



**Indoor Environmental Quality + Workplace Environment
UMTC Bell Museum
St. Paul, MN**

**June 2019, Minneapolis, MN
Sustainable Post-Occupancy Evaluation Survey (SPOES)
B3 Guidelines**

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1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design of the UMTC Bell Museum facility and occupants' satisfaction with their work environments located in the facility. This report communicates responses from employees about the overall facility and their workplace (WP). The facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainable Building Guidelines or MSBG), which were in effect at the time that the design and construction were funded. It was completed for occupancy in January 2018. The B3 Guidelines track specific state-funded, B3 buildings as a means of demonstrating real outcomes aimed at the conservation of energy resources, creation and maintenance of healthy environments, and occupants' satisfaction with their work environments. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in workplace, classroom, and residence hall settings in compliance with the B3 Guidelines project tracking requirements. This is a report of occupants' (hereafter called employees) responses from the survey conducted in May 2019.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 26 indoor environmental quality (IEQ) criteria such as lighting, thermal, and acoustic conditions in their primary workspaces, i.e., offices. Employees' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on their perceptions of their work performance and health also are included. Finally, a brief look at employees' commuting and physical activities within the building are reported. The report provides descriptive information about employees' perceptions of the IEQ of their work environments. In addition, this information serves the broader development of knowledge regarding the influence of IEQ on employees.

2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by employees. The SPOES questionnaire has been tested for **validity** (measures what it is intended to measure) and **reliability** (repeatability or replicability of findings). Employees rate their level of satisfaction on a **Likert-type scale** (measurement scale) from 1 (very dissatisfied) to 7 (very satisfied) with IEQ of the facility and their primary workspaces. They also rate the influence of their physical environment on their perception of their work performance and health on a scale from 1 (hindered) to 7 (enhanced).

The report provides a descriptive summary of the results stated as a **mean** (average of all responses), **standard deviations** (SD) (how different scores are from each other and the mean), and **number of responses** (N) for each question analyzed. The mean for a 7-point scale is 4.00. Lower or higher means reflect stronger tendencies towards dissatisfaction/satisfaction and hindered/enhanced. Means that are close to the center of the scale (4) are considered to be neither dissatisfied/hindered or satisfied/enhanced.

When interpreting **mean** responses, the following labels were used:

- 1.00 - 3.50 dissatisfied (or hindered)
- 3.51 - 4.50 neither dissatisfied (or hindered) nor satisfied (or enhanced)
- 4.51 - 7.00 satisfied (or enhanced)

An IEQ Score is also calculated for employees' satisfaction with IEQ criteria in their primary workspaces. This is a statistical combination of all category-level (explained below) IEQ scores, which results in a single IEQ score for all respondents and is reported in an IEQ Scorecard.

2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility (site, building, and interior) and the influence of their physical environment on their perception of their work performance and health. Then they respond to questions about their satisfaction with their primary workspaces in relation to IEQ criteria from the B3 Guidelines. Additionally, employees' demographic, physical activity, and commuting practice data are collected to provide context for the study.

In the SPOES questionnaire, the 26 IEQ criteria listed below are evaluated. There are two levels of criteria, categories and attributes. As shown in the list, the 'overall' criteria are boldfaced and called 'categories' or 'category level' criteria. A category is broader or more general such as Overall View Conditions or Overall Indoor Air Quality. Some categories have 'attributes' or 'attribute level' criteria and provide greater detail about the category. For example, Overall Thermal Conditions is a category level question, and there are four attribute level questions related to thermal conditions such as adjustability, air velocity (draft), humidity, and temperature. Overall Acoustic Conditions is a category with attributes of employees' ability to hear desired sounds and their ability to limit undesired sounds. There are 12 category-level and 14 attribute level questions. Means are calculated and reported for all category and attribute-level criteria.

An IEQ Satisfaction Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of the 12 category-level criteria only and results in a single, mean IEQ Satisfaction Score for all employees' satisfaction with the physical conditions of their primary workspaces. Attribute-level criteria are not included in the IEQ Score because unequal weight would be given to criteria that have both category and attribute-level questions.

In the following list, **category (boldface)** criteria are listed in alphabetical order. If a category has attributes, they are listed with the category.

Overall Acoustic Quality

- Ability to hear desired sounds
- Ability to limit undesired sounds

Overall Appearance (aesthetics)

Overall Cleaning and Maintenance

Overall Daylighting Conditions

- Amount of daylighting
- Adjustability of daylighting

Overall Electric Lighting Conditions

- Amount of electric lighting
- Adjustability of electric lighting
- Adjustability of task lighting

Overall Furnishings

- Function of furnishings
- Adjustability of furnishings

Overall Indoor Air Quality

Overall Privacy

Overall Technology

- Access to electric outlets

Overall Thermal Conditions

- Adjustability of thermal conditions
- Air velocity (drafty/stagnant)
- Humidity (dry or moist)
- Temperature (hot or cold)

Overall Vibration and Movement

Overall View Conditions

2.2 Limitations

Employees' participation is voluntary, and responses are self-reported. As is true with all survey research, the responses indicate employees' perceptions. There were no physical measurements, e.g., temperature, humidity, or lighting levels of the environment taken. This study is limited to employees' perceptions.

3.0 Sample Description

3.1 Description of Building

The Bell Museum facility resides at 2088 Larpenteur Avenue West, St. Paul, MN. The Bell Museum facility (see Figure 1) is a three-story (two stories above grade), 92,404 gross square foot building; 53,817 square feet are usable for program, exhibit, and planetarium spaces; lobbies and support facilities; and office and staff support space. Storage, fabrication space, and mechanical and electrical equipment are contained within the story below grade. This study focuses on the overall facility and staff offices, approximately 4,500 square feet within the Bell Museum facility.



Figure 1. Bell Museum (Photo courtesy of Peter J. Sieger)

3.2 Project Team

The relevant project team members to the SPOES process for Bell Museum was comprised of the owner, design team, and commissioning agent, and general contractor. They are identified below, relative to their capacity and involvement.

Owner	Regents of the University of Minnesota
Architect	Perkins + Will
Mechanical Engineer	Michaud Cooley Erickson
Electrical Engineer	Michaud Cooley Erickson
Interior Designer	Perkins + Will
Exhibit Designer	Gallagher & Associates
Acoustic Consultant	Kvernstoen, Rönholm & Associates
Landscape Architect	Perkins + Will
Commissioning Agent	University of Minnesota
General Contractor	McGough

3.3 Description of Respondents

This survey was administered to 138 employees with workspace in the facility in May 2019. The response rate to the questionnaire was over 60%. Of those responding, 73% were female, 22% were male, and 5% responded as “other.” The mean age of respondents was 27 years, with a range from 18-67 years of age.

The Bell Museum construction was completed and ready for operation by the staff in January 2018. The facility opened to the public in July 2018. Since staff occupied the facility, 34% of the respondents reported that they worked at the Bell Museum facility for 1-2 years, and 66% of the respondents have spent less than one year at this facility. Relating to hours worked during a typical week at the Bell Museum, over 25% of the employees reported they spend 40+ hours a week in the facility, 10% spend 30-40 hours a week at the Bell Museum, nearly 17% spend 20-29 hours at the facility, and 48% work there less than 20 hours per week.

Relating to the time employees spend per week in their primary workspace, nearly 33% of the employees reported they spend more than 75% of their weekly time in their primary workspace; nearly 34% spend 51-75% of their time in their primary workspace; over 18% spend 25-50% of their time in their primary workspace; and nearly 16% spend less than 25% of their time in their primary workspace. These responses indicate the amount of time employees are exposed to IEQ conditions in their workplace environment.

The Bell Museum is a workplace with private offices; enclosed shared offices; cubicles with low partitions, benching (long worktable, multiple workspaces), and a desk in an open office or public space (reception) without partitions, all serving as primary workspaces. Over 75% of employees indicated that their primary workspaces were located within 15 feet of an exterior window, nearly 21% of the employees were not within 15 feet of an exterior window, and nearly 4% were unsure of how far they were from an exterior window.

4.0 Findings and Discussion

4.1 Bell Museum Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning the Bell Museum facility (site, building, and interior) and their overall satisfaction with the facility, overall perceptions of their work performance in relation to the facility, and their overall perception of their health in relation to the facility. Table 1 shows the

means and standard deviations of their responses as well as how the responses are interpreted. Figure 2 is a graph that shows the mean for each question, which is identified with a blue mark. The standard deviation is shown by the green/red vertical bar with green representing satisfied (or enhanced) and red representing dissatisfaction (or hindered). Gray represents the 'neither/nor' range of responses. In cases where there were no dissatisfied responses, the bar may be all green or gray and green. This graph is simply a visual image of the findings from Table 1.

Table 1 Bell Museum facility - overall satisfaction, work performance, and health

Overall	Mean	SD	N	Interpretation
Satisfaction	6.29	1.05	83	Satisfied
Work Performance	5.89	1.24	83	Enhanced
Health	5.38	1.15	83	Enhanced

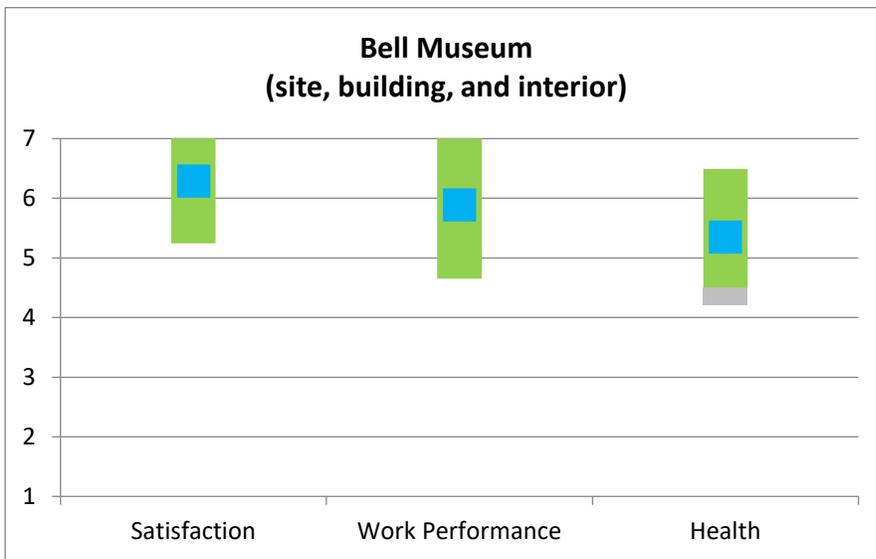


Figure 2. Bell Museum facility - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 6.29)** with the physical environment of the Bell Museum facility (building, site, and interior) and reported that their overall work performance was **enhanced (M = 5.89)** by the facility. Employees reported that their overall health was **enhanced (M = 5.35)** by the facility.

4.2 Primary Workspace: Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction and overall perceptions of their work performance and health as related to their primary workspace (e.g., private office, shared office, or other primary workspace). Table 2 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 3 is a visual image of the findings from Table 2; an explanation of the graph was given for Figure 2.

Table 2. Bell Museum primary workspace – overall satisfaction, work performance and health

Overall	Mean	SD	N	Interpretation
Satisfaction	5.38	1.47	81	Satisfied
Work Performance	5.14	1.55	81	Enhanced
Health	4.89	1.23	81	Enhanced

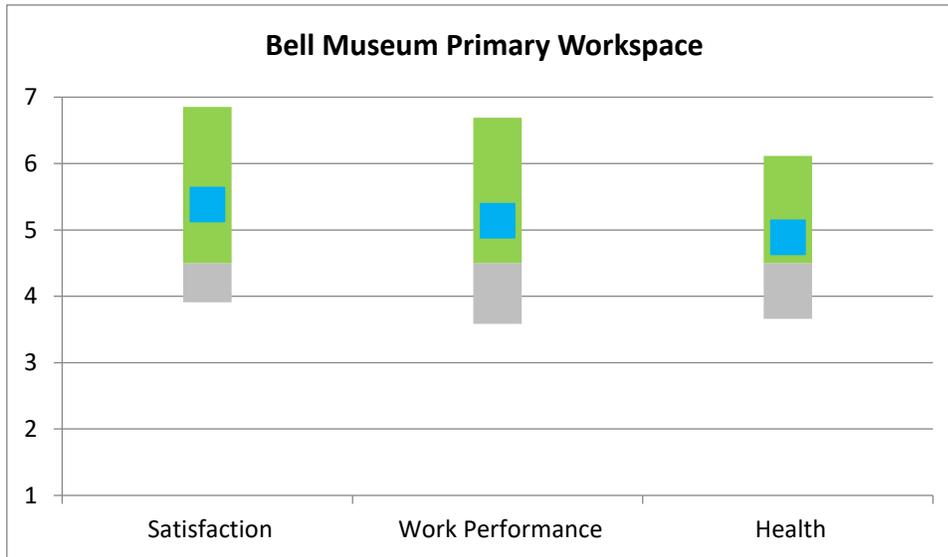


Figure 3. Bell Museum primary workspace - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 5.38)** with their primary workspace, their overall work performance was **enhanced (M = 5.14)** by their primary workspace, and their overall health was **enhanced (M = 4.89)** by their primary workspace.

4.3 Primary Workspace: Satisfaction with Indoor Environmental Quality (IEQ)

Employees responded to questions concerning their satisfaction with IEQ categories (thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 3 shows the means and standard deviations of their responses from highest to lowest mean, as well as how the responses are interpreted. Figure 4 is a visual image of the findings from Table 3; an explanation of the graph was given for Figure 2.

Table 3. Bell Museum primary workspace - satisfaction with IEQ criteria

#	IEQ Criteria (1-26) (Category level criteria are bold face)	Mean	SD	N	Interpretation (D =Dissatisfied) (S = Satisfied)
1	Overall cleaning and maintenance	6.11	1.19	81	Satisfied
2	Overall indoor air quality	6.05	1.22	81	Satisfied
3	Air velocity (drafty or stagnant)	5.81	1.24	81	Satisfied
4	Amount of daylighting	5.80	1.59	81	Satisfied
5	Overall vibration and movement	5.79	1.30	81	Satisfied
6	Overall appearance (aesthetics)	5.78	1.46	81	Satisfied
7	Overall daylighting conditions	5.75	1.53	81	Satisfied
8	Humidity (dry or moist)	5.75	1.29	80	Satisfied
9	Amount of electric light	5.70	1.51	81	Satisfied
10	Overall electric lighting conditions	5.65	1.48	81	Satisfied
11	Overall technology	5.62	1.54	81	Satisfied
12	Ability to hear desired sounds	5.59	1.53	81	Satisfied
13	Adjustability of daylighting	5.48	1.81	81	Satisfied
14	Function of furnishings	5.48	1.53	81	Satisfied
15	Overall acoustic quality	5.46	1.61	81	Satisfied
16	Adjustability of furnishings	5.45	1.57	80	Satisfied
17	Adjustability of task lighting	5.42	1.62	81	Satisfied
18	Overall furnishings	5.38	1.45	81	Satisfied
19	Overall view conditions	5.36	1.87	81	Satisfied
20	Access to electric outlets	5.31	1.49	81	Satisfied
21	Overall thermal conditions	5.30	1.53	81	Satisfied
22	Temperature (hot or cold)	5.14	1.60	81	Satisfied
23	Adjustability of task lighting	5.09	1.85	80	Satisfied
24	Ability to limit undesired sounds	4.60	1.83	80	Satisfied
25	Overall privacy (sound and visual privacy)	4.41	2.04	81	Neither S or D
26	Adjustability of thermal conditions	4.32	1.94	81	Neither S or D

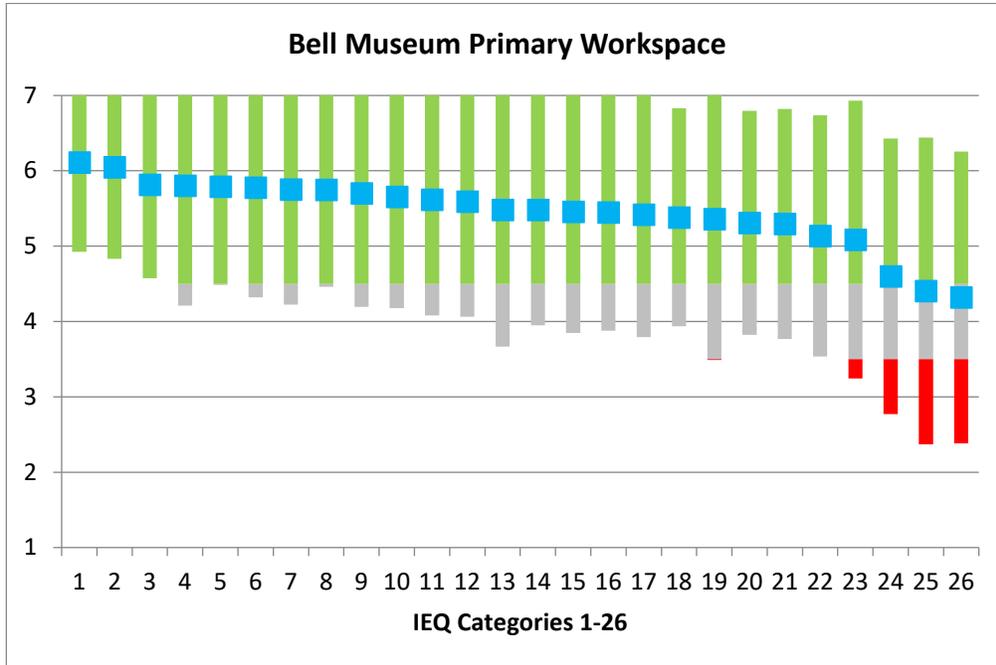


Figure 4. Bell Museum primary workspace - satisfaction with IEQ criteria (IEQ 1-26 refer to Table 3)

Results indicate that employees were **satisfied** with 24 of the 26 IEQ criteria in their primary workspaces, i.e., means at or above 4.50. Satisfied means ranged from **6.11** (Overall cleaning and maintenance) to **4.60** (ability to limit undesired sounds). Employees were **neither satisfied nor dissatisfied** (i.e., neutral) with two (2) IEQ criteria, ranging from a mean of **4.41** (Overall privacy, sound and visual) to **4.32** (adjustability of thermal conditions). The criteria in the 'neutral' satisfaction range should be considered for change. Potential for change will be addressed in Section 6.2 Recommendations. Further explanation of these scores also can be found in Appendix A. Open-Ended Responses.

4.4 IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by calculating a mean of the 12 'Overall' category level IEQ criteria. At this time, criteria are weighted equally in this calculation as little evidence exists that provides rationale for weighting some criteria heavier than others. The IEQ mean is representative of a fair overall IEQ score and can serve as a benchmark of employees' satisfaction with the physical environment of their primary workspace. As shown in Figure 5, the **IEQ Satisfaction Score** for the Bell Museum is **5.55**, which falls in middle quadrant of the satisfied range, i.e., a moderately high IEQ Score.



Figure 5. Bell Museum primary workspace - IEQ Satisfaction Score

As shown in Table 3, satisfaction with Overall cleaning and maintenance, Overall indoor air quality, Overall vibration and movement, Overall appearance (aesthetics), Overall daylighting conditions, Overall electric lighting conditions, and Overall technology were the seven (7) categories with the highest satisfaction means (**5.62 or higher**), near the moderately high end of the satisfied range. In combination with the remaining five (5) satisfied scores ranging from **5.46** (Overall acoustic quality) to **5.30** (Overall thermal conditions), they were successful in pulling the IEQ Satisfaction Score in a positive direction. Only one (1) of the 12 mean scores was in the neutral range, **4.41** (Overall privacy, sound and visual). Please note that the IEQ Satisfaction Score only uses the category level criteria (those labeled ‘Overall’; see section 2.1, paragraph 3 for explanation).

5.0 Physical Activity Engagement and Commuting Practices

In the final section of the survey, employees responded to questions regarding their overall physical activity while at Bell Museum (site, building, and interior) and their commuting practices.

5.1 Physical Activity Engagement

Providing employees with opportunities for alternative paths of travel around the workplace, e.g., taking stairs as opposed to the elevator, provides opportunities to engage in additional types of physical activities. Engaging in physical travel throughout the work environment can be associated with healthier lifestyles.

Table 4. Overall physical activity (walking, stair use, etc.) affected by the Bell Museum facility

Bell Museum (site, building, and interior)	Mean	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	5.65	1.20	77	Enhanced

Results indicate that employees felt that Bell Museum **enhanced (M = 5.65)** their physical activities (walking, stair use, etc.).

5.2 Commuting Practices

The Bell Museum facility resides at the corner of Larpenteur and Cleveland Avenues on the University of Minnesota’s St Paul Campus, directly across the street from Gibbs Farm. It is accessible via highways 280 to the west and 36 to the north. There is adjacent surface lot parking and bike racks on both the north and south sides of the facility. There are also indoor bicycle racks for staff near the loading dock. Public bus transportation is offered by the University of Minnesota’s St. Paul Circulator and Metro Transit, Routes 61 and 87. Note that the overall percentages presented below may not total 100%, due to rounding.

Table 5 provides results on employees’ primary mode of transportation; Table 6 summarizes commuting distances between home and the Bell Museum facility; and Table 7 summarizes employees’ ability to commute using alternative choices (walk, public transit, bike, van or carpool, motorcycle/moped, etc.). These results, although not related to IEQ, do offer insight into employees’ commuting behaviors and opinions. These data can provide important information about commuting practices that can reduce transportation energy consumption.

Table 5. Commuting Practices – Bell Museum Primary mode of transportation

Primary Mode of Transportation (N=77)	Drive Alone (or w/children <16)	Public Transit	Walk	Bike	Carpool or Vanpool	Other
Commuting to Bell Museum	39%	40%	6%	6%	4%	4%

Related to primary modes of transportation, nearly 38% of employees drive alone (or with children under 16), over 40% of employees use public transportation, over 6% walk, over 6% bike, nearly 4% use a carpool or vanpool, and nearly 4% use other forms of transportation. No employees used a motorcycle or moped to get to work and none telecommuted.

Table 6. Commuting Practices – Bell Museum Commuting distance traveled

Miles Traveled (N=77)	0-5	6-15	16-30
Home-to-Bell Museum (One-way)	65%	30%	5%

Results indicate that nearly 65% of employees commute 0-15 miles one-way between home and the Bell Museum, followed by 30% who commute 6-15 miles, and 5% who commute 16-30 miles. No one commutes more than 30 miles. These are one-way miles.

Table 7. Commuting practices – Bell Museum location and alternative commuting behaviors

Alternative Commuting	Mean	SD	N
Ability to commute in alternative ways	4.52	1.88	77

Results indicate that location of the Bell Museum **enhanced (M = 4.52)** employees’ ability to commute to work in alternative ways, e.g., walk, bicycle, public transit, etc.

6.0 Conclusions

6.1 Summary

A post-occupancy evaluation was conducted of employees of the Bell Museum at approximately 16 months after it was first occupied. About 60% of the staff responded to the survey, reporting their satisfaction with the physical environment of the facility and their primary workspace. Results indicate that over 35% of employees spend more than 30 hours per week in the Bell Museum facility, and over 67% of employees spend more than 50% of their time at the Bell Museum in their primary work space.

The survey included questions related to employees' satisfaction with the facility (site, building, and interior) and influence of the facility on their work performance and health. Employees were **satisfied** with the facility (**M = 6.29**); they found the facility **enhanced** their work performance (**M = 5.89**) and **enhanced** their health (**M = 5.35**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private office, shared office, workstations, etc.). They reported **satisfaction** (**M = 5.38**) with their primary workspaces, that their work performance was **enhanced** (**M = 5.14**), and their health was **enhanced** (**M = 4.89**) by their primary workspace. As the range of scores was from 1-7, the scores showed a moderately high level of satisfaction with the facility and the primary workspace. (The satisfaction/enhancement range is 4.51-7.00).

Most of the survey questions related to employees' satisfaction with the IEQ criteria in their primary workspaces (private office, workstations, etc.). Employees' responses showed they were **satisfied** with 24 of the 26 IEQ criteria. The mean satisfaction scores ranged from **6.11** (Overall cleaning and maintenance) to **4.60** (ability to limit undesired sounds). Again, this shows a positive level of **satisfaction**. Employees responded **neither dissatisfied nor satisfied** with two (2) IEQ criteria, with mean satisfaction scores ranging from **4.41** (Overall privacy, sound and visual) to **4.32** (adjustability of thermal conditions).

From employees' responses, an IEQ Score was developed and shows respondents' moderately high level of satisfaction with the majority of all IEQ category level criteria. For the Bell Museum, the IEQ Satisfaction Score was **5.55**. This score reflects the influence of the moderately high satisfaction level of 11 of the 12 categories and the neither dissatisfied nor satisfied level of one (1) of the 12 IEQ categories. Finally, employees reported that the Bell Museum **enhanced** (**5.65**) their physical activity, which is one of the sustainable design criteria that influences occupant behavior.

It seems obvious that employees' satisfaction can be improved by addressing the categories that had 'neither dissatisfied nor satisfied' scores. However, it is possible that the rest of the criteria would benefit from some attention as well. The following recommendations can help address change in these criteria to further improve employees' satisfaction. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary workspace. It must be noted that the expense of building and operating a facility is second only to employee-related expenses over the life of the building. Therefore, maintaining or improving employees' satisfaction is a sound investment, which, in turn affects their performance and their health.

This study investigated employees' satisfaction with the facility and primary workspaces. IEQ satisfaction is individual, but the results of the survey show a central tendency of moderately lower

satisfaction with the facility and most of the IEQ categories. The results can be used as a diagnostic tool to aid in improving IEQ conditions for employees and to set the benchmarks from which improvement can be measured in the future.

6.2 Recommendations

Most IEQ criteria satisfaction scores are in the positive direction, however, improvement on the 'neutral' criteria may be possible. For IEQ categories that can be physically measured (e.g., thermal, acoustic, and lighting), it is recommended that these measurements be taken in the primary workspaces. Specific recommendations for the most common areas of occupants' concern follow:

Acoustic Conditions

- Identify acoustic criteria for overall requirements.
- Determine if any task areas differ now from their original spatial layout/use (i.e., collaborative work spaces now located adjacent to focused work areas, individual workstations).
- Develop specialized acoustical performance requirements to support functional programming employees' tasks (e.g., sources of recurrent noise that need to be controlled, special user populations that may have distinct auditory performance limitations, or multiple uses of building spaces that may have different acoustic criteria). Identify and apply appropriate acoustics modeling software for the project.
- Measure acoustic performance onsite with full building systems (heating, ventilation, and air conditioning) running.
- Identify employees' privacy concerns via focus groups and/or log complaints relative to acoustical conditions for further evaluation.
- Consider employees' tasks within shared spaces to determine if spatial layout changes can be made for increased acoustic control.

Lighting Conditions

- Identify employees' lighting performance criteria that are to be met to achieve goals by conducting onsite measurements of existing illumination and compare them to standards for employees' tasks as identified by the Illuminating Engineering Society (IES).
- Determine if any task areas differ now from original intent to be sure illumination level and quality of lighting are not impeded by physical changes to the space (i.e., walls, ceilings, furnishings, fixtures, or equipment).
- Develop additional quality lighting criteria as needed for special facility (e.g., influence of daylight quality or quantity) or employee (e.g., age, task duration) issues.
- Log complaints related to lighting conditions for further evaluation.
- Identify poor lighting conditions in the workspace caused by a lack of control over daylighting, which can cause glare and eyestrain.

Personal Adjustability

- Determine what adjustability issues arise with temperature, lighting, or furnishings via a focus group.
- Identify personal, individual problem areas and relate them to other IEQ issues via a log of complaints relative to adjustability.
- Provide education to employees about any existing/achievable adjustment options (e.g., furnishings, air diffusers, lighting, temperature control, etc.)

Privacy Conditions

- Identify employees' privacy concerns via focus groups or log complaints relative to privacy to determine if visual or audio privacy is most affected.
- Determine if any task areas or responsibilities differ from original intent and develop alternatives or modifications.
- Consider adding noise masking equipment and/or visual screening depending on the nature of the complaints.
- Document and compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

Thermal Conditions

- Measure thermal performance conditions on site.
- Log complaints related to thermal conditions for further evaluation.
- Determine special thermal comfort requirements or problems that may be encountered in the building due to physicality of work activities, duration of sitting, or design/layout considerations. Focus groups can be useful in identifying problem locations.
- Determine if any employees' task areas differ now from original layout to determine if air flow is meeting systems design intent.
- Review conditions that affect thermal comfort using the applicable version of ASHRAE Standard 55, or Human Factors Design Handbook (see B3 Guidelines). For additional information, consider reviewing Human Factors and Ergonomics Design Handbook, Third Edition (2016), by Barry Tillman, published by McGraw-Hill, NY.

Appendix A. Open-Ended Responses

Employees had the opportunity to raise specific concerns on the overall facility and their primary workspaces. Important information can be gleaned from the open-ended survey responses. The Bell Museum employees raised many general and very specific concerns and positive comments related to acoustics and privacy; amenities; cleaning and maintenance; daylighting, electric lighting, and controls; furnishings; indoor air quality; spatial layout; technology/electrical; thermal conditions and control; view conditions; and wayfinding. Generally, the comments are shown exactly as written.

Overall Positive/Negative

- It's overall a pleasant facility.
- Overall, I thoroughly enjoy working at the Bell Museum.
- The Bell is a very new and modern building, it is quite comfortable.
- Generally good.
- I love working in the public settings at the Bell. However, the student staff room is always chilly, dirty, and just kind of sad (there is no natural lighting and always greasy tables). The permanent staff room is beautiful and has a lot of natural, light furnishings. It's a little upsetting that ours [student staff room] is such a stark contrast.
- Be nice if there was a shuttle regardless of school schedule, impossible to bus when shuttle isn't running.

Acoustics and Privacy

- Because of the low walls, conversations carry from across the office space which can be distracting at times even with headphones.
- The white noise is too loud.
- Our space has a white noise system that was installed to cut down on sounds from individual cubicles. I understand that it works for some individuals but for me personally, it provides a constant humming in my ears that makes it extremely difficult to focus. This work space has significantly increased my stress level and number of headaches at work.
- I'm not a fan of the whooshing white noise sound...sometimes it's the white noise machine and sometimes it's just the air vents. I have some hearing loss and the white noise is aggravating to me and I often wear noise cancelling headphones even when I'm alone in the office.
- Wish we had more space to go take private business phone calls. Not a lot of privacy in cubicle farm.
- I also wish we had 2 enclosed places with a phone where we could work privately when we need to focus on a webinar or conference call. It's very hard to do that from your desk and not have interruptions. The conference rooms are frequently booked and can't be used reliably for this.

Amenities

- It would be good to have more benches, and not just the weird looking black benches that come out of the wall.
- Storage and organization options are severely limited/lacking.
- The lack of space for larger projects is an ongoing issue; we have no real storage or workspace at our work stations.

Cleaning and Maintenance

- The garbage is rarely taken care of.
- Shared work space is untidy.
- There are one set of blinds that can't be used as there is no obvious button. There are times when the sun would shine in and be blinding to look on that side of the room, so it would be nice to be able to send the blinds down.

Daylighting, Electric Lighting, and Controls

- I appreciate all the natural light that comes in.
- There's great natural light, but not close enough for me to benefit.
- In the office there is no natural light.
- Need better control of lighting.
- The workbenches are difficult to task light, so we are ordering desk lamps.
- There's no task lighting.

Furnishings

- As our spaces are already small, I am not sure that I will then have enough space for my desk items when we add lamps [too dark without task lighting].
- I am used to having a standing desk, and as I am not comfortable not being able to work standing up for at least most of my day. I have a desk at the workbench where I need to take incoming calls all day long, so I can't switch to the standing work stations without having my voicemail fill up with missed calls.
- The desk and chair are easy to adjust to standing or sitting height, so that's a plus.

Indoor Air Quality

- Is it possible that not every office always being cleaned? Air isn't very fresh.

Spatial Layout

- The work spaces are too small.
- There was obviously more thought put into "cramming X number of people in a limited space" than "comfort of people crammed into a limited space".

Technology/Electrical

- There could be more electrical outlets in the education wing rooms. Or at least, they could have been placed more effectively. Currently, people who teach from there have to use a lot of tape to make sure wires aren't a tripping hazard.
- It would be nice to have outlets at the desk level and cork boards or some material above the desk level to post papers for the workbench stations. We have had to order these individually.

Thermal Conditions and Control

- Temperature is often too high.
- In the office it is often a little too warm.
- Way too hot and no way to control it is the chief concern.
- The temperature along the workbench areas seems to trend cold. Many of us have blankets at our desk. I still would much rather be cold than hot, personally. And when I'm cold I use the blanket.

- It's cold!
- The building tends to be very hot with stagnant air in certain rooms (especially T&S) but very cold in others (upstairs by the dioramas).
- I was once working in the upstairs museum portion for four hours and the thermostat was set to 79 degrees at my station and no one was able to adjust it and so I was incredible uncomfortable

View Conditions

- My view is a wall.
- Window is high and does allow for direct views outside.

Wayfinding

- The museum is also maze like, hard to navigate.

Appendix B. Glossary

Descriptive statistics

Statistics used to summarize large sets of data (i.e., means, frequencies, medians). Descriptive statistics describe only the sample under consideration and are not intended to infer results to the larger population.

Frequency

A descriptive statistic that provides information about how many of a particular response or measurement is observed.

Likert-type scale

A measurement technique, employed in questionnaires and interviews, that utilizes a range of standardized response categories such as strongly agree, agree, etc.

Mean

The average score of a set of data calculated by adding all scores together, then dividing by the number of scores.

N

The number of subjects or participants responding to the questions, or a single question, in the study.

Reliability

The repeatability or replicability of findings; the same results are produced each time. Instruments and procedures should produce the same results when applied to similar people in similar situations, or on a second occasion.

Standard deviation

A statistic used to measure the variability of a group of scores (how different scores are from each other and the mean). For example, if the range of scores is 1-7 and the mean (average) is 5.0 with a standard deviation of 1.0, then the scores are closely clustered around the mean, i.e., there is one unit of variation among all scores. If the mean was 5.0 and the SD was 3.0, there is a broader range of variation among the scores...a smaller SD means the scores are similar and the mean score is likely to be more accurate and more useful (this is better!).

Validity

The extent to which an instrument or procedure measures what it is intended to measure (internal validity). The generalizability of results to another population (external validity).