

Case Study with Caltech

Gates-Thomas Building Renovation

A Study Conducted by:



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The California Sustainability Alliance (the Alliance) is an innovative market transformation program funded by California utility customers under the auspices of the California Public Utilities Commission. The Alliance leverages action on environmental initiatives such as climate, smart land use and growth, renewable energy, waste management, water use efficiency and transportation planning to help the State of California achieve its aggressive energy efficiency goals more effectively and economically. In partnership with public and private organizations throughout California, the Alliance precipitates widespread market transformation by tackling major barriers to sustainability.

For information about the California Sustainability Alliance, go to:

www.sustainca.org

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EXECUTIVE SUMMARY

Background

There is a significant new trend in the world of green buildings – wellness. Building owners and facility managers are increasingly interested in the ideas of occupant wellness and are starting to put decisions related to occupant wellness in front of those related to sustainability. For example, the WELL building standard, which examines how buildings can support healthy living has over 300 projects registered across the globe. Additionally, company spending on wellness-based incentives, increased approximately 17% from 2014 to 2015.

The goal of this case study was to explore the overlap between sustainability and occupant wellness within a building design process. The Alliance team hypothesized that focusing on occupant wellness could help building owners and facility managers to drive greater achievement of energy efficiency and sustainability in their projects, by avoiding the typical roadblock of value engineering.

Significant Findings

Through this case study, the Alliance team engaged with stakeholders responsible for the recent renovation of the Gates-Thomas building at Caltech. This project clearly showed occupant wellness as a value proposition that engaged all stakeholders around a central ideal. In fact, in a survey of building occupants, approximately 70% of survey respondents indicated that working in a healthy building was more important to them than working in a sustainable building.

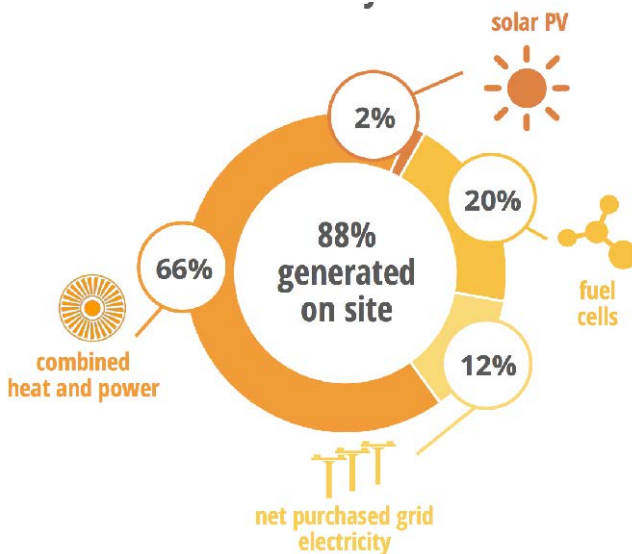
The increasing focus on occupant wellness is one that can be supported by all stakeholders in the building design discussion, from designers, to owners/manager, to occupants. While sustainable building design often left stakeholder groups on different sides of the discussion, with misalignment within the value proposition, a design focus on occupant wellness does not run into the same barriers and can even drive sustainability and energy efficiency to higher levels of achievement.

CASE STUDY WITH CALTECH

The California Institute of Technology (Caltech or The Institute, www.caltech.edu) was founded in 1891 under the name of Throop University. Today, Caltech is a nationally recognized and distinguished science and technology institute located in Pasadena, California. Caltech has a faculty of approximately 300 and a student body composed of approximately 1,000 undergraduates and 1,250 graduate students, located on facilities spread over 124 acres.

Caltech is committed to sustainability and ongoing efforts include an array of action plans, from large scale projects such as LEED certified buildings, to individual opportunities such as recycling and transportation.¹ Clear demonstration of Caltech's investment in sustainability is evident in the built environment. Based on *the 2016 Annual Sustainability Updates* released by Caltech in June 2017,² the Institute now claims nine LEED certified buildings, a significant increase in comparison to the one LEED certified building in 2008. Additionally, all new buildings on the Caltech campus are required to be LEED certified. Caltech has clearly articulated and demonstrated a commitment to sustainable building practices in a way that can be an example to other educational institutions.

Figure 1. Caltech 2016 Electricity Portfolio



Source: Caltech Annual Sustainability Update 2016.

Due to the science laboratories and research-intensive nature of the work conducted at Caltech, the Institute naturally accounts for substantial energy usage. In 2016, Caltech consumed 300 kBtu per gross square foot, which constituted a 3% increase over the previous year as a result of increased onsite combustion of natural gas.³ A significant portion of the campus energy needs are met from onsite power generation (Figure 1), which currently accounts for 88% of total energy needs on site.

To explore first-hand the advantages of considering occupant wellness in building design, the Alliance

partnered with Caltech to review a recently completed renovation to the Gates-Thomas

¹ CalTech Facilities Department Sustainability Statement, May 2013.

https://www.sustainability.caltech.edu/documents/93-cit_facilities_sustainability_statement.pdf

² <https://www.sustainability.caltech.edu/>

³ CalTech Facilities Department Sustainability Statement, May 2013.

https://www.sustainability.caltech.edu/documents/93-cit_facilities_sustainability_statement.pdf

Lab. The Gates-Thomas Lab houses the Department of Mechanical and Civil Engineering and represents one of the most recent, large-scale renovation and healthy building endeavors at Caltech. As part of this case study, the Alliance interviewed members of the Gates-Thomas renovation team (including both members of the design team and the Caltech decision making team) and completed a post occupant survey of building occupants. The results of these efforts are woven through this section of the report.

The Design Impetus

Through this recent renovation, the Gates-Thomas building modified to support a higher density of faculty and grad students and to improve efficiency in the workspace in response to the pressing demand. The renovated building has a larger footprint than before, due to the addition of new connecting stairs (Figure 2), an 88-seat auditorium, and associated meeting and recreation space. Adding the new program to the Gates-Thomas building was made possible through the decision to move the existing onsite data center out of the building.⁴

Figure 2. The New Connecting Stair in the Gates-Thomas Building, Caltech



Source: Randall Howard (photo credit), http://www.mce.caltech.edu/about/gates_thomas

In the project planning the design team in coordination with the Caltech Sustainability Team, adopted LEED v3 Gold as the design standard for the Gates-Thomas renovation. However, during the project planning phase, which started with feasibility studies in

⁴ The existing data center moved to a centralized facility at Caltech.

2010 and concluded with design review in 2012, the new LEED v4 standard was released. When the project officially kicked-off in January 2013 (only three months after the release of the LEED v4 standard in October 2012) the design team along with the energy management team, faculty representatives, and other key stakeholders made the decision to make an early plan to achieve Gold under the LEED v4 certification system. To support this decision, the design team brought on a LEED consultant and the Gates-Thomas renovation project achieved the goal: Gold under the LEED v4 certification system.

Human-Centric, Healthy Design

Building a functional space for human occupants was the central concept of the Gates-Thomas renovation. While this human focus was prescribed by the Caltech design team from the start of the process, the focus on human centric design is also a high value for the building occupants, as documented in the post occupancy survey conducted by the Alliance team and detailed later in this section. The renovated Gates-Thomas building is a clear example of the Caltech design team’s commitment to this focus on human design.

Figure 3. A Lobby/Café in the Renovated Gates-Thomas Building



Source: Randall Howard (photo credit), http://www.mce.caltech.edu/about/gates_thomas

A core decision that carried through the design and implementation was to modify the entire building layout to favor an open-space concept for the occupants. This fundamental design decision led to the use of glass walls to separate offices, open gathering spaces (Figure 3), and the elimination of the existing, long, dead-end

corridors. There were several other open-space design strategies used in the building, but these were the most visible and impactful ones.

Another clear component of the human-centric design ideals is the decision to allow occupants to personalize their spaces to meet their specific needs. The design team supported building occupants, including faculty and staff, to envision their ideal workspace by using a vacant space that the occupant could mock-up using a kit of parts. In this way, the building occupants could configure their offices using furniture and fixtures that would best meet their functional and aesthetic needs. The design team supported this effort by educating building occupants about the best ways to use the built-in furniture to ensure that the office spaces would be both functional and personal.

The offices resulting from this personalization process were smaller than previously – approximately 250 sq. ft. compared to 350 sq. ft. in the existing design (Figure 4). The design strategy used throughout the renovation, functioned to cluster and interconnect suites to promote better human interaction and foster team collaboration.

Figure 4. Faculty Offices in the Renovated Gates-Thomas Building



Source: Randall Howard (photo credit), http://www.mce.caltech.edu/about/gates_thomas

Individual occupant environmental control was also highly prioritized in the design. Occupants were given a range of control over their environment, specifically in respect to lighting and temperature. Every occupant room included a thermostat for individual space control and a window to provide natural lighting. Overall, the design/project team

was determined to allow for individualization and occupant control of every space within the building.

For Caltech the underlying impetus for human-centric, healthy building design is the underlying concept of *intellectual wellness*. For Caltech, the value of healthy building design is not only in occupant happiness, but more importantly in intellectual output – both in more and deeper educational work. The bottom-line goal for the Caltech team was to develop a design to support intimate spaces for people to interact, so that they can come up with the next great idea – wellness epitomized through scientific collegiality.⁵

Energy Impacts

Caltech has made a significant institutional commitment to reduce greenhouse gas (GHG) emissions, and more specifically the GHG emissions derived from fossil fuel combustion in all levels of the supply chain. In 2003, a notable step was taken under this commitment, when an obsolete 5.5 MW combined heat and power plan was updated to a high-efficiency 12.5 MW system.⁶ The high-efficiency system, which captures waste heat from natural gas combustion to generate electricity, quickly supported an energy load twice as large as the previous system while reducing NO_x and CO₂ emissions by 17 percent.⁷

The Caltech co-generation plant, in conjunction with extensive solar PV installations across the campus, and increasing use of fuel cell systems, support the Caltech energy island-grid. Currently, significant clean energy is produced across the Caltech campus, but this does not cover the entirety of what is needed to power the campus. A portion of Caltech's electricity is purchased from Pasadena Water and Power, which relies on fossil fuel (primarily coal) as the sources for its electricity production. To reduce fossil fuel use and the related GHG emissions, Caltech is actively evaluating cleaner options that are both economically viable and will support their work, teaching, and research needs.

The primary reason for the Gates-Thomas building renovation was to design a better environment for the building occupants. But a close second goal, was improving the energy efficiency of the building. One decision with significant energy impacts made during the Gates-Thomas renovation design process was the decision to relocate a small data center from the old building to a large, centralized data center. This decision resulted in energy savings for the Gates-Thomas building, and the entire campus, as equipment in the central facility is more efficient than the previous facility. This decision will continue to result in campus-wide energy savings, as it formalized Caltech's

⁵ Personal conversation with Onderdonk, John, Director, Sustainability Programs, Caltech.

⁶ Caltech Annual Sustainability Update 2016. Published June 2017.

https://www.sustainability.caltech.edu/documents/240-fy16_annual_report_web.zip

⁷ Ibid.

centralized data networking architecture, and existing remote data centers will continue to join this central system.

A large focus within the renovated Gates-Thomas building is on operational education of the occupants. Placards are placed throughout the building to help occupants to understand the environmental impact of their actions and how to best use the designed building systems (Figure 5). In addition, the energy and facilities teams at Caltech use building management systems and other resources to verify that as designed efficiency levels are met in practice.

Figure 5. Building Occupant, Operations Guide, Gates-Thomas Building



Source: Danielle Vitoff, California Sustainability Alliance

The Survey Results

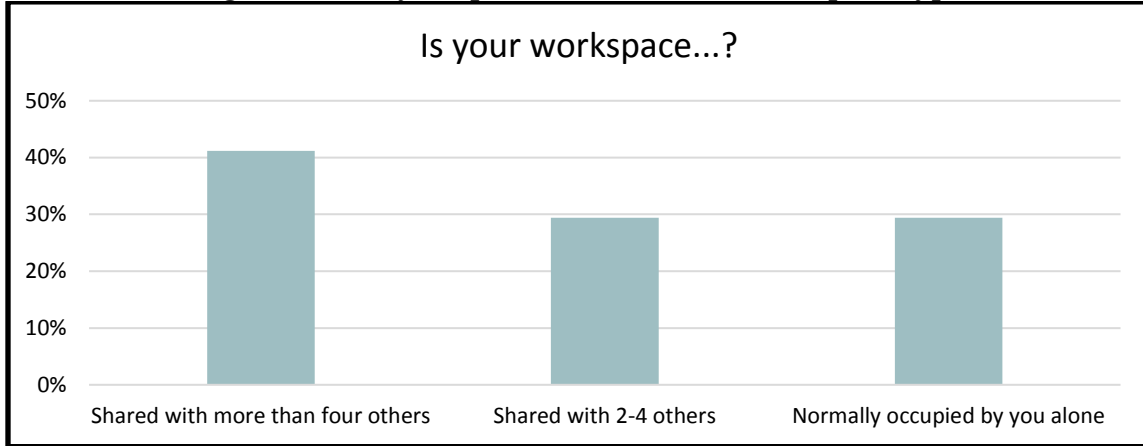
The Alliance team completed a short, online, post-occupancy survey of Gates-Thomas building occupants. The survey, which was supported by the sustainability team at Caltech, entered participants who completed the survey into a drawing for a \$50 Amazon gift card. Invites to the survey were sent to a list of building occupants provided by the Caltech sustainability team and 51 complete responses were collected over the course of two weeks.

Of the 51 respondents who completed the survey, 27 identified as graduate students, 10 as staff/support, 9 as faculty, and 4 as postdoc students and 1 as other. Twenty-one of the survey respondents worked in the building prior to the renovation, while the other 31 did not. Of the 21 respondents who worked in the building prior to the renovation, 17 had worked in the building for longer than one year.

As the post-occupancy survey was focused primarily on the human interaction with the workspace within the renovated Gates-Thomas building, it was important to identify the

types of workspaces for which the results apply. Approximately 30% of the survey respondents indicated that they had an individual workspace, while the remainder inhabited a shared workspace (Figure 6).

Figure 6. Survey Respondent, Identified Workspace Type



Source: Navigant Analysis of Gates-Thomas Building Survey

Twenty-seven percent of the survey occupants reported that their workspace was in the basement, with 20% located on the main level, 24% on the second floor and 29% on the third floor. The majority (94%) of the survey respondents indicated that they had access to a window in their workspace, while 6% indicated they did not have access to a window. For those that had access to a window, the group was relatively well split in terms of which direction that window faced, with 23% facing North, 38% South, 11% East, and 28% West.

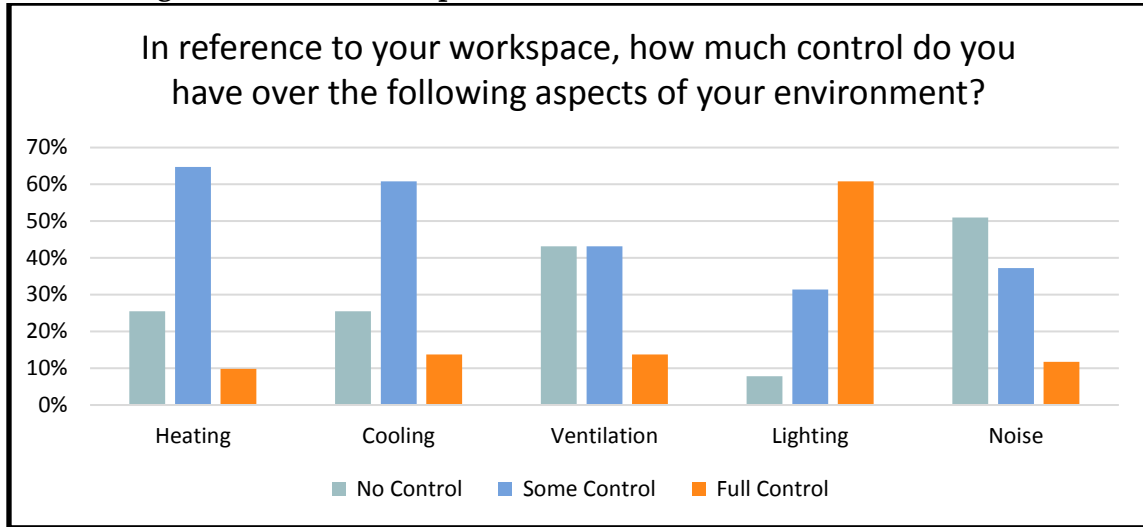
The heart of the occupant survey was focused on occupant satisfaction, specifically in relation to environmental controls. First respondents were asked, “on a scale from 1 to 5, where 1 means not at all important and 5 means very important, how important is it for you to adjust environmental controls related to (heating, cooling, ventilation, lighting, and noise).” The occupant responses were averaged for each category to rank the categories as most and least important in terms adjustment. The resulting averages were all above 3.5, meaning that environmental control was important for all categories, with the least important being ventilation and the most important being cooling. The categories with their calculated averages are as follows.

- Ventilation – 3.51
- Noise – 3.92
- Heating – 4.10
- Lighting – 4.16
- Cooling – 4.31

Occupants were asked about the level of control that they have over heating, cooling, ventilation, lighting, and noise within their workspace. Over 50% of occupants indicated

that they have at least some control over all environmental conditions except noise (Figure 7). Occupants indicated that they had the greatest level of control over lighting, followed by heating/cooling, ventilation, then noise.

Figure 7. Level of Occupant Control over Environmental Conditions



Source: Navigant Analysis of Gates-Thomas Building Survey

User accessibility was a critical component of the Gates-Thomas building renovation. Within the building, thermostats are clearly identified (Figure 8) and directions are provided to ensure correct use (Figure 5).

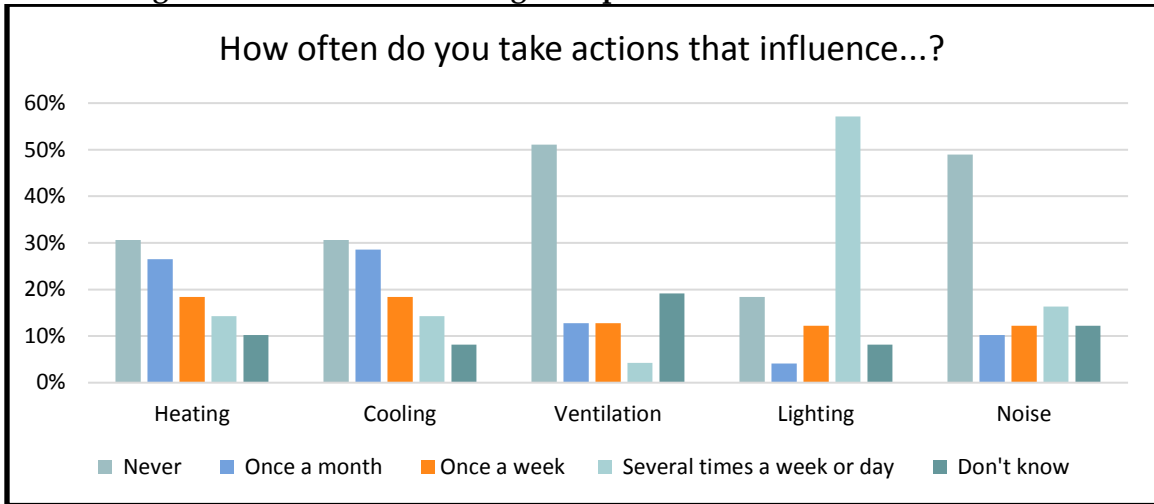
Figure 8. Thermostat Controls in the Gates-Thomas Building



Source: Danielle Vitoff, California Sustainability Alliance

Building occupants report that they take actions to adjust the lighting in their workspace at a much higher rate than they adjust any other environmental factor. Over 50% of building occupants indicated that they adjust their lighting at least several times a week in comparison to approximately 50% of occupants reporting that they never adjust their environment in relation to ventilation or noise, as seen in Figure 9.

Figure 9. How Often Building Occupants Control their Environment



Source: Navigant Analysis of Gates-Thomas Building Survey

Gates-Thomas building occupants were in general satisfied with the accessibility of building controls in the renovated space. Approximately 60% of respondents indicated that they were either satisfied or very satisfied with the accessibility of controls. Approximately 30% reported that they were somewhat unsatisfied, with the final 10% indicating that they were very unsatisfied. These percentages were relatively consistent with building occupant's satisfaction with the level of control that they have in their workspace (Figure 10) as well as the general temperature in their workspace.

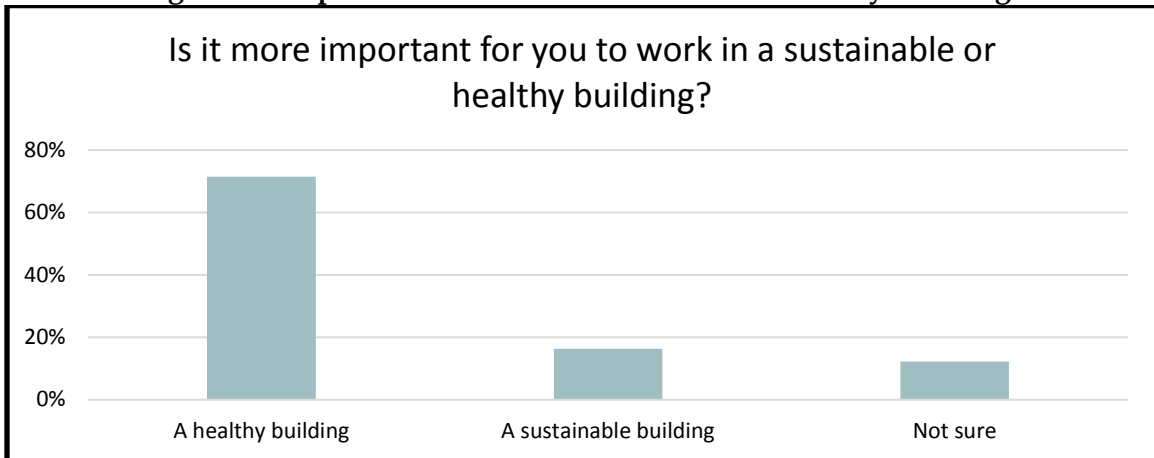
Figure 10. How Satisfied Occupants are with the Level of Control in their Workspace



Source: Navigant Analysis of Gates-Thomas Building Survey

The final, and maybe most important question in the building occupant survey conducted by the Alliance team asked occupants to identify whether it was more important for them to work in a healthy or sustainable building. Even for a college engineering building at Caltech, where interest in sustainability and energy efficiency is expected to be high, approximately 70% of survey respondents indicated that working in a healthy building was more important to them (Figure 11).

Figure 11. Importance Placed on Sustainable or Healthy Buildings



Source: Navigant Analysis of Gates-Thomas Building Survey

APPENDIX: GATES-THOMAS ONLINE OCCUPANT SURVEY

Web Email Invitation

SUBJECT: Invitation to Complete Gates-Thomas Building Renovation Survey

Dear <FNAME> <LNAME>,

You have been invited to participate in a survey exploring the renovation of the Gates-Thomas building. This survey is being run by the California Sustainability Alliance (sustainca.org) in partnership with John Onderdonk, Director of Sustainability Programs at Caltech. Your participation in this survey will help us to better understand occupant activities and comfort in the Gates-Thomas building both before and after the renovation.

As a thank you for your participation, all respondents who complete the survey will be entered into a drawing to win a \$50 Amazon gift card.

Please go to: www.ABC.com to complete the survey.

If you have any questions about the survey or the California Sustainability Alliance, please contact Cameron Moy at 303.381.7776 or Cameron.moy@navigant.com.

Thank you,
The California Sustainability Alliance

Survey Questions

1. What is your current position?
 - a. Faculty
 - b. Staff/Support
 - c. Graduate Student
 - d. Undergraduate Student
 - e. Other [If Q1 = d, "Please explain" open ended response]
2. Did you work in the Gates-Thomas building prior to the renovation?
 - a. Yes
 - b. No
3. [If Q1 = a] How long did you work in the Gates-Thomas building prior to the renovation?
 - a. Less than one year
 - b. More than one year

4. [If Q1 = a] Is your workspace in the renovated building generally similar to your workspace prior to the building renovation (i.e. if you worked in a shared workspace before the renovation, you still work in a shared workspace)?
 - a. Yes
 - b. No [If Q3 = b, "Please explain" open ended response]
5. Is your workspace...
 - a. Normally occupied by you alone
 - b. Shared with 1 other
 - c. Shared with 2-4 others
 - d. Shared with more than four others
6. On which floor is your workspace located?
 - a. Basement
 - b. Main Level
 - c. Second Level
 - d. Third Level
7. Does your current workspace have a window?
 - a. Yes
 - b. No
8. [If Q8 = a] Does your window face...
 - a. North
 - b. South
 - c. East
 - d. West
9. On a scale from 1 to 5, where 1 means not at all important and 5 means very important, how important is it for you to adjust environmental controls related to:
 - a. Heating [Scale from 1 to 5]
 - b. Cooling [Scale from 1 to 5]
 - c. Ventilation [Scale from 1 to 5]
 - d. Lighting [Scale from 1 to 5]
 - e. Noise [Scale from 1 to 5]
10. In reference to your workspace, how much control do you have over the following aspects of your environment?

	Full Control	Some Control	No Control
a. Heating			
b. Cooling			
c. Ventilation			

d. Lighting			
e. Noise			

11. How often do you take actions that influence...? Note: Consider that some actions can influence more than one aspect of your indoor environment.

	Never	Once a month	Once a week	Several times a week or day	Don't Know
a. Heating					
b. Cooling					
c. Ventilation					
d. Lighting					
e. Noise					

12. For actions that you take which involve building controls, on average how would you rate their accessibility?

- a. Very conveniently located
- b. Somewhat conveniently located
- c. Not at all conveniently located
- d. Don't know

13. In general, how satisfied are you with the level of control that you have in your workspace?

- a. Very satisfied
- b. Satisfied
- c. Somewhat unsatisfied
- d. Very unsatisfied

14. In general, how satisfied are you with the temperature in your workspace?

- a. Satisfied
- b. Somewhat satisfied
- c. Somewhat dissatisfied
- d. Very dissatisfied

15. Is it more important for you to work in an energy efficient building or a healthy building? A healthy building means that the building is designed with a specific focus on occupant health and well-being.

- a. A sustainable building
- b. A healthy building
- c. Not sure

16. Thank you for your input. Before we finish the survey, please provide your contact information to be entered to win a \$50 Amazon gift card.

- a. Name [Fields for first and last name]
- b. Email [Field for email]
- c. Phone [Field for phone]