Allen Hall Thermal Comfort Analysis

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June 2010

Campus Planning & Real Estate
Part 1: Thermal Comfort Survey

Summary, Results, and Analysis
Allen Hall Thermal Comfort Evaluation

Introduction
Campus Planning & Real Estate conducted an electronic survey on the Thermal Comfort in the University of Oregon building, Allen Hall, with the goal of not only improving the planning process for the future remodel and expansion of the building, but also gaining awareness of the existing building conditions from the users’ vantage point.

Allen Hall, originally built in 1922 and expanded in 1954, is currently the home to the ever growing School of Journalism and Communication at the UO. The goal of this survey was to evaluate the Thermal Comfort of the building (window operation, air flow, temperature consistency, etc.) based on the users’ experience.

The single-paned, aluminum windows installed with the 1954 addition of Allen Hall are most frequently cited as being the source of user discomfort in Allen Hall. This survey aims to clarify what the true source for this discomfort is and how we can help to enhance the comfort in the building.

Methodology
The goal of the survey was to collect data from five (5) different user types within this multi-use University building.
- Faculty
- Staff/Admin
- Undergraduate Students
- Graduate Students
- Journalism Majors

An email with the survey link was sent to the five population groups. The voluntary survey was conducted April 16 through April 30, 2010. This summary analyzes the results of 126 responses from current and past users of Allen Hall at a completion rate of 67.74%.

The respondent group was comprised of 9.71% Faculty, 11.43% Staff/Admin, 44% Undergraduate Students, 5.14% Graduate Students, and 29.71% Journalism Majors.

*For direct graphs of survey questions, see Appendix A.*

The survey included rating-scale based questions, closed-ended questions, and optional open-ended questions.
Summary of Results

*Thermal Comfort Survey*

- The general comfort level related to temperature from every user group-based on a 1-5 scale (1 being most uncomfortable).
  - Faculty, Staff, and Administration seem to be the most uncomfortable on average.
  - Journalism Majors seem to be most comfortable on average.

*For larger graph, see Appendix B.*

Main Concerns for Faculty/Staff/Admin:
- Offices are either too hot or too cold, sometimes both in one day.
- Lack of control of heaters/air conditioning units.
- Only half of the building has air conditioning.

Main Concerns for Students:
- Lecture Hall 221 is very uncomfortable to be in for everyone.
- The 3rd floor labs are generally too cold.

General Concerns throughout the Building:
- Thermal Comfort cannot be predicted – you never know what you are going to get.
- The users need to have more control over the air handling to fit personalized needs.
- The air handling system should be “smart” – reacting in accordance to the outdoor temperature.
The general comfort level (1 being most uncomfortable) based on temperature in accordance to user’s location in the building:
- The north and west sides of the building seem to be more uncomfortable on average.
- The east side of the building seems to have the least amount of issues (however, this orientation has the least amount of user spaces physically connected to the outdoors).

*For larger graph, see Appendix B.

Relevant Air Handling Information throughout Allen Hall:
First Floor:
- Siemens: Almost every room
- Secondary Air System: none
- No A/C: H101, 102, 123, 126, all service areas

Second Floor:
- Siemens: 200-211 (West Façade, West Wing)
- Secondary Air System: Suite 218 (South Façade, East Wing)
- No A/C: most of the East Wing, service areas, and Room 221 (East Façade, West Wing)

Third Floor:
- Siemens: all of the West Wing (minus service areas)
- Secondary Air System: Suite 312 (East and South Facades, East Wing)
- No A/C: rest of the East Wing

*Graphs of this information provided on pages 6-8, also see Part 2: Summary and Analysis page 10.
• The average hours per day a window is open in an office or lab by choice in accordance with area in the building:

![Graph showing window opening times](image)

*For larger graph, see Appendix B.*

- Majority of users do not open windows at all.
- South Façade windows are open the least amount.
- East Façade windows are open on a more regular basis as compared to the rest of the orientations.

No area of the building seems to be consistent in how much time windows are open. All areas have variations; however, it is clear that users in the majority of all orientations choose not to open the windows.

It is interesting that on the North, East, and somewhat the West facades the graph line is in a “U” shape – “not at all” being the most popular then dipping in the middle, and back up for 4-6 hours a day. Conversely, the South façade does almost the opposite – “not at all” is still the most popular, however after that it is a curved decline with 4-6 hours a day being the least popular answer.

Therefore, it appears that users facing North, East, and West tend never to open the windows or to open them for longer periods of time, while users facing South tend to leave windows open for shorter periods.
• Amount of time a window is open (on average per day) in accordance with general thermal comfort (1 being the most uncomfortable, 5 being most comfortable):

*For larger graph, see Appendix B.

Of those who never open their windows, 85% are pretty comfortable (comfortable being 3-5) and 15% are uncomfortable. Similarly, of those who open their windows 4-6 hours a day, around 80-85% are pretty comfortable with 20% being uncomfortable.

However, of those who open their windows 0-2 hours a day, only about 65% are comfortable (35% being uncomfortable). Of those who open their windows 2-4 hours a day, the percentage drops even more to around a 50% even split between comfortable and uncomfortable.

- Very few people selected 5 as a comfort level (most comfortable possible), but of those who did all of them said that they never open their windows.
- Possible reasons for this could be that every person who chose a comfort level of 5 was an undergraduate student who may not have direct access to windows unless placed next to one in a lab or classroom.
Summary of Results

Allen Hall Floor Plans

Room 111 - Siemens officially set at 70°
Day Cooling set point at 74°

The first floor of Allen Hall is almost entirely run under Siemens, which is set at 72° in the Faculty office room 111.

* For temperature data on room 111, refer to Part 2: Summary and Analysis page 11.

There are two problem areas on this floor, as identified by the survey participants – Room 101 and 139 (Hall of Achievement). Both of these spaces were too cold for the users, though Rm 139 was very inconsistent. The users seem to be unable to predict the temperature in that room.

*For larger plans, see Appendix C.*
The second floor of Allen Hall has the least amount of space under Siemens control; however, Suite 218 does have a secondary air handling system.

The offices on the West façade (under Siemens) are set to about 74° daily – a bit warmer than the first floor. However, unlike the first floor, the second floor is inconsistent almost everywhere.

Some office users complain of being hot, while users next door complain of being cold. Likewise, the offices on the Northeastern edge of the building experience inconsistent temperature swings within one day.

The most significant issue on the second floor is Room 221. This lecture hall is east facing and does not have any kind of A/C. In the afternoons the users are too hot so they open the windows, but in the morning after the windows have been open all night users are too cold so they close the windows back up. No one wants to sit next to the windows because they feel uncomfortable all year. Overall, this is the most inconsistent room in the building, and most of the users strongly suggest it be improved.

*For temperature data on room 221, refer to Part 2: Summary and Analysis page 16.
The third floor of Allen Hall is split in half in terms of A/C. The West Wing is under Siemens (minus the restrooms and stairwells) while the East Wing is not. Suite 312, however, has a secondary air-handling unit much like Suite 218 on the second floor.

The labs occupy the West Façade of this floor. The students use these labs day and night and experience a wide range of temperatures there.

During the day it can get quite hot, but at night users complain of it being too cold. In looking at Siemens data, the average difference in temperature from day to night in these spaces is around 6° with a base temperature at around 72°. This 6° drop brings the nighttime temperature to around 64°.

Besides the issue with the Labs, however, the third floor occupants seem to be relatively comfortable despite being without A/C in the West Wing and on the top floor of the building. There are complaints of the North Façade being too hot, and the South Façade being too cold, but these accounts are isolated complaints.

*For temperature data on rooms 302 and 306 refer to Part 2: Summery and Analysis pages 17 and 18.
Part 2: Temperature Data Collection

Summary, Results, and Analysis
Allen Hall Temperature Data Collection
Summary and Analysis

<table>
<thead>
<tr>
<th>Room Number</th>
<th>Room Use</th>
<th>Conditioned/Unconditioned</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>Faculty office</td>
<td>Conditioned</td>
<td>West</td>
</tr>
<tr>
<td>135</td>
<td>Faculty office</td>
<td>Unconditioned</td>
<td>South</td>
</tr>
<tr>
<td>202, 203</td>
<td>Faculty office</td>
<td>Conditioned</td>
<td>West</td>
</tr>
<tr>
<td>215D</td>
<td>Faculty office</td>
<td>Unconditioned</td>
<td>North and East</td>
</tr>
<tr>
<td>218C</td>
<td>Faculty office</td>
<td>Unconditioned</td>
<td>South</td>
</tr>
<tr>
<td>221</td>
<td>Classroom</td>
<td>Unconditioned</td>
<td>East</td>
</tr>
<tr>
<td>302</td>
<td>Computer lab</td>
<td>Conditioned</td>
<td>West</td>
</tr>
<tr>
<td>306</td>
<td>Computer lab</td>
<td>Conditioned</td>
<td>North and East</td>
</tr>
<tr>
<td>314</td>
<td>Computer lab</td>
<td>Unconditioned</td>
<td>South</td>
</tr>
</tbody>
</table>

Allen Hall Floor Plans

First-Floor Plan

Second-Floor Plan

Third-Floor Plan

Rooms from which temperature data were collected are highlighted in the floor plans. Green indicates conditioned spaces, yellow indicates unconditioned spaces. The conditioned spaces were monitored using the Siemens temperature control devices already installed in the rooms. HOBO data loggers were used to collect data from the unconditioned rooms. The test period spanned three weeks, beginning February 27, 2010 and ending March 19, 2010. The resulting data points were then plotted for each individual room against the outside air temperature. The temperature readings for each room also were plotted against one another to facilitate comparisons among the spaces.
Room 111

- Room 111 is a conditioned, west-facing Faculty office.
- Small space, few occupants, therefore temperature does not fluctuate greatly.
- There is no difference in temperature regulation between weekends and weekdays.
- Compare to Rooms 202, 203 (also conditioned, west-facing faculty offices).
- Room 111 has a smaller temperature range than Rooms 202, 203.
- The temperature of Room 111 is more or less constant at 72° during work hours – about 2 degrees lower than the average working day temperature of Rooms 202, 203.
Room 135

- Room 135 is an unconditioned, south-facing Faculty office.
- Compare to Room 218 (also a south-facing Faculty office). The temperature of Room 135 varies much less dramatically than that of 218.
- The average temperature of Room 135 is about 70 degrees, at least 5 degrees below that of 218.
- Outside shading from trees and location on a lower level may account for lower average temperatures in Room 135.

*For user feedback on room 135A, see Appendix D.*
• Rooms 202 and 203 are conditioned, west-facing Faculty offices.
• Small space, few occupants, therefore temperature does not fluctuate greatly.
• There is no difference in temperature regulation between weekends and weekdays.
• Compare to Room 111 (also a conditioned, west-facing faculty office).
• Rooms 202 and 203 have a larger temperature range than Room 111.
• The temperature of Rooms 202 and 203 is more or less constant at 74 degrees during work hours – about 2 degrees higher than the average working day temperature of Room 111.

*For user feedback on room 202, see Appendix D.*
Room 215D

- Room 215D is an unconditioned north- and east-facing Faculty office.
- The temperature of Room 215 fluctuates from 70 to 80°F.
- Compare to Room 135, an unconditioned south-facing faculty office, which has a much smaller temperature range. Also compare to Room 218, an unconditioned south-facing faculty office, which has a much wider temperature range and whose temperature plot is characterized by much sharper peaks and troughs.
- Indoor temperature changes generally mirror outdoor temperature changes.

*For user feedback on room 215B, see Appendix D.*
Room 218C

- Room 218C is an unconditioned, south-facing Faculty office (see Part 1: Thermal Comfort Evaluation, p. 7).
- Compare to Rooms 215 (an unconditioned, north and east-facing Faculty office) and 135 (also an unconditioned, south-facing Faculty office).
- Temperatures vary between 68 and 85 degrees over the 3-week test period. This is the widest temperature range of any of the rooms tested, and peak temperatures are the highest of any room tested.

*For user feedback on room 218B and 218D, see Appendix D.*
Room 221

- Room 221 is an unconditioned, east-facing classroom.
- Temperatures peak with occupancy of the classroom.
- Room 221 experiences the lowest average temperature of any of the rooms tested (mid-60s except for occupancy spikes).
- Compare to Room 314 (an unconditioned south-facing computer lab). Temperature variations in the lab are generally characterized by smooth wave forms rather than the sharp peaks of the classroom. This may be due to the regulating effect of the mechanical heat generated by the computers.

*For user feedback on Room 221, see p. 7 in Part 1: Thermal Comfort Survey.*
Room 302 is a conditioned, west-facing computer lab. Temperatures are more or less constant at 72 degrees during work hours. The cycle of daily temperatures are fairly regular until 3/17/2010, when the temperature range became much larger, particularly because of the minimum temperature troughs. No difference between temperature regulation between weekends and weekdays. Compare to Room 306 (same floor and usage, but north and east facing).

*For user feedback of lab spaces on the third floor, see p. 8 in Part 1: Thermal Comfort Survey.*
Room 306 is a conditioned, north and east-facing computer lab. It has much wider variations in temperature than Room 302 and experiences higher temperatures on average even though Room 306 is north and east facing, whereas 302 is west facing. A large occupancy group and mechanical heat generated by the computers gives Room 306 a high average temperature. The temperatures vary more often and more dramatically because more people walk in and out of the computer lab more often than in classrooms or faculty offices. Compare to Room 314 (unconditioned south-facing lab space – only a few degrees warmer than Room 306).
Room 314

• Room 314 is an unconditioned, south-facing computer lab.
• Data collection for Room 314 only begins on 3/08/2010.
• Although Room 314 is unconditioned and south facing, it is only a few degrees warmer than Room 306, which is conditioned and faces north and east.
Part 3: Conclusions
According to the survey data, the main issue with Allen Hall is the inconsistency with temperature. Regardless of their location, and with or without A/C, users complain of being both too hot and too cold – sometimes both in one day.

The 1922 wing (East) is mostly unconditioned (other than the first floor), and the 1954 wing (West) is mostly conditioned, which does not seem to make a difference in the thermal comfort of the users.

In Siemens and HOBO research of the building, it was found that the Faculty offices generally had more consistent temperatures than the Student Labs or Graduate Teaching Fellow offices – perhaps because they are smaller and hold fewer people – yet these were the spaces about which users complained most frequently.

Areas that seem to be most problematic for users (in order of most complaints) would be:

1. Room 221 (Lecture Hall)
   • Inconsistent temperature
2. Room 306, and 302 (3rd Floor Labs)
   • Frequently too hot during the day and too cold at night
3. Room 139 (Hall of Achievement)
   • Inconsistent temperature
4. Room 101 (Student Services Office Suite)
   • Frequently too cold
5. Room 210 (GTF Offices)
   • Inconsistent temperature

The data collected demonstrates that there is a disconnect between the actual and perceived temperatures in Allen Hall.

Room 221 has the lowest average temperature of all of the rooms studied; however, users maintain that the temperature is too inconsistent and needs some form of regulation. The graphs generated from HOBO do not substantiate users’ complaints - a disjuncture that seems to be a theme in this building.

The third-floor computer labs (302, 306) are similar to room 221. As these rooms are both conditioned - the graphs from Siemens show a fairly constant temperature for both rooms. Room 306 has more variance, but this could be because it has a higher occupancy. The users, however, feel that the spaces are too hot during the day and too cold at night.

Room 306 more closely correlates to the outdoor temperature than Room 302, especially at night. This could indicate two things: inadequate window insulation and/or lack of Siemens operation. Air conditioning turning off at night is a normal occurrence; however, in this particular setting students use these types of spaces at all hours of the day, including 3 a.m. (as one user commented).
Final Conclusions

HOBO and Siemens data show that the temperatures in conditioned rooms of Allen Hall stay fairly constant, while the unconditioned rooms vary in temperature according to outdoor temperature conditions. Regardless, user complaints apply to both conditioned and unconditioned spaces.

The unconditioned rooms show the greatest correlation to outdoor temperature changes, which could suggest that the windows in these rooms are inadequate in their insulation.

Overall, Allen Hall is adequate for most of its users. However, for those who are not comfortable, temperature regulation is a prevalent issue that they want to see fixed. The spaces mentioned on the previous page are forefront, however users also complain that the Faculty offices on the 2nd floor of the West Wing are either too hot or too cold.

Inconsistency in both actual and perceived temperatures in Allen Hall is causing users to feel uncomfortable in their spaces. Improving the thermal comfort of all users - frequent or infrequent - should be considered in any remodel of Allen Hall.

Campus Planning and Real Estate currently is in the design phases of a remodel and expansion of Allen Hall. This Thermal Comfort survey is intended to assist planners and designers in determining what needs to be done to improve the user’s thermal comfort experience within the building.
Appendix A:
Direct graphs of results from survey questions
Allen Hall User (check all that apply):

In what area of Allen Hall do you spend the most time? (check all that apply)
On a scale of 1 to 5, 5 being the most comfortable you could be, how would you rank your comfort with regards to thermal comfort in Allen Hall?

In each term, during what times do you feel the most uncomfortable in Allen Hall?
During which time of the year do you feel the most comfortable due to thermal comfort in Allen Hall?

How often do you have a window open in your office on an average day?
Appendix B
Cross Analyzing of Data

The general comfort level, based on temperature, from every user group based on a 1-5 scale (1 being most uncomfortable):

![Bar chart showing comfort level across different user groups and locations.]

The general comfort level, based on temperature, from users in accordance to their location in the building:

![Bar chart showing comfort level across different locations in the building.]

EW = East Wing built in 1954  ---------------------  WW = West Wing Built in 1922

North (EW)  South (EW)  East (WW)  West (WW)
In each term from the previous question, you are uncomfortable because of feeling:

The average hours per day a window is open in an office or lab by choice, in accordance to location in the building:
Amount of time a window is open (on average per day) in accordance with general thermal comfort:
### Appendix D

**Excel Chart Data**

<table>
<thead>
<tr>
<th>North (EW)</th>
<th>Type</th>
<th>Complaint</th>
<th>Windows open</th>
<th>Time Most Uncom.</th>
<th>A/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm 213</td>
<td>Single</td>
<td>Cold (W)</td>
<td>Never</td>
<td>Evenings (W)</td>
<td></td>
</tr>
<tr>
<td>Rm 214D</td>
<td>Single</td>
<td>Cold (W) Hot (Su)</td>
<td>2-4 hours</td>
<td>Late Mornings</td>
<td></td>
</tr>
<tr>
<td>Rm 215B</td>
<td>Single</td>
<td>Cold (W) Hot (Sp/Su)</td>
<td>4-6 hours</td>
<td>L. Afn. &amp; E. Morn.</td>
<td></td>
</tr>
<tr>
<td>Rm 311A</td>
<td>Shared</td>
<td>Hot (Sp) &quot;stuffy&quot;</td>
<td>4-6 hours</td>
<td>Afternoons (Sp)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>South (EW)</th>
<th>Type</th>
<th>Complaint</th>
<th>Windows open</th>
<th>Time Most Uncom.</th>
<th>A/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm 218B</td>
<td>Single</td>
<td>Hot</td>
<td>0-2 hours</td>
<td>Afternoons</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 218D</td>
<td>Single</td>
<td>Cold</td>
<td>N/A</td>
<td>Mornings</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 313A</td>
<td>Single</td>
<td>Cold</td>
<td>0-2 hours</td>
<td>A.N.(F/Su) All(W)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 135A</td>
<td>Shared</td>
<td>Cold</td>
<td>Never</td>
<td>Mornings (W)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 312B</td>
<td>Shared</td>
<td>N/A</td>
<td>Never</td>
<td>N/A</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>East (WW)</th>
<th>Type</th>
<th>Complaint</th>
<th>Windows open</th>
<th>Time Most Uncom.</th>
<th>A/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm 216A</td>
<td>Single</td>
<td>Hot &quot;stuffy&quot;</td>
<td>2-4 hours</td>
<td>A.N.(Sp) All(Su)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 312A</td>
<td>Single</td>
<td>Hot (F/W)</td>
<td>2-4 hours</td>
<td>Morn.(F/W)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>West (WW)</th>
<th>Type</th>
<th>Complaint</th>
<th>Windows open</th>
<th>Time Most Uncom.</th>
<th>A/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm 101A</td>
<td>Single</td>
<td>Cold</td>
<td>Never</td>
<td>All</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 201</td>
<td>Single</td>
<td>Hot</td>
<td>0-2 hours</td>
<td>A.N. &amp; Evenings (Sp)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 202</td>
<td>Single</td>
<td>Cold (W)</td>
<td>Never</td>
<td>Mornings (W)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rm 301B</td>
<td>Lab</td>
<td>Hot</td>
<td>4-6 hours</td>
<td>Afternoon (all year)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

F = Fall        Su = Summer
W - Winter      A.N. = Afternoon
Sp - Spring