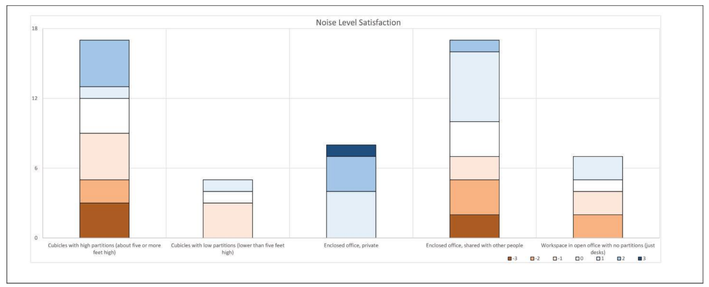
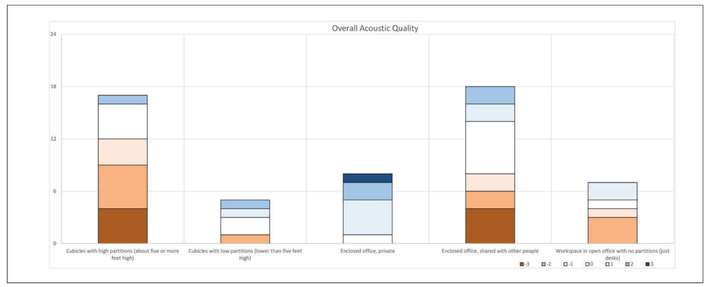
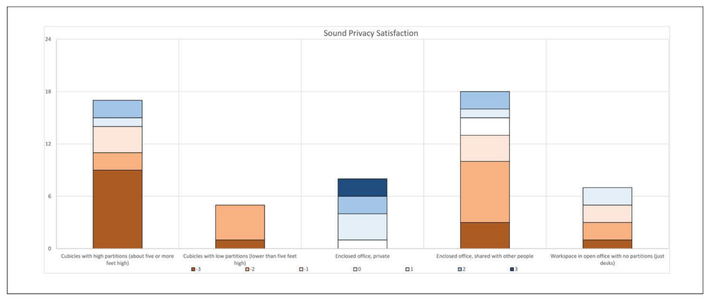
# ACOUSTICS :: Haas School of Business

# HYPOTHESIS




**LOCATION**
2220 Piedmont Avenue
Berkeley, CA 94704

**BUILDINGS**
Classroom Wing (Cheit Hall)
Faculty Wing
Student Services Wing

**GROSS FLOOR AREA**
200,000 ft$^2$

**BUILT**
1995

**Operating Hours**
90 hours

**Enrollment**
2200 students

**Number of FTE**
300 faculty and staff

**Grant Dollars**
$300 million

**Number of Computers**
500 computers

**Occupancy :: 90%**

## CBE SURVEY

Beyond the standard analysis of the CBE (Center for the Built Environment) Survey, we evaluated occupants' responses by the conditions of their spaces. As shown, occupants with high partitions were the least satisfied with their noise level, sound privacy, and overall acoustic quality. Those with private offices were the most satisfied.

**BASIC PERFORMANCE MEASURES (LEVEL 1)**

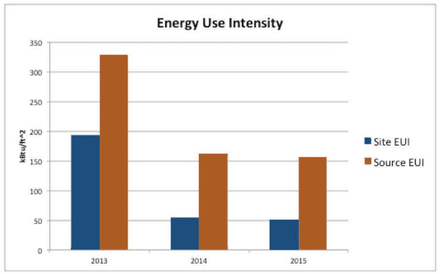
| Room Types / Applications | | Ideal $L_{eq}$ (dBA) | Maximum $L_{eq}$ (dBA) |
|---|---|---|---|
| Outdoor Ambient | Intrusion from transportation vehicle noise | 40 | 50 |
| | Noise Exposure of neighboring property from operation of building equipment through louvers and from outdoor equipment. | 45 at the property line | Local Ordinance |
| Apartments and condominiums | | 30 | 40 |
| Hotels/Motels | Individual rooms or suites | 30 | 40 |
| | Meeting/banquets rooms | 30 | 40 |
| | Corridors and lobbies | 40 | 50 |
| | Service/support areas | 40 | 50 |
| Office Buildings | Executive and private offices | 30 | 40 |
| | Conference rooms | 30 | 40 |
| | Teleconference rooms | 25 | 30 |
| | Open-plan offices without sound masking | 35 | 45 |
| | Open-plan offices with sound masking | 35 | 40 |
| | Corridors and lobbies | 40 | 50 |
| Courtrooms | Unamplified speech | 30 | 40 |
| | Amplified speech | 35 | 45 |

ACOUSTICS PERFORMANCE BENCHMARKS

Energy Use Intensity

| Year Ending | Site EUI (kBtu/ft^2) | Source EUI (kBtu/ft^2) | National Median Site EUI (kBtu/ft^2) | National Median Source EUI (kBtu/ft^2) | Difference from National Median Source EUI |
|---|---|---|---|---|---|
| 7/31/2015 | 194.7 | 329.5 | 155.1 | 262.6 | 25.5 |
| 7/31/2014 | 55.0 | 162.4 | 89 | 262.6 | -38.2 |
| 7/31/2013 | 51.1 | 156.5 | 85.7 | 262.6 | -40.4 |

| Total Energy Usage | | |
|---|---|---|
| Year Ending | Total Site EUI (kBtu) | Total Source EUI (kBtu) |
| 7/31/2015 | 38940000 | 65900000 |
| 7/31/2014 | 11000000 | 32480000 |
| 7/31/2013 | 10220000 | 31300000 |




## Hypotheses

Even though there is a plethora of anecdotal evidence that the acoustical environment within a large portion of Haas School of Business creates many problems and is not up to personal requirements for a workplace, the noise and sound levels in the buildings comply with all relevant codes and standards.

Grievances with the current acoustical environment is due to overcrowding resulting from poor layout and space planning rather than material and construction choices.

The lack of consideration for overall acoustical comfort has led to a combination of worse overall indoor environmental comfort (focusing on thermal comfort and IAQ) and more strain being placed on the building mechanical system.

## References


Atlas Sound (2015) TSD-GPN 1200 Sound Masking Generator Owner's Manual. Retrieved on November 27, 2015, from http://www.atlassound.com/.

GSA (2011) Sound Matters: How to achieve acoustic comfort in the contemporary office. GSA Public Buildings Service.

Haas School of Business (2015) About Haas. Retrieved on November 29, 2015, from www.haas.berkeley.edu/haas/about/.

Hongisto, V. (2008) Effects of sound masking on workers - a case study in a landscaped office. 9th International Congress on Noise as a Public Health Problem (ICBEN), Foxwoods, CT.

Miller, H. (2003) Sound Masking in the Office: Reducing Noise Distractions to Increase Worker Productivity. Herman Miller, Inc., Zeeland, Michigan.

Moiseev, N. (2010) Acoustic Performance Measurement Protocols. ASHRAE Journal, ASHRAE, inc. Retrieved from www.ashrae.org.

Salter, C. (2012) Acoustical Performance Measurement Protocols for Commercial Buildings. Summary Report. Charles M. Salter Associate, Inc.





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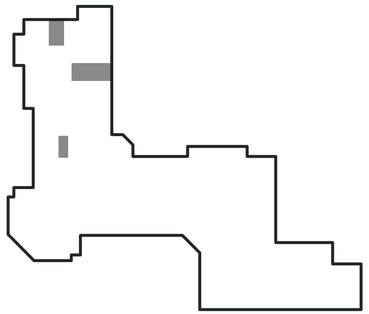
# ANALYSIS

## Floor Plans

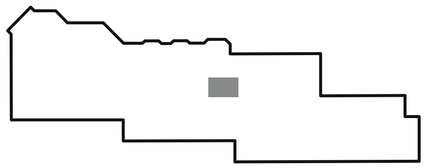


Faculty Wing | 4th Floor

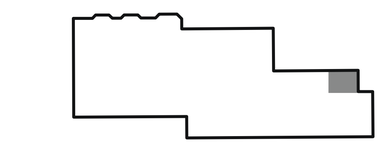
Scale Floor Plans: 1/4” = 1’
Room Plans: 1/2” = 1’

Exceeds Minimum dB(A) Range

Falls Below Minimum dB(A) Range

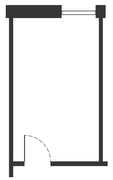


Student ServicesWing | 4th Floor



Student ServicesWing | 5th Floor

## Room Plans



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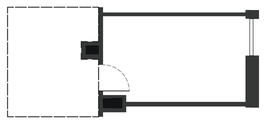

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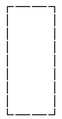

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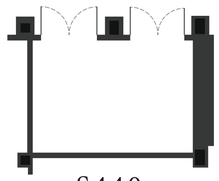

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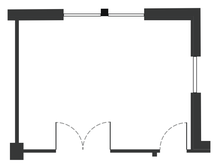


S522

## Data Measurements

| Room Type | Condition | Time of Day | Min. dB(A) | Max. dB(A) |
|---|---|---|---|---|
| Conference Room | Construction, Windows Open | Afternoon | 48.6 | 59.9 |
| Conference Room | Construction, Windows Closed | Afternoon | 36.5 | 46.4 |
| Conference Room | No Construction, Windows Open, Traffic | Night | 42.6 | 51 |
| Conference Room | No Construction, Windows Closed, Traffic | Night | 34 | 48.7 |

| Room Type | Condition | Time of Day | Min. dB(A) | Max. dB(A) |
|---|---|---|---|---|
| Private Office | Door Open | Early Morning | 29.7 | 58.2 |
| Private Office | Door Closed | Early Morning | 27.4 | 50 |
| Private Office | People In Close By Rooms Talking | Afternoon | 43 | 50.7 |
| Private Office | No Talking | Afternoon | 31.8 | 51.9 |

| Room Type | Condition | Time of Day | Min. dB(A) | Max. dB(A) |
|---|---|---|---|---|
| Hallway | | Early Morning | 27.6 | 56.7 |
| Hallway | | Morning | 36.9 | 66.4 |
| Hallway | | Afternoon | 39.3 | 50.3 |

| Room Type | Condition | Time of Day | Min. dB(A) | Max. dB(A) |
|---|---|---|---|---|
| Open Office | Door Closed, No Talking | Morning | 37.6 | 47.8 |
| Open Office | Door Closed, Talking 19 ft. Away | Morning | 43.7 | 69.7 |
| Open Office | Door Closed, No Talking | Afternoon | 43.5 | 57.1 |
| Open Office | Door Closed, No Talking | Night | 27.2 | 57.6 |

| Room Type | Condition | Time of Day | Min. dB(A) | Max. dB(A) |
|---|---|---|---|---|
| Conference Room | Windows Closed, No Fan | Early Morning | 21.8 | 58.9 |
| Conference Room | Windows Open, No Fan | Early Morning | 32.9 | 62 |
| Conference Room | Windows Open, Fan On | Early Morning | 38 | 61.1 |
| Conference Room | Windows Closed, Fan On | Early Morning | 37.7 | 56 |
| Conference Room | Windows Closed, No Fan | Morning | 37.8 | 60.6 |
| Conference Room | Windows Open, No Fan | Morning | 40.9 | 50.2 |
| Conference Room | Windows Open, Fan On | Morning | 46.4 | 50.5 |
| Conference Room | Windows Closed, Fan On | Morning | 48.5 | 50.7 |

## Layout of Rooms

Multiple rooms including a few not shown in this poster were examined for their acoustical quality. The five (if we show all five) displayed were chosen to be representative of the sources of dissatisfaction and of the types of rooms in the CBE Survey.

## Results

The results of our experiment demonstrate that the building complies with most ASHRAE standards. There were only a couple of instances where the background noise was either too low or too high. Of those situations, construction and traffic played a role for high background noise level.

Sound Masking System Estimates

| | 1 Min./Day, 4 Occupants | 8 Min./Day, 8 Occupants | 15 Min./Day, 8 Occupants | Range |
|---|---|---|---|---|
| Projected Savings ($/week) | 6.67 | 53.33 | 200 | 3 - 400 |
| | Capital | Electricity | Total | Range |
| Projected Costs ($/week) | 4 | 1.6 | 5.6 | 2.2 - 17 |

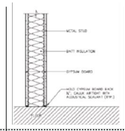
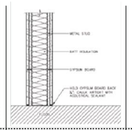
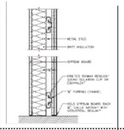
| (A) Noise Level (dba) | (C) Sound Isolation (dba) | (D) Found Background Noise (dba) | (B) Speech Privacy (dba) | | Typical Values (dba) |
|---|---|---|---|---|---|
| Low Voice - 54 | 35 | 27.2 | -8.2 | (C) Estimated Noise Reduction for Partition Built to Ceiling Grid | 35 |
| Normal Voice - 60 | 35 | 27.2 | -2.2 | (D) Typical Background Noise for Open Offices | 45 |
| Raised Voice - 66 | 35 | 27.2 | 3.8 | (B) Unacceptable Speech Privacy | 0 or More |
| Loud Voice - 72 | 35 | 27.2 | 9.8 | (B) Normal Speech Privacy | -9 |

### Young’s Method

[For open office (S440)]

**A - C - D = B**

Speech Privacy Unacceptable

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCTION | |  |  |  | | | |
| DESCRIPTION | Baseline Partition | Partition Type #1 | Partition Type #2 | Partition Type #3 | Sound absorbing wall panel | Lay-in acoustical tile ceiling in 2x4 grid | Lay-in acoustical tile ceiling in 2x4 grid | Sound masking system |
| | 12’ high 20 gauge studs slab to slab, 24” o/c, 5/8” gypsum board each side, Level 4 finish, painted.<br>Baseline partition is not sound rated. | Same as Baseline Partition plus R-11 fiberglass insulation, in stud cavity. Wall penetrations and perimeter sealed with acoustical caulking. Low voltage devices placed in outlet boxes. All electrical outlets sealed with outlet box pads.<br>STC 40 | Same as Partition Type #1 plus one layer of 5/8” gypsum board added on each side.<br>STC 45 | Same as Partition Type #2 except only one layer of gypsum board on one side and 1 3/8” resilient channels isolating gypsum board on the other side.<br>STC 53 | NRC 0.8 minimum | Celotex BET-197<br>NRC 0.55 | Capaul Nubby<br>NRC 0.9 | Logison |
| COST | $154.30/lineal foot<br>$12.86/sq. ft. | 15% more than Baseline Partition<br>$176.69/lineal foot<br>$14.73/sq. ft. | 31% more than Partition Type #1<br>50% more than Baseline Partition<br>$231.66/lineal foot<br>$19.30/sq. ft. | 3% less than Partition Type #2<br>45% more than Baseline Partition<br>$224.56/lineal foot<br>$18.71/sq. ft. | $22.30/sq.ft. installed | $5.42/sq. ft.<br>Installation of grid and tile, not including lights, sprinklers, etc. | $6.97/sq. ft.<br>28% more than standard acoustical tile ceiling | $1.81 per sq. ft. installed |

## Conclusion

From the CBE Survey, our experimental results, and Sound Matters (the U.S. General Services Administration Acoustics Tool) we found that partitions were not the answer for solving the acoustical issues of the spaces. A sound masking system, however, could be a viable option for increasing productivity by adding to the background noise, thereby decreasing distractions and improving the ability to focus on tasks. The economic benefit analysis further illustrated that financial feasibility even when using estimates below that of 8 minutes saved per day (Hongisto 2008). Thus, we recommend the Haas School of Business should implement sound masking systems, especially where space is shared and occupants are unsatisfied.



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