IMPLEMENTING THE 2010 IMPERATIVE IN A BEGINNING ARCHITECTURAL DESIGN STUDIO

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ABSTRACT

How can a beginning studio implement the 2010 Imperative? The imperative states: *"Beginning in 2007, add to all design studio problems that: "the design engage the environment in a way that dramatically reduces or eliminates the need for fossil fuel.""*

By teaching how energy use in buildings is related to architectural form, space and order students were able to design a simple building that eliminated the need to use fossil fuel for heating and cooling in a mild climate. Hopefully, this will give the students confidence to do the same in larger more complex building in a harsher climate.

1. INTRODUCTION

The 2010 Imperative states: *"To successfully impact global warming and world resource depletion, it is imperative that ecological literacy become a central tenet of design education. Yet today, the interdependent relationship between ecology and design is virtually absent in many professional curricula. To meet the immediate and future challenges facing our professions, a major transformation of the academic design community must begin today. To accomplish this, The 2010 Imperative calls upon this community to adopt the following: Beginning in 2007, add to all design studio problems that: "the design engage the environment in a way that dramatically reduces or eliminates the need for fossil fuel.""*

How does the "2010 Imperative" fit into a beginning design studio where the stated objective is to teach form, space and order, and the students have not yet taken a environmental control systems class? A series of exercises were developed to help students make the connection between architectural form and fossil fuel use. The design studio was a second year class at California Polytechnic State University in San Luis Obispo, California during the fall of 2007.

2. SELLING THE IDEA

Selling the idea that sustainability is one of the most important aspects of design in this new century can be difficult in some environments. Through the efforts of environmental pioneers and finally one key movie, the tipping point for the importance of reduced carbon emissions and sustainability has come to pass. Educating students on the subjects has become easier and most students have become willing participants. The students in this studio have already fully embraced the need to reduce the use of fossil fuels but they lacked the tools and knowledge to implement their desires in their designs.

3. STRATEGY

The following line of reasoning was employed to help students understand how and why energy is used in buildings and how it might be reduced by well thought out architectural form. The strategies were met and employed with enthusiasm by the students.

3.1 Energy Use

A discussion with the students about how our actions relate to the world was initiated by using the architecture2030 website (1) as well as various online ecological footprint calculators. Other topics for discussion were; different fuels types used in energy production, the pros and cons of each type of fuel, how reducing the amount of fuel used in buildings compares to just switching the source of energy and how personal choices that we make in all aspects of life can lead to great change. Buildings and their energy use was discussed as well as the students future roles as architects making decisions about the design of the buildings and their possible impacts on energy use.

3.2 Energy Use related to Comfort

The question of why buildings use energy usually gets the reply that it is used to heat, cool and light the building. Heating and cooling employed to make the occupants thermally comfortable and lighting is used for visual comfort. This leads the students to start thinking about what comfort means.

Fig. 1: Favorite place

3.3 Comfort

An exercise that simply asks the students to sketch their favorite place on the campus was used as a vehicle to talk about what comfort might mean. After the students hand in the sketches, a tour of their favorite places took place. The students brought us to the place and talked about the qualities that made it special to them. (Fig. 1) Handheld tools were brought along on the tour and the students were able to measure air temperature, air speed and humidity with a Kestrel 3000 Pocket Weather Meter; measure surface temperature of the surrounds using a Raytek Hand-held Infrared Thermometers MT-4; and to measure light levels using various light level meters. The data collected was recorded and the question was raised why each space was comfortable with such a wide range of temperature levels. The lowest air temperature recorded was 68° F and the highest was 81° F. A quick lecture on human comfort was given defining clothing levels, activities, mean radiant temperature, air temperature, relative humidity and air speed. The adaptive model of comfort was also discussed where acceptable degrees of comfort is possible over a range of temperatures from 63° F to 88° F, if occupants are allowed to adapt to their surroundings. This temperature range would be the goal for the buildings they designed.

3.4 Comfort related to Architectural Form, Space and Order

Through the favorite place exercise the students also began to understand how the architectural form of their space led to why they found the space appealing. The places might have a cooler a temperature but it also had a thermal mass that was warmed by the sun to make the place feel warmer. A place with direct solar gain might have a cool breeze that made it feel comfortable. A place that received no direct sun would be well lit because it opened up to the sky.

4. THE DESIGN PROCESS

4.1 Climate And Site

The site that was chosen for the project is in a very mild climate. A mild climate will give students a chance to design a building that uses no fossil fuels for heating and cooling. The idea is to give the students confidence when they tackle more severe climates.
Since the University is located in San Luis Obispo, California, which is a mild climate, it was chosen for the project. San Luis Obispo has a normal average high temperature in September of 78° F and in January a normal average low of 38° F.

4.2 Solar Access as Building Form Generator

The site chosen had a slight slope down to the south and was divided into 18 lots for each of the students. Before the program was given, an 1/8" = 1' site model was built with an attached sun peg. The students were asked to make five 12' by 12' boxes at scale and the boxes and site model were brought outside. Next each student placed one of their boxes on their lot and the model was tilted and rotated to check the solar access on each box for the whole year using the sun peg. The students were then asked to place another box on their lot and again solar access was checked. The process was repeated until the students had put four to five boxes on their site that had solar access for the entire year. The shape generated in this exercise would now be used for the shape of their building. (Fig. 2 and 3)

4.3 Setting the Design Problem

A small building with a simple program was chosen. The students were asked to design a writers retreat that would be used all year, but by different writers for up to six weeks.

The building would require a place to write, a place to sleep, a place to prepare food, and a place to wash. Several writers were interviewed to find out what type of environment they required to write.

Fig.2: Placing cubes

Fig. 3: Solar access

4.4 Simple Design Tools

Simple visual software developed by the author was used to size the required glazing, mass and insulation that the building would need to perform as a passively heated building. Similar software was used to place windows for daylighting.

5. EVALUATING AND TESTING

An important part of a sustainable studio should be evaluation and accountability. Since the buildings did not use an HVAC system, the stated goal of the imperative could be met no matter what the students designed, the additional goals for the studio were evaluated to see if the designed building was comfortable and sustainable. Two methods were used to evaluate the buildings at the end of the quarter, one was a self-evaluation in the form of a scorecard and the other was an energy analysis program.

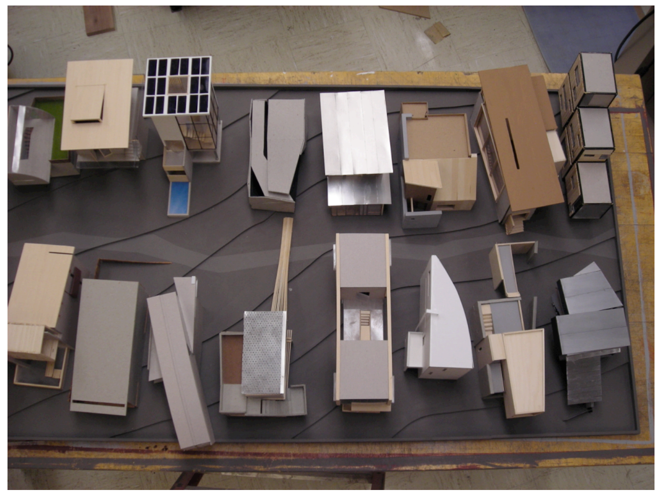

Fig. 4: Final Results

5.1 Checklist

The scorecard used was the "A Regeneration-based Checklist for Design and Construction" based on Malcolm Well's 1969 rating system and updated by the Society of Building Science Educators (SBSE) in 1999. (2) The issues covered by the updated checklist are divided into site issues and building issues. The issues are given a score from negative one hundred for degeneration of earth resources to positive one hundred for regeneration of earth resources. Sustainability is given a score of zero. For this studio the students were asked to self evaluate their projects using the building issues only. The building issues are broken down into twelve categories which are daylight, heating, cooling, maintenance, human comfort, circulation means, indoor air quality, materials, life cycle, how it interacts with its neighbors, aesthetics and how it will influence the future built environment. The maximum possible score is 1200 points for a building that regenerates earth resources and the minimum possible score is negative 1200 points for a building that degenerates earth resources. The average score that the students gave their buildings was 915 with a low score of 600 and a high score of 1150. The high and low scores were not in my opinion the most and least sustainable buildings. Some of the students were more thoughtful and truthful in their scoring, but all of them were more aware of the issues of sustainability because of the checklist.

5.2 HEED: Home Energy Efficient Design

A computer program called HEED (3) developed by Murray Milne at UCLA is an easy to use energy analysis program that can be used to simulate the thermal comfort levels in the students designs. The basic geometry, insulation levels and placement of windows was input into the program. The thermostat levels were set at 40° F for heating and 100° F for cooling. In HEED the climate data is selected by inputting the zip code, which eliminates any guesswork by the students. The energy analysis was only run after the buildings were finished, but this program would make a great design tool to use throughout the studio since very little input is necessary to get initial results and the design can be fine-tuned easily as the students developed their designs. For the climate of San Luis Obispo most of the students were able to easily maintain their building within the adaptive comfort levels of 63° to 88° F for this very mild climate. Most of the designs were able to maintain temperatures of 66° F to 75° F. This will hopefully give the students confidence to tackle more difficult climate challenges. (Fig. 5)

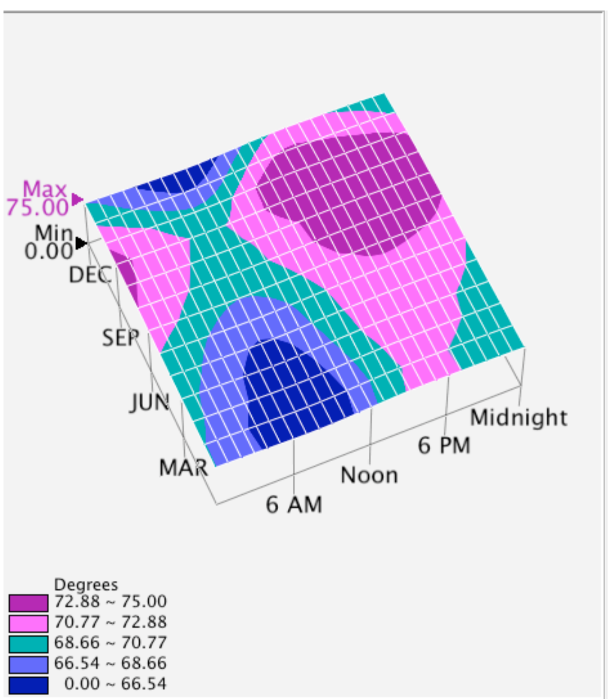

Fig. 5: HEED indoor temperature

6. CONCLUSION

The students in this studio, for the most part, rose to the given challenge of designing in a way that engaged the environment to dramatically reduce and eliminate the need for fossil fuel. (Fig. 6) I feel that the students were successful in designing a simple building that would be sustainable in their first design studio, hopefully giving them confidence to eliminate fossil fuels from future, more complex, studio projects and then all projects when they go into the practice of Architecture.

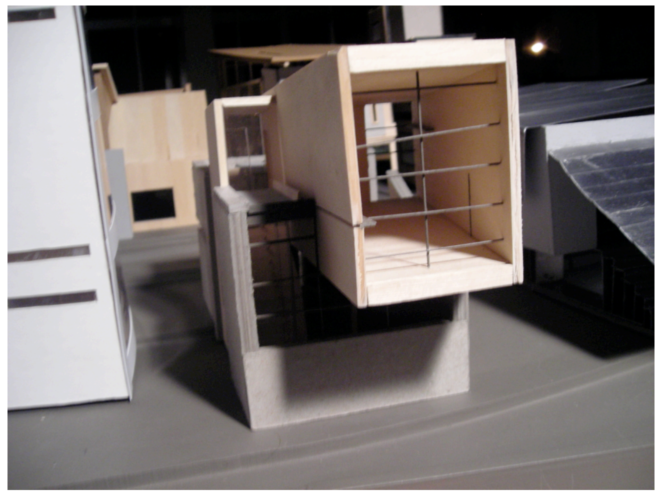

Fig. 6: Writer's retreat by Michael Meizen

7. ACKNOWLEDGEMENTS

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8. REFERENCES

(1) Architecture 2030, www.architecture2030.org
(2) A Regeneration-based Checklist for Design and Construction, Society of Building Science Educators, (www.sbse.org)
(3) HEED: Home Energy Efficient Design, Murray Milne, University of California, Los Angeles, (http://mackintosh.aud.ucla.edu/heed/)