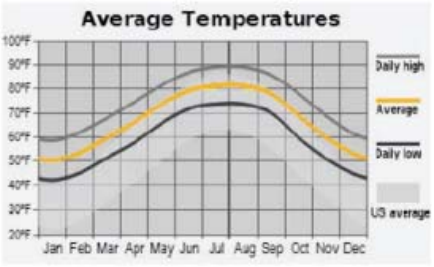

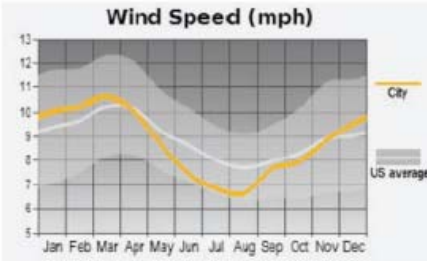

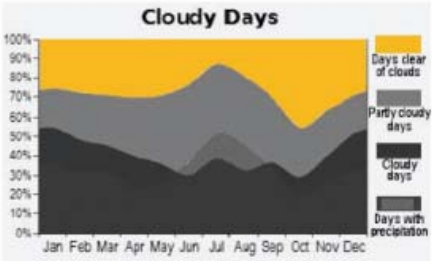

Climate Analysis
Student: *Amy Fruge*

In addition to the climate graphs illustrated here, the students also generated wind roses, sun path charts, sundial tools, and bioclimatic charts for use in diagramming specific design responses to climate.

Design/Performance Objective

These images illustrate the investigation of relationship between possible design strategies and the climate and microclimate, and the quantitative physical properties of the site. The objective of these exercises was to develop an understanding of the relationship between the building program and the site that would serve to facilitate the realization of the designer's intentions as the design process unfolded.

Investigative Strategy

Climate Consultant, Sun, Wind and Light, The Green Studio Handbook, data provided by the National Park Service, etc.

Evaluation Process

Individual documents were evaluated based on the following: document form (appearance, layout, spelling, grammar, readability); graphic representations; understanding and analysis of basic site, precedent, and program information; interpretation of this information; statement of design intentions; and active participation on research teams and in on-site exercises.

Evaluative Criteria

Accuracy and appearance.

Cautions- Possible Confusions

Most of the data gathering is pretty straightforward. The problems come in interpreting the data. Many students are confused by the wind roses.

Duration of Exercise

The first three weeks of a semester-long project.

Degree of Difficulty

Generally easy, with the exception of the interpretation of the data.

References

Climate Consultant http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=123/pagename_menu=mac/pagename=platforms
Brown, C.Z. and Mark DeKay. *Sun, Wind, and Light: Architectural Design Strategies.*
Kwok, Alison and Walter Grondzik. *The Green Studio Handbook.*

Site Analysis_Site Visit

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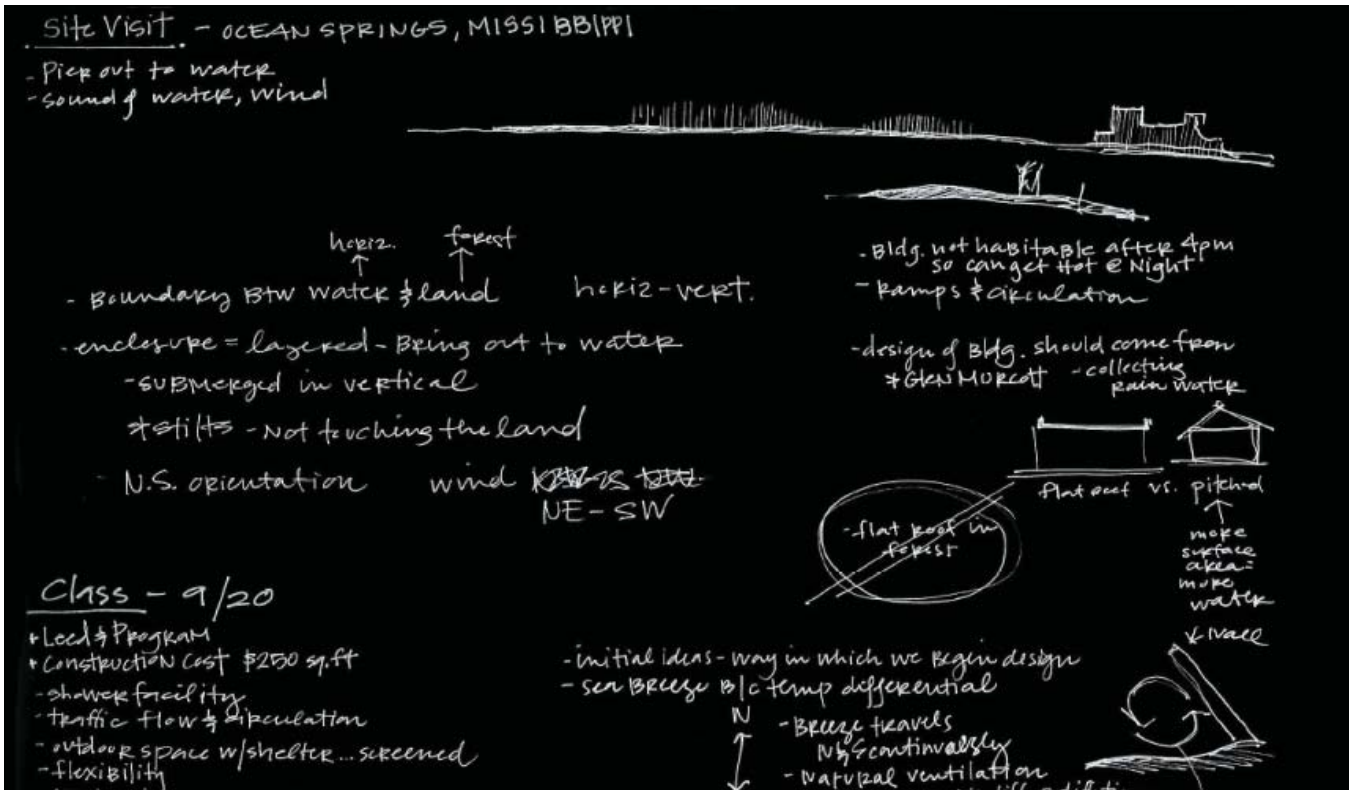

Site Analysis
Student: *Amy Fruge*

The image above is one of several that the student recorded in a journal while on the site after generating the previously illustrated data. The intent was to place the quantitative data in the context of the qualitative experience of the site and to generate specific design strategies.

Design/Performance Objective

Illustrate the investigation of relationship between possible design strategies and the climate and microclimate, and the quantitative physical properties of the site.

Investigative Strategy

"Climate Consultant", Sun, Wind and Light, The Green Studio Handbook, data provided by the National Park Service, etc.

Evaluation Process

Individual documents were evaluated based on the following: document form (appearance, layout, spelling, grammar, readability); graphic representations; understanding and analysis of basic site, precedent, and program information; interpretation of this information; statement of design intentions; active participation on research teams and in on-site exercises; and accuracy and appropriate interpretation and illustration of design strategies.

Evaluative Criteria

This exercise can be somewhat subjective, but the most important thing is that the student takes it seriously. If the students are aware that they will be expected to use the results in the schematic design phase of the project they are likely to take it more seriously. Specific evaluation criteria are thoroughness (did they "cover all of the bases"), composition (is there a clear sequence of ideas), and clarity (do the diagrams make sense).

Cautions- Possible Confusions

See above.

Duration of Exercise

First three weeks of a semester-long project. Students were on the site as a group for two days and were able to return to the site as necessary as individuals or in small groups.

Degree of Difficulty

Relatively easy. Depends on how seriously the students take it.

References

Brown, C.Z. and Mark DeKay. *Sun, Wind, and Light: Architectural Design Strategies.*

Design Strategy_Sustainable Elements

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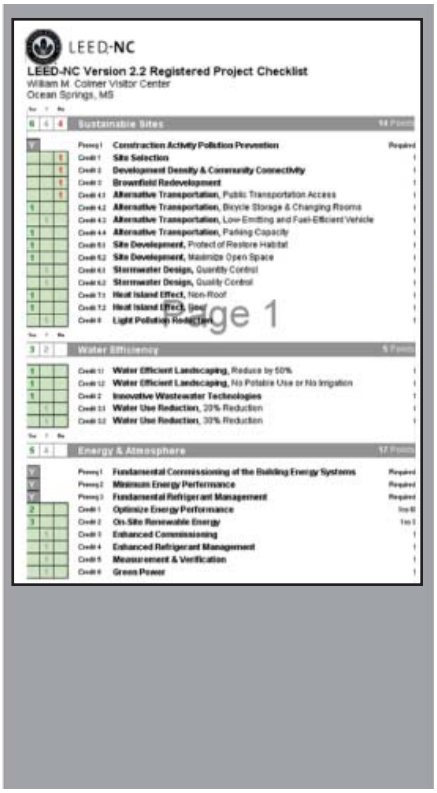

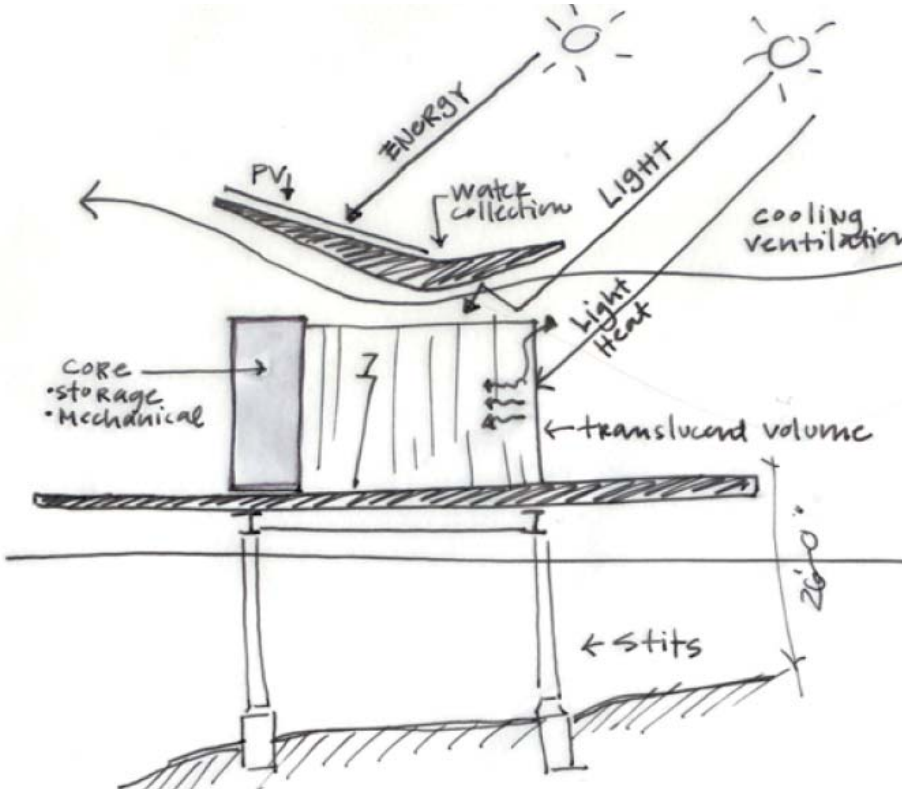

LEED Analysis
Student: *Amy Fruge*

Design/Performance Objective

This image illustrates the last portion of the research phase in which the students did a preliminary LEED analysis, investigated specific sustainable design strategies, and produced diagrams of these strategies.

Investigative Strategy

LEED checklist and descriptions of individual credits, "GreenBuilding Suite", etc.

Evaluation Process

Individual documents were evaluated based on the following: document form (appearance, layout, spelling, grammar, readability); graphic representations; understanding and analysis of basic site, precedent, and program information; interpretation of this information; statement of design intentions; active participation on research teams and in on-site exercises; and accuracy and appropriate interpretation and illustration of design strategies.

Evaluative Criteria

Understanding of the requirements for LEED Certification. Understanding of the sustainable design strategies illustrated. Clarity of illustrations.

Cautions- Possible Confusions

Students often don't fully understand the strategies they propose. The diagrams will reveal this and must be carefully scrutinized.

Duration of Exercise

Approximately one week.

Degree of Difficulty

Relatively easy but, as noted above, some students tend to over-simplify this exercise.

References

LEED Green Building Rating System For New Construction & Major Renovations Version 2.2 (or most current) and *Reference Guide*. www.usgbc.org
BuildingGreen Suite www.buildinggreen.com
Kwok, Alison and Walter Grondzik. *The Green Studio Handbook.*

Schematic Design_Resource Consumption

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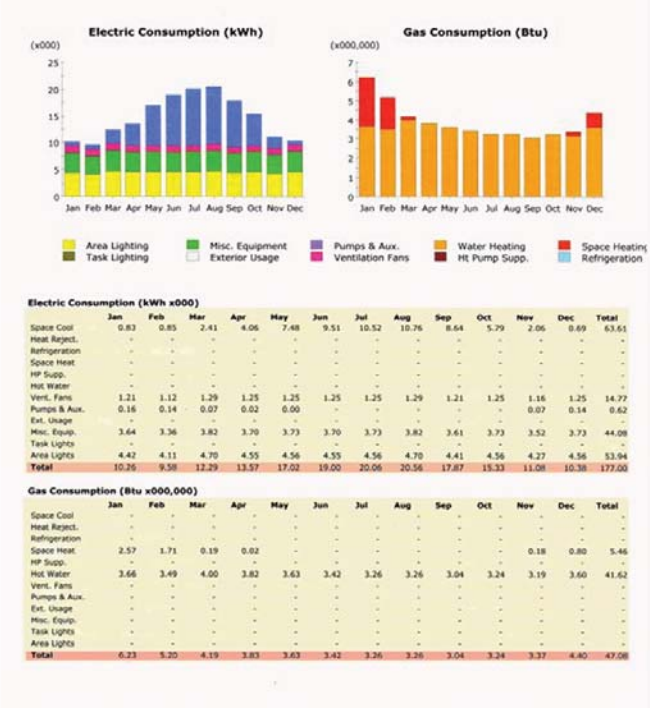

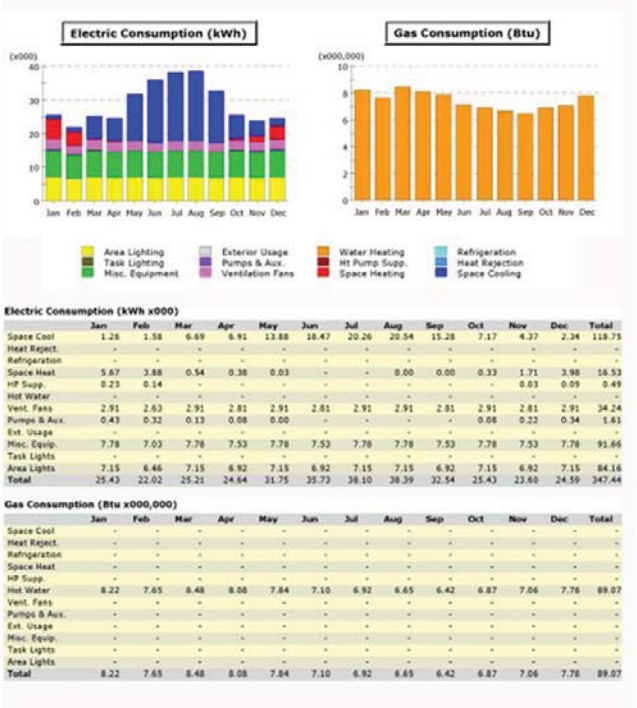

Performance Simulation
Student: *Amy Fruge*

Design/Performance Objective

This image illustrates the results of the schematic design phase and the tools used to measure and simulate building performance.

Investigative Strategy

Use the LEED checklist and the eQuest computer program to monitor building performance throughout the schematic design phase.

Evaluation Process

Appropriate and accurate interpretation and application of measurement tools.

Evaluative Criteria

Accurate modeling of schematic design and understanding of the outcomes.

Cautions- Possible Confusions

The eQuest simulation program is a powerful tool, but it has a rather cumbersome modeling tool. Students often get frustrated with this (we've had better results recently with Ecotect and EnergyPlus plugin for SketchUp). Also, students often need help in selecting the proper values to input.

Duration of Exercise

Approximately one week.

Degree of Difficulty

Moderately difficult. Depends on the students familiarity with the simulation tool used.

References

Various modeling tools: eQuest, Ecotect, EnergyPlus plugin for SketchUp.
http://doe2.com/equest/index.html
www.ecotect.com
http://apps1.eere.energy.gov/buildings/energyplus/openstudio.cfm
Stein, Reynolds, Grondzik, Kwok. *Mechanical and Electrical Equipment for Buildings*.

Design Development_Envelope

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Louisiana State University

Fall 2007 Arch. 5001 (UG) Comprehensive Architectural Design Studio

Design/Performance Objective

These images illustrate the design development phase of the project and specifically the refinement of the building envelope to assure that it will meet the performance expectations of the initial computer simulations.

Investigative Strategy

Use *COMcheck* and *BuildingGreen Suite* in the design and detailing of the building envelope.

Evaluation Process

Accurate utilization of *COMcheck*, especially the proper input of information and the validation of this information through detailed drawings

Evaluative Criteria

Accuracy.

Cautions- Possible Confusions

COMcheck is relatively easy to use but, as with any software, the proper values must be entered. Students sometimes enter values (such as R-values for walls and u-values for glazing assemblies) without understanding the implications (wall thickness, cost, etc.).

Duration of Exercise

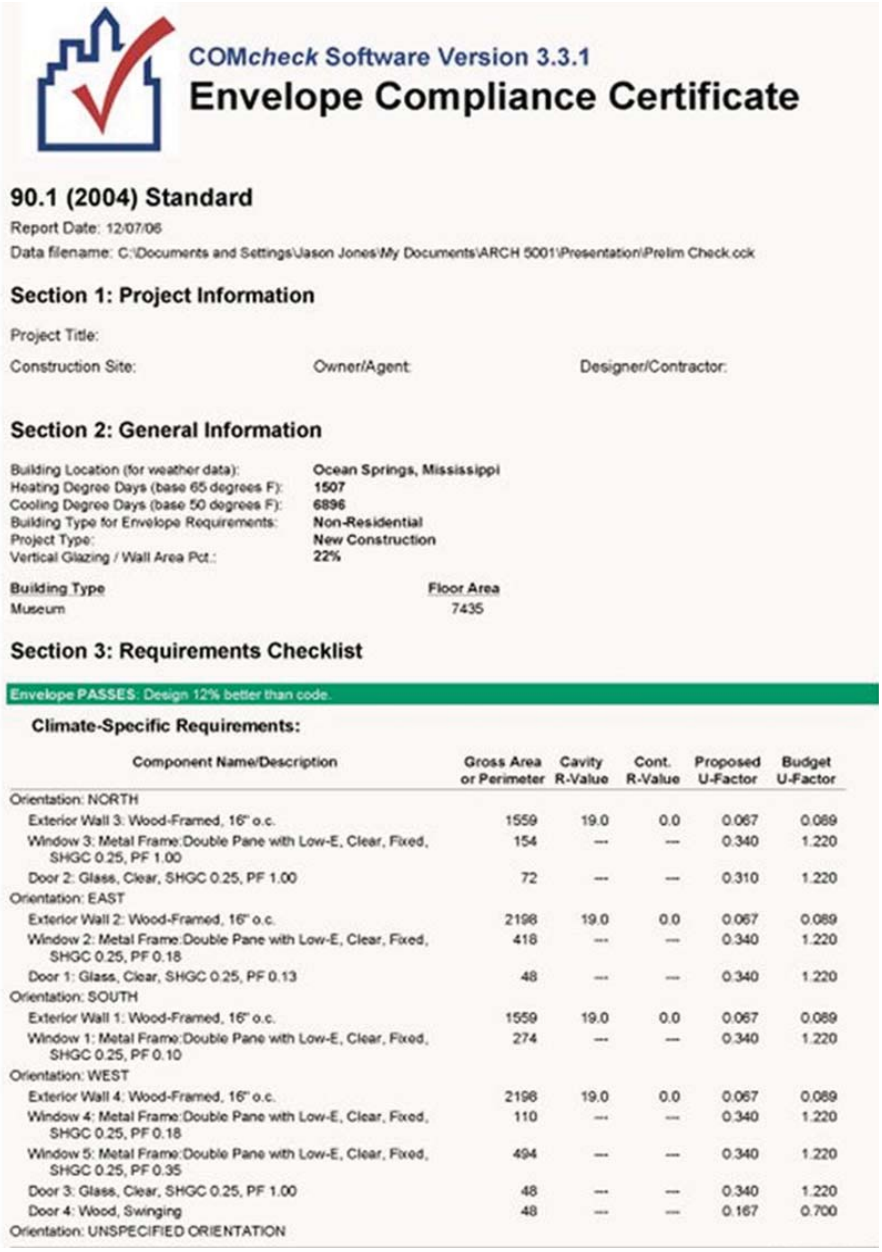
Depends on the complexity of the project, but usually can be accomplished in a few hours.

Degree of Difficulty

Relatively easy.

References

COMcheck http://www.energycodes.gov/comcheck/
BuildingGreen Suite www.buildinggreen.com
Stein, Reynolds, Grondzik, Kwok. *Mechanical and Electrical Equipment for Buildings*.



COMcheck Software Version 3.3.1

Envelope Compliance Certificate

90.1 (2004) Standard

Report Date: 12/07/06

Data filename: C:\Documents and Settings\Jason Jones\My Documents\ARCH 5001\Presentation\Prelim Check.cck

Section 1: Project Information

Project Title:

Construction Site: Owner/Agent: Designer/Contractor:

Section 2: General Information

Building Location (for weather data):	Ocean Springs, Mississippi
Heating Degree Days (base 65 degrees F):	1507
Cooling Degree Days (base 50 degrees F):	6896
Building Type for Envelope Requirements:	Non-Residential
Project Type:	New Construction
Vertical Glazing / Wall Area Pct.:	22%

Building Type	Floor Area
Museum	7435

Section 3: Requirements Checklist

Envelope PASSES: Design 12% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor
Orientation: NORTH					
Exterior Wall 3: Wood-Framed, 16" o.c.	1559	19.0	0.0	0.067	0.089
Window 3: Metal Frame:Double Pane with Low-E, Clear, Fixed, SHGC 0.25, PF 1.00	154	---	---	0.340	1.220
Door 2: Glass, Clear, SHGC 0.25, PF 1.00	72	---	---	0.310	1.220
Orientation: EAST					
Exterior Wall 2: Wood-Framed, 16" o.c.	2198	19.0	0.0	0.067	0.089
Window 2: Metal Frame:Double Pane with Low-E, Clear, Fixed, SHGC 0.25, PF 0.18	418	---	---	0.340	1.220
Door 1: Glass, Clear, SHGC 0.25, PF 0.13	48	---	---	0.340	1.220
Orientation: SOUTH					
Exterior Wall 1: Wood-Framed, 16" o.c.	1559	19.0	0.0	0.067	0.089
Window 1: Metal Frame:Double Pane with Low-E, Clear, Fixed, SHGC 0.25, PF 0.10	274	---	---	0.340	1.220
Orientation: WEST					
Exterior Wall 4: Wood-Framed, 16" o.c.	2198	19.0	0.0	0.067	0.089
Window 4: Metal Frame:Double Pane with Low-E, Clear, Fixed, SHGC 0.25, PF 0.18	110	---	---	0.340	1.220
Window 5: Metal Frame:Double Pane with Low-E, Clear, Fixed, SHGC 0.25, PF 0.35	494	---	---	0.340	1.220
Door 3: Glass, Clear, SHGC 0.25, PF 1.00	48	---	---	0.340	1.220
Door 4: Wood, Swinging	48	---	---	0.167	0.700
Orientation: UNSPECIFIED ORIENTATION					

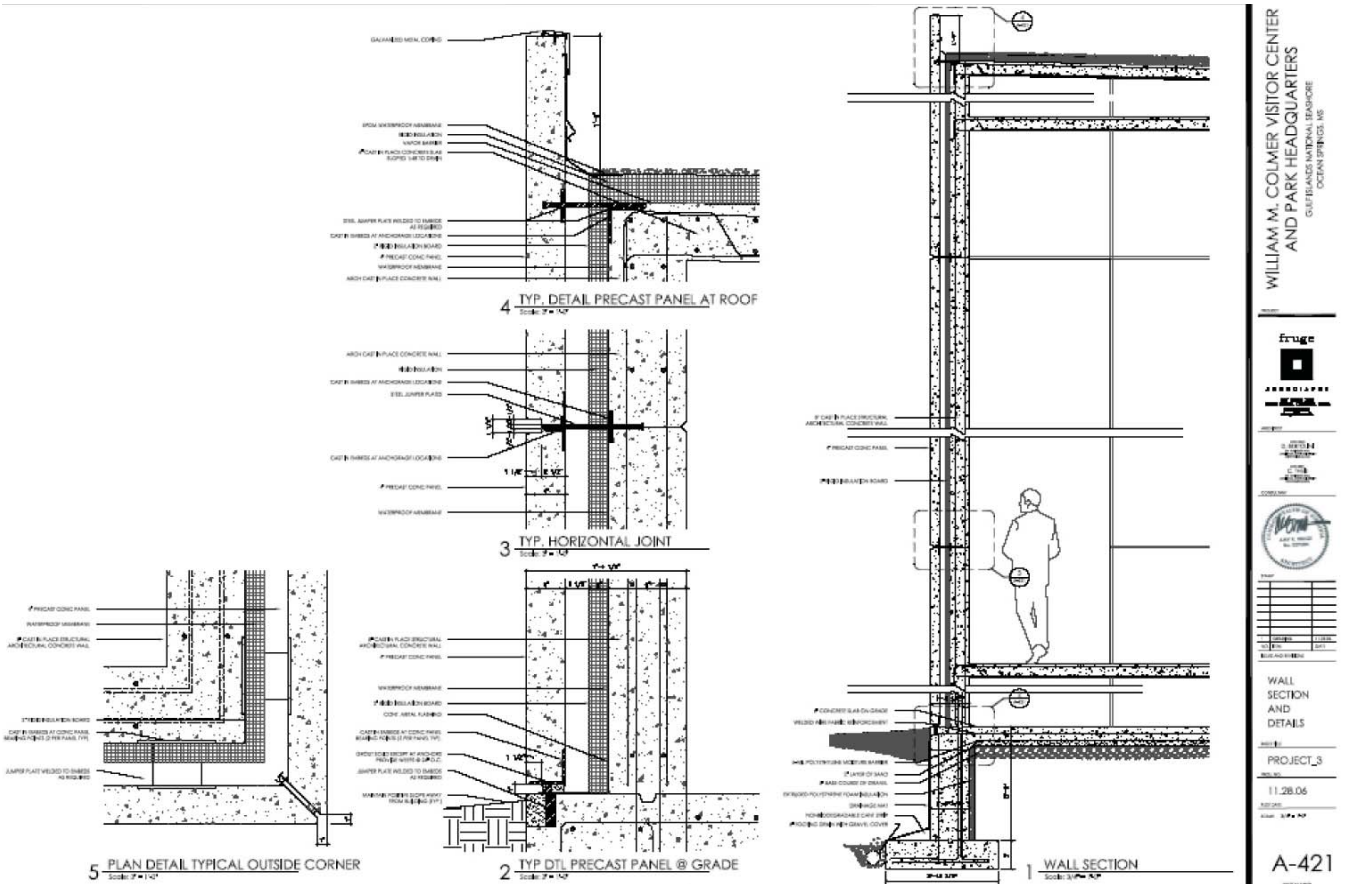
Design Development
Student: *Amy Fruge*

The image above is one page of the final output of the COMcheck analysis recording the inputs and the percentage above or below the chosen energy code.

Design Development_Details

Chris Theis
Louisiana State University

Fall 2007 Arch. 5001 (UG) Comprehensive Architectural Design Studio



Design/Performance Objective

These images illustrate the design development phase of the project and specifically the refinement of the building envelope to assure that it will meet the performance expectations of the initial computer simulations.

Investigative Strategy

Use *COMcheck* and *BuildingGreen Suite* in the design and detailing of the building envelope.

Evaluation Process

Accurate utilization of *COMcheck*, especially the proper input of information and the validation of this information through detailed drawings

Evaluative Criteria

Accuracy.
Evaluating the quality of the drawings was the responsibility of the instructor of the companion course.

Cautions- Possible Confusions

This portion of the project obviously requires close coordination with another course. We haven't experienced any problems, but it could be a potential problem.

Duration of Exercise

Approximately one month.

Degree of Difficulty

Can be quite difficult for some students, depending on their previous experience.

Detail Drawings
Student: *Amy Fruge*

The drawings above are from a partial set of construction drawings the student produced in a companion course. During the second half of the design studio course there is a direct connection with the companion course, which focuses on contemporary methods of producing construction documents.

References

COMcheck http://www.energycodes.gov/comcheck/
BuildingGreen Suite www.buildinggreen.com
Stein, Reynolds, Grondzik, Kwok. *Mechanical and Electrical Equipment for Buildings*.
Wakita, Osamu A. and Richard M. Linde. *The Professional Practice of Architectural Working Drawings*.