LECTURE HALL THERMAL COMFORT

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1. INTRODUCTION

According to the University of Oregon press release, the Lillis Business Complex (located in Eugene, Oregon) is "the only environmentally friendly building at a top-ranked business school." The Complex, designed by SRG Architects and finished in 2004, is considered at the leading edge of sustainable design in architecture.

Lillis 282 [Figures 1 & 2] is a 243 seat lecture hall designed to incorporate a combination of passive and active environmental controls, both for lighting and for ventilation. Active ventilation occurs through two systems of air inlets, each with a separate VAV distributor. One set of vents serves the front of the lecture hall near the podium and one serves the back, near the entrances. The passive system is fueled by a stack at the north end of the room.

2. HYPOTHESES

I chose to investigate the thermal qualities of the room and present them in a quantitative manner in reference to the American Society of Refrigeration, Heating, and Air-Conditioning Engineers' 2004 standards. Specifically, I decided to compare the thermal performance of 282 Lillis to the ASHRAE 55-2004 thermal comfort guidelines. I hypothesize that 282 Lillis is...

...within ASHRAE 55-2004 comfort zone during February and March throughout the school day, defined as hours of the day during which classes are in session in the lecture hall.

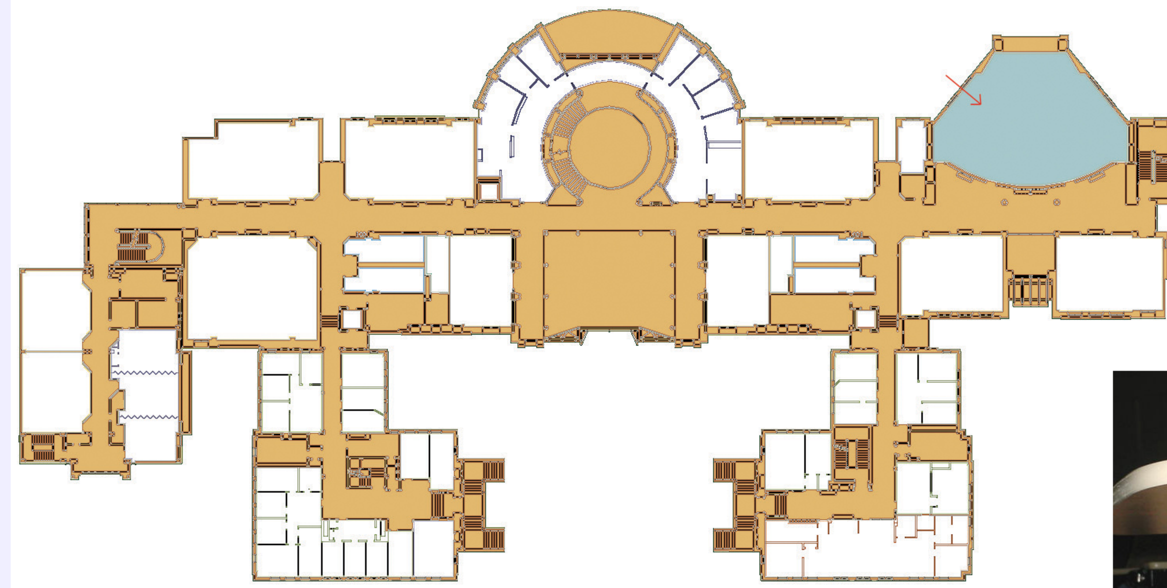
...within ASHRAE 55-2004 comfort zone during February and March throughout the lecture hall, defined as the zone in which students sit throughout the lecture hall, as measured below an imaginary line five feet above the

3. METHODOLOGY

To test my hypotheses, I placed five HOBO microdataloggers in the positions shown in Figure 3 and one on the north side of the building adjacent to the lecture hall. These dataloggers recorded relative humidity and dry-bulb temperature in 5 second increments from 8:25am to 8:45pm during test days. I placed the sensors only on Wednesdays in order to get comparable data between days with identical class schedules.

4. ANALYSIS

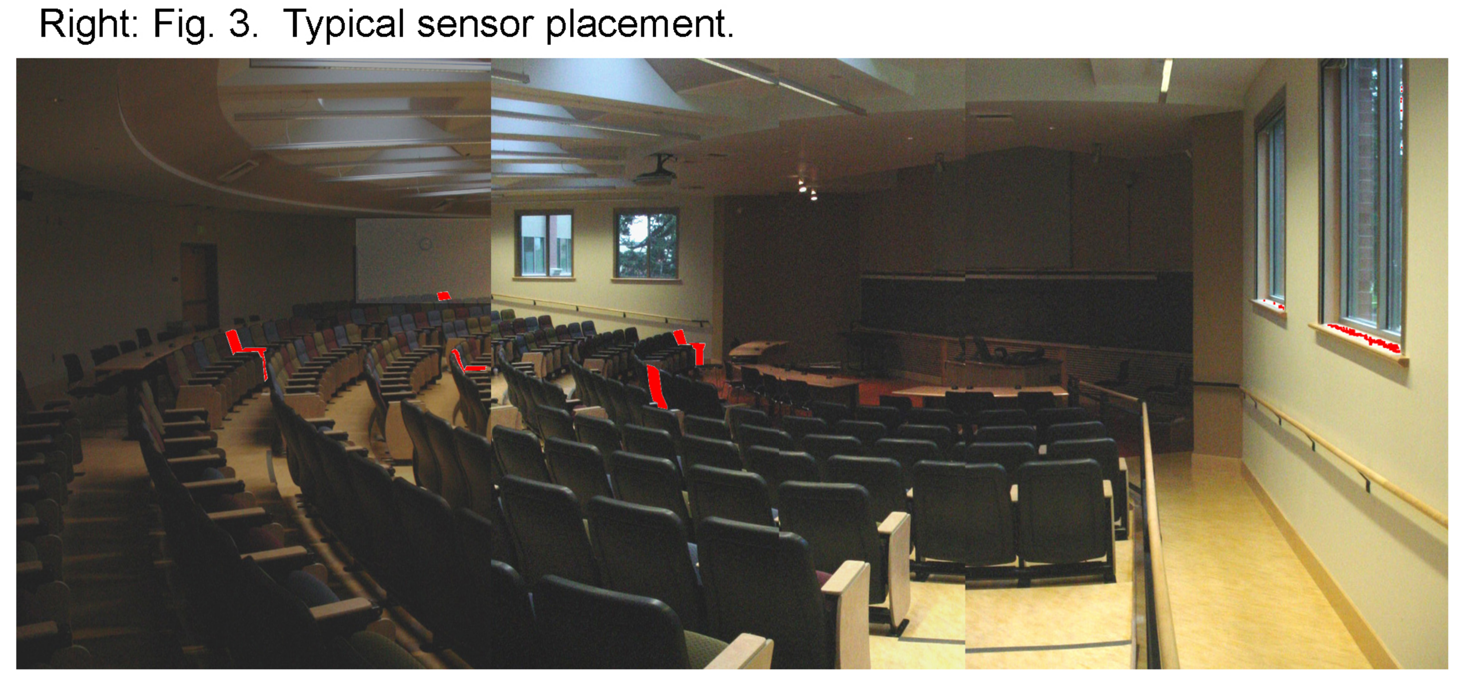
Results of the March 2 tests are displayed in Figure 4 with degrees Fahrenheit as the range and time of day from 8:25am to 8:45pm as the domain. In addition, a flat line is included for each sensor, indicating the average temperature read by the sensor throughout the testing period. Times of day when the room is occupied are shaded regions on the graphs.



Above: Fig. 1. Lillis Business Complex, second floor plan

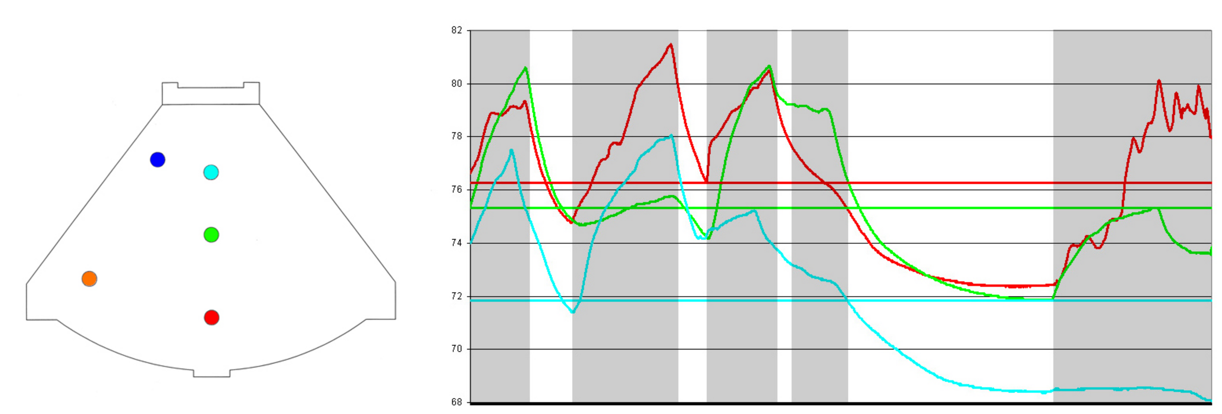
Below: Fig. 2. Interior with sensor positions highlighted

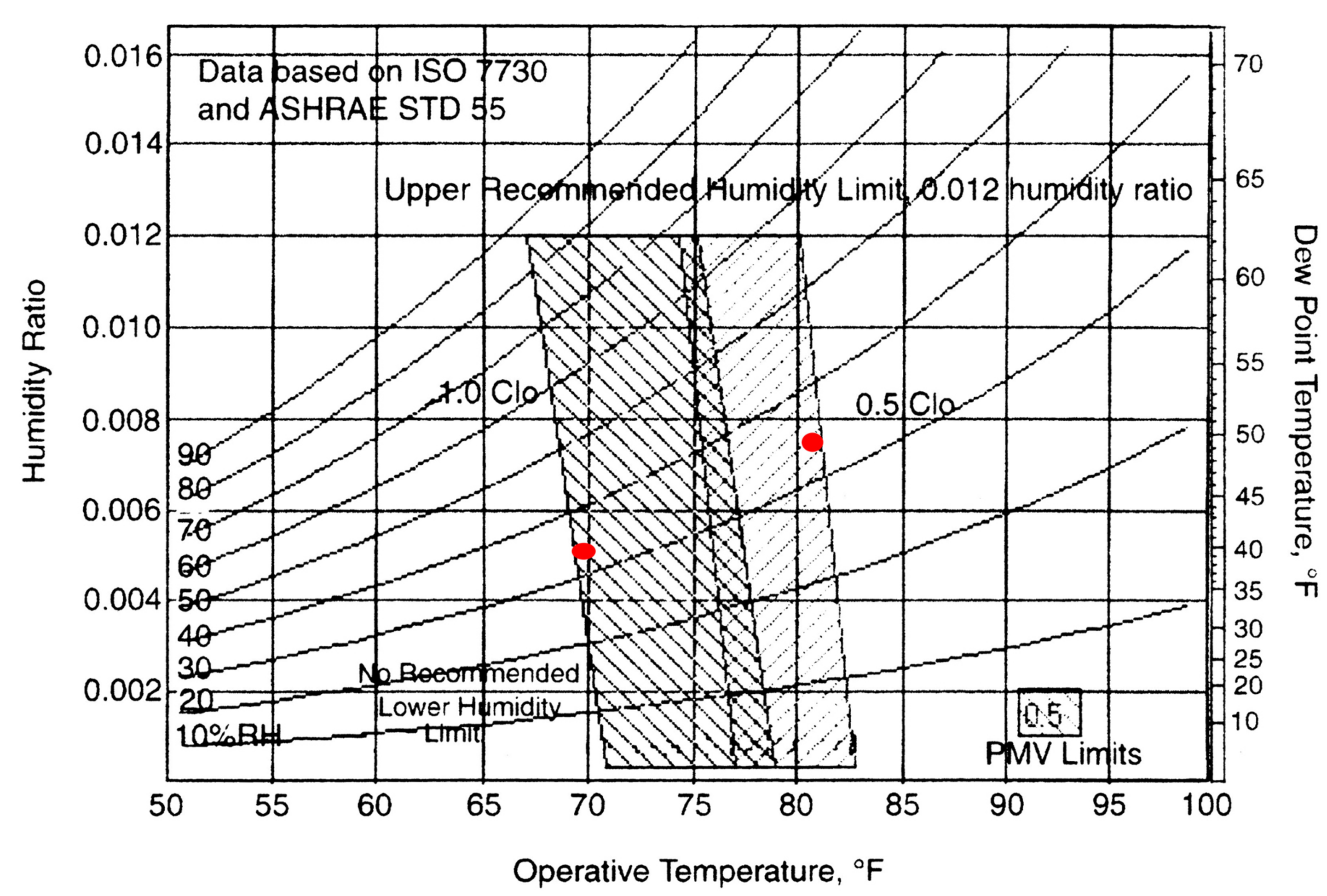
Right: Fig. 3. Typical sensor placement.



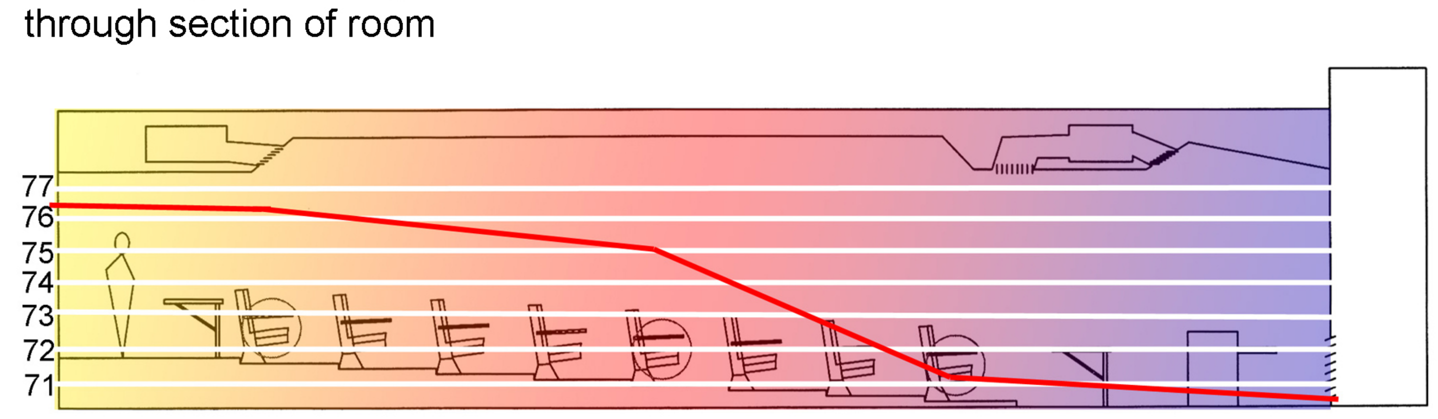
Right: Fig. 4 with sensor location key

Below: Fig. 5. Extreme temperatures during the test period





Below: Fig. 6. Average temperatures through section of room



ANALYSIS (COT'D)

There are three morning classes (the third following immediately after the second), two afternoon classes, and one evening class. Indoor humidity remained between 30 and 40% during the test period and is not shown on the graph.

5. CONCLUSION

The coldest position / time during the occupied March 2 test period is the end of the last class of the day in the middle of the front of the room and the warmest position /time during the occupied March 2 test period is the end of the third class in the middle-back of the room. In both cases, the humidity / temperature readings are within the ASHRAE 55-2004 comfort zone [see Figure 5]. This proves my hypotheses correct; 282 Lillis is within the thermal comfort zone throughout the day and throughout the room.

Extreme hot and cold readings from the pilot test data (which can not be used to prove or disprove the hypotheses) indicate measurements should be taken during more test days within 282 to determine possible micro-seasonal effects on the temperature within the room.

6. ADDITIONAL ANALYSIS

In Figure 6, data from dataloggers are supplemented by surface readings taken by a Raytec surface temperature sensor outside of the March 2 test period (March 7 from (2:00 to 3:00pm). These measurements, all taken along the north-south axis of the room at waist level, show that there is a steady rise in temperature from the front to the back of the hall. Possible causes of this differential include all or a combination of the following:

1. Overall dip in temperature of fresh air entering the room, caused by a change in outdoor air temperature.
2. Differences of internal loading caused by the number and distribution of students and changes in lighting.
3. Stack effect caused by room section geometry
4. Different rates of heat loss through skin caused by room plan geometry.

7. DIRECTIONS FOR FUTURE STUDY

In order to deem the conclusions of future studies even more usable, complete data sets should be obtained from different test days within the season or throughout the year. In addition to this, parallel subjective studies should be performed using questionnaires to obtain subjective comfort data. Future studies should include data taken from the Lillis room sensors on behavior of the rooms' ventilation systems. Finally, the thermal behavior of the room should also be measured while the room is vacant to isolate effects of the geometry of the room and loss of thermal energy through the building's envelope.