

STUDENTS' PERSPECTIVES OF THEIR LEARNING SPACES:  
AN ECOLOGIC CASE STUDY OF SAGE HALL

A Thesis

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by

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## ABSTRACT

A recent trend in the corporate work style, mobile working, has caused the boundaries between traditional work spaces to become blurred. In a higher education setting, these boundaries can become even more blurred as college students often use the same spaces to do various activities. The goal of this study was to explore the design features of informal work settings in Sage Hall, on the campus of Cornell University, that are perceived as important by the Business School students, and to identify key design features that are associated with students' preference of space for work. A multi-tool method was developed in this study, including traditional methods of a survey and interview, as well as a non-traditional data collection method that utilized photographs.

It was found that access to technology, particularly electrical outlets, and access to natural light were most important to students. A new method of visualizing work space preference, the bivariate choropleth, was also explored. Serving as a pilot study on critical characteristics of informal learning and working environments, this thesis also generated research design suggestions for future studies on this intriguing topic.

## BIOGRAPHICAL SKETCH

Michelle Beatty was born and raised in Northern Virginia where she attended Chantilly High School. She graduated from James Madison University in 2012 with a Bachelor of Science in Engineering (general) and a minor in Mathematics. Realizing that she wanted to learn more about the psychology between people and their environments, Michelle entered the Department of Design and Environmental Analysis at Cornell University in fall 2012. She originally intended to complete the ergonomics concentration but was greatly influenced by the IFMA Workplace Strategy Summit, held on campus in fall 2012, which led her to declare facilities planning and management. During her time at Cornell, Michelle worked at the Statler Hotel as well as Cornell's Big Red Barn where she was a TGIF manager and hosted weekly trivia nights. She finished her MS degree in August 2014 and is currently working as a consultant in New York City.

Dedicated to my cohort: Bre, Kay, Angie, Kathy, Ryan, and Martina

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## LIST OF DEFINITIONS

**Work space:** A space in which students do school related tasks, including but not limited to independent and/or group studying, completing homework assignments, preparing presentations, and organizing case studies

**Space use:** A student's affirmation that a space is a location in which they would prefer to do work or have done work in the past

**Breakout room:** Room dedicated for students to work in groups of two or more.  
Students must reserve these rooms electronically and in advance in order to use them.

## LIST OF SYMBOLS

**N:** Number of participants

$\bar{x}$ : Average participant response

## **1. Introduction**

A recent trend in the corporate work style is the idea of mobile working and utilizing work spaces other than a typical office cubicle, closed-door office, or even an open-plan layout office. Individuals may now use mobile technology to create virtual work stations anywhere they have access to the internet. This trend towards mobility now allows some individuals the choice of place to work, which is based predominantly on their preferences, not solely on necessity. The idea that work can now be done remotely is blurring the boundaries of work spaces and is leading to a new and more fluid interpretation of what makes a space suitable for work.

In a higher education setting, the boundaries of traditional and formal work spaces can become even more blurred as college students often use the same spaces to congregate, socialize, eat, study, work on assignments (both individually and in various-size teams), etc. As a learning environment, higher education environments are distinctive, compared to kindergarten through high school (K-12) environments, in that the needs of higher education students can be vastly diverse. While the K-12 education delivery structure typically involves the formal learning style of being inside classrooms, students on a higher educational campus have more flexibility in their schedules and more autonomy on selecting where to study. Consequently, more learning takes place in informal settings outside classrooms in higher education compared to K-12. Additionally, college campuses are used as both a residential and a work environment for many students, making it also vastly different from both K-12 and corporate work environments. In order to investigate the unique characteristics of higher education, this thesis intends to study Sage Hall (Figure 1.1) on Cornell's main campus in Ithaca, New York, as a case study of key design features of higher education learning environments.



Figure 1.1 Sage Hall south facing exterior

Sage Hall houses the Samuel Curtis Johnson Graduate School of Management (the Johnson School) and provides students with the education to obtain a Master of Business Administration (MBA) degree. There are approximately 500 students in the two-year MBA program, with an average age of 26 and an average of 5 years of professional experience before entering the program. The students are working in a variety of team configurations throughout their time in the Johnson School. There is also an option to complete a one-year MBA program but the size of this program is significantly smaller, having only about 70 students. However, both programs are designed to be full-time, beginning in the fall term.

Sage Hall was opened in 1875 as a residential college for women on Cornell's Ithaca campus. The historical building was gutted and underwent a complete internal renovation between 1996 and 1998 in order to transform the building from a dormitory into a building that would include educational and administrative space for students and staff for its new occupant, the Johnson School. The building has one basement floor (Appendix B) and four above-grade floors (Appendix B) totaling 150,716 square feet.



There are several different types of spaces for students to study and work within the Sage Hall. All seven classrooms, the only available formal learning spaces, are located on the basement floor, in addition to a student lounge. Breakout rooms (approximately 30) are located on the basement, first, and second floors and range in size from 51 to 188 square feet. A 4,978-square foot library is located on the first floor and second floor of the building and is comprised of soft seating, individual desks, and open tables along with stacks of books. The third and fourth floors of this building are mainly closed offices and meeting rooms. The centerpiece of the Sage Hall is a 4,784-square foot, three-story atrium in the center of the building that serves as a space for a wide variety of activities, including studying and working, organized events, and dining (Figure 1.2).



Figure 1.2 Sage Hall atrium

Designed as a large, open space that could serve a variety of functions, this atrium was the inspiration for this study. As shown in Figure 1.2 the atrium is a highly active space used by many Johnson School students on a daily basis. The idea that students have the option to work in this type of environment instead of a more traditional work environment (i.e. behind a desk or in an office) led to the theme of student preferences. Students, often the end-users of academic spaces, have been found to form an opinion about their physical environments (Maxwell, 2000),

yet they are not often meaningfully involved in the design of their environments (Jamieson, Fisher, Gilding, Taylor, & Trevitt, 2000). In fact, Grummon (2008) found that it was more often the individuals who managed the space that tended to have the most input in the design of spaces rather than the students or end-users. Students' preferences may be used to synthesize design recommendations and guidelines tailored to students' specific needs in order to inform future designs of the space.

This study aims to serve as a pilot study that focuses on developing a tool to analyze the critical characteristics of informal learning and working environments. A pilot study is valuable in that it uses a small sample size to explore tools and themes in order to narrow down future research directions. In this study, a survey tool and corresponding data visualization tool are introduced as a way to measure student preference.

The goal of this study is to explore the design features of informal work settings in Sage Hall that are perceived as important by the Business School students, and to identify key design features that are associated with students' preference of space for work. To achieve the research goal, a multi-tool method was developed in this study, including traditional methods of a survey and interview, as well as a non-traditional data collection method that utilized photographs. Design suggestions for informal work spaces were made, based on the analysis of the data collected in this study, to inform future renovation and new construction of campus buildings for better supporting student needs.

This study contributes to the body of research by introducing a visual tool, floor plan bivariate choropleths, to display student spatial preference data. While choropleths have previously been used to convey geographic information systems (GIS) information on geographic maps, no research could be found that used this method to convey information on

floor plans. The use of floor plan choropleths may provide designers, researchers, and end-users with a common tool that is valuable to all parties and serves as a starting point for collaboration. The study also adds to the limited research that focuses on higher education spaces and provides a variation of a post-occupancy evaluation that specifically focuses on the student perspective. Post-occupancy evaluations are especially useful because their goal is to understand how buildings function and facilitate end-user needs after a period of use, typically 6-12 months. This is especially important to understand how designs either did or did not meet the anticipated needs of the end-users and to determine what changes should be made on future designs.

In the context of this study, “work spaces” refers to those spaces in Sage Hall where students learn complete school related tasks, including but not limited to independent and/or group studying and discussion, completing assignments, and preparing and rehearsing presentations. The construct of student preference of space is defined in this study as a student’s affirmation that a space is a location where they would prefer to do work or have done work in the past. It is not the numerical count for how often a space is used. Based on students’ perspectives as a fundamental resource, this study highlighted two main themes in order to study student preference of space: students’ perception of the importance of certain design features of work spaces and their spatial satisfaction. Based on these themes and the overall goal of this study, the following research question and research questions were generated:

**Research Question 1:** What are the design features of the informal work spaces in the Sage Hall that are recognized as important by its users?

RQ 1.1: It is important to students that work spaces are close to main circulation paths.

RQ 1.2: Access to technology in a work space is important to students.

RQ 1.3: A comfortable ambient environment in a work space is important to students.

RQ 1.4: Students rate work spaces that offer groups of students the ability to work together as important.

**Research Question 2:** What attributes of a space affect user satisfaction with current spaces within Sage Hall?

RQ 2.1: Students' satisfaction with the quality of work spaces is associated with their satisfaction with the variety of settings for work.

## 2. Literature

### 2.1 Learning and Work Space

This section will examine the recent changes of learning styles in higher education, assess how learning style changes have impacted the importance of informal learning spaces, and discuss the significance of the physical environment and its role in student learning. The physical environment includes those aspects of the space that are experienced by individuals (e.g. thermal temperature, acoustics, spatial arrangement, spatial quality, visual appearance, etc.).

#### *Changes of Learning Styles in Higher Education*

In the past several decades there have been three significant changes in higher education: a shift from passive to active learning, an increase in technology usage, and an increase in the importance of group work (Bonwell & Eison, 1991; Jamieson, Dane, & Lippman, 2005; Starkey & Tempest, 2009; Vavoula, 2005).

Formal learning is typically regarded as the acquisition of knowledge through listening passively to an instructor in a classroom setting (Jamieson, 2009). Although education environments almost always involve classroom instruction (Bonwell & Eison, 1991; Jamieson et al., 2005), research is changing the way academia views the learning process by challenging the role of traditional, lecture-style instruction. A two-year study conducted by the Committee on Developments in the Science of Learning found that learning is better achieved through an active process that involves student engagement rather than a passive process that does not involve the student (e.g. listening to a lecture) (Bransford, Brown, Cocking, & National Research Council, 1999). Examples of this active learning include higher-order thinking tasks (analysis, evaluation, evaluation, etc.) and engagement activities (reading, discussion, writing, etc.) (Bonwell & Eison,

1991). Unlike passive learning, which typically requires an instructor and classroom, active learning can be accomplished by students working independently or within groups and does not require an instructor at all times (Bonwell & Eison, 1991). In fact, research indicates that higher education is moving towards student-regulated learning where instructors are used to create a conducive learning environment, not necessarily to impose knowledge, while students are in charge of their actual learning (Svinicki, 2010). Due to the changing role of instructors and the increasing move towards self-regulated learning, it can be reasonably argued that active learning is possible and should be encouraged outside of the classroom where students can work either independently or within groups.

In addition to the concept of active learning, technology has been a fundamental driver in learning changes. Students in the past several decades have become more surrounded by technology than ever before. Specifically, student use of the internet for learning purposes rather than tangible alternative (e.g. textbooks or libraries) has become more dominant in recent years (Garrison & Kanuka, 2004). The internet's effects on learning are particularly interesting in an educational setting because it allows students to find information quickly and remotely. The flexibility to find information from remote locations reinforces the concept that learning no longer takes place solely in classrooms. Vavoula (2005) investigated this concept by asking adult participants to self-record where their learning activities took place over a two-week period. Results showed that 49% of participants' time spent learning was spent in locations other than their typical learning environment which suggests that technology is related to learning in non-traditional locations (Vavoula, 2005).

As the significance of instructors and classrooms are changing (Jamieson et al., 2005; Svinicki, 2010) the importance of group work is changing as well. Although individual

performance (i.e. grade point average) is still prominent in education, the ability for student to work well in groups is becoming more important (Thorley & Gregory, 1994). Harvey, Moon, Geall, and Bower (1997) specifically highlight this trend in higher education, noting that college graduates are now expected to demonstrate high levels of experience in teamwork and interpersonal communication. One reason for this trend is the acknowledgement that the numbers of student in higher education has steadily increased, creating a more diverse range of learning styles and a need to include multiple types of learning styles, namely individual and group learning opportunities, in higher education (Thorley & Gregory, 1994). Additionally, group work has been used as a way to reduce the increased strain put on faculty due to the rising number of students in higher education (Gregory & Thorley, 2013). In the corporate setting, the importance of group work is also apparent in that work is now more team based and collaborative while the sense of hierarchy has become less important (National Research Council, 2001). The job market has responded to this trend and now requires that students learn to work collaboratively in order to stay competitive (Starkey & Tempest, 2009). In business schools specifically, students need to learn to work collaboratively in order to stay competitive in today's market (Starkey & Tempest, 2009).

### *Informal Learning Spaces*

As the concept of student learning changes, so does the perception of a learning space. Education researchers now recognizes that classrooms are not the only location where learning is taking place, but rather the entire campus should be considered a potential work space (Chism, 2006; Felix & Brown, 2011). These spaces that afford learning outside of the typical classroom environment, particularly advantageous for small or medium-sized groups, are commonly

referred to as informal learning spaces (M. Brown & Long, 2006; Oblinger, 2006). The concept of an informal learning space is unique in that different informal learning environments (cafés, libraries, group space, etc.) can have unclear boundaries and spaces are more integrated with each other (Temple & Fillippakou, 2007).

There is now a need to support students in these informal learning spaces (M. Brown & Lippincott, 2003) as active learning has been found to be more prevalent in these environments (McLaughlin & Mills, 2008; McLaughlin & Faulkner, 2012). For example, McLaughlin and Faulkner (2012) performed a case study in which they conducted eight semi-structured interviews with twelve students over the course of one year. They found that active learning was more common when students were within an informal learning setting rather than inside a classroom. This implication is specifically important because, as previously mentioned, learning is now considered to be an active process.

The coffee shop is a unique example of an informal learning space that has unclear boundaries between work and socialization and may offer an opportunity for active learning. In her study analyzing three coffee shops, Waxman (2006) used visual documentation, observation and behavior mapping, interviews, and surveys to study what design features and characteristics were appealing to patrons. Survey results revealed that, for participants' ideal coffee shop, the design characteristics with the highest value were "cleanliness, appealing aroma, adequate lighting, comfortable furniture, and a view to the outside" (Waxman, 2006, p. 35). During observations it was noted the most favored seating options were those available along walls; interviews explained that this preference was due to the architectural shelter offered by the walls as well as the access to electrical outlets (Waxman, 2006). These study results are especially interesting for higher education research because, due to the location of the study, over half of



the participants were college students (Waxman, 2006). When asked why they preferred studying at the coffee shop, students “expressed a strong preference...stating the ability to drink coffee, people-watch, take a break and have a conversation, listen to music, and just avoid what they perceived as a sterile library atmosphere” (Waxman, 2006, p. 47). This research supports the idea that students rely not just on libraries for informal learning opportunities, but other types of informal environments as well.

It is also important to not only note the type of informal learning space, but the relative location, or adjacency, of that space within a building as well. As previously mentioned, the role of the classroom as a location for learning is changing (Chism, 2006; Felix & Brown, 2011); however, Jamieson (2005) reports that higher education facilities do not typically provide a range of learning space options for students to select. Several researchers looked at this issue and noted that circulation paths may be a viable option for locating informal learning spaces (Jamieson et al., 2005; Lippman, 2002; Lippman, 2003; Pasalar, 2003). Lippman (2002) specifically comments that corridors and stairs may be designed to facilitate learning and should not strictly be seen as places for movement. To test this concept, Pasalar (2003) performed a multiple case analysis of four middle schools using behavior mapping and spatial layout analysis to understand how physical environment characteristics relate to student behavior. Results found that there were higher spontaneous interactions among students in layouts that were easily accessible, had highly visible public spaces, and were in direct walking paths. This result implies that informal learning spaces located along circulation paths may increase spontaneous interactions and active learning opportunities.

Corporate workplace research has also studied how the adjacency of spaces affects the users of the space. Specifically, Hua (2010) studied how the distribution and number of

collaborative workspaces affected employees' perceptions of whether the layout promoted or inhibited collaboration. The two-year study was conducted using 308 participants in eleven buildings across eight United States cities. Participants were given the workplace collaborative environment questionnaire collect information regarding employees' satisfaction with the location, size, availability, variety, and arrangement of collaborative spaces. Additionally, the percentage of space dedicated to meeting, shared service, and amenity spaces were measured in addition to the distance from employee workstations to the closest meeting space, shared copy/print area, and shared kitchen/coffee area. Results found that employees' perception of collaborative work environments were significantly affected by the location of various collaborative spaces. Specifically, regression model suggested that "meeting spaces need to be located close to neighborhoods of workstations to ensure a high level of occupant-perceived support for collaboration" (Hua, 2010, p. 445).

### *Significance of the Physical Environment for Performance*

In addition to understanding the significance of the type and location of informal learning spaces, it is also important to understand the role of the physical environment itself. As Monahan (2000) explains, the physical environment is a significant feature in education as it "embod[ies] curricula and values by design" and "enable[s] and constrain[s] certain modes of social action and interaction" (p. 1). Multiple studies have acknowledged the importance of the physical environment and studied its effects on elementary, middle, and high school (K-12) education. These studies indicated that the physical environment has an effect on student retention, attention, motivation, learning, and academic achievement (Blincoe, 2008; Durán-Narucki, 2008; Earthman, 2004; Kumar, O'Malley, & Johnston, 2008; Schneider, 2002). Additional literature,

however, has specifically noted that there is a gap in research concerning how the intentional, evidence-based design of a space may affect student learning (Scott-Webber, Strickland, & Ring Kapitulka, 2013; Temple, 2008). This research gap between purposeful design and learning outcomes is more pronounced in higher education settings because the physical environment in higher education has been under-researched in general (Temple, 2008).

While there is a dearth of higher education environment research, there are many more studies that examine K-12 facilities. Specifically, K-12 research has found that the quality and condition of the physical environment is linked to student achievement (CABE, 2002; Green & Turrell, 2005; Uline & Tschannen-Moran, 2008; Young, Green, Roehrich-Patrick, Joseph, & Gibson, 2003). For example, Uline et al. (2008) used a seven-item quality of school index, School Climate Index, and resource support items to compare the quality of eighty Virginia middle schools to student achievement. Using bivariate correlation analysis, they found a positive relationship between student achievement and the quality of the school. Jensen (2005) also notes that classroom flexibility has also been found to reduce stress in students. Despite this existing research, there is still a lack of empirical research linking individual features of the K-12 physical environment, such as daylight levels, noise, and room size, to student outcomes (Woolner, Hall, Higgins, McCaughey, & Wall, 2007). Additionally, the research that exists regarding K-12 facilities may not be applicable to higher education, likely because college students tend to be seen as adult learners rather than K-12 learners (Jamieson et al., 2005) and have a different relationship with their environment than K-12 students (Fulton, 1991; Hill & Epps, 2009; Jamieson et al., 2005).

It is also important to consider the physical environment as not simply a space for learning, but as a tangible resource that has the potential to further an institutions main

pedagogical objective rather than the traditional practice of viewing space in solely a financial feasibility context (Temple, 2008). In order to understand the benefit of treating the physical environment as a resource, it is important for higher educational institutions to recognize the underlying messages that physical spaces convey to students. Felix and Brown (2011) note that students often relate the physical condition of a space to the importance of that space and the activities that space promotes. Chism and Bickford (2002) add that a higher education institution that provides quality, well-maintained learning spaces promote an idea that the institution values learning as well as their students. Knowing that the physical environment conveys a sense of the institution's values, it is important for institutions to understand how student perceive the spaces in which they work and learn to determine if the message being sent through the physical environment match the institutions goals.

## 2.2 Technology and the Corporate Workplace

This section will introduce the corporate work environment and its changes due to technology as a reference to higher education.

Although research has shown the significance of the physical environment, it is also important to understand how technology may affect students in higher education since many institutions have begun incorporating technology into their campus in order to maintain a competitive position among other universities and to attract the highest quality student (Jamieson et al., 2005). To understand how technology affects students, it may be more appropriate to compare higher education to a corporate setting rather than an educational environment as higher education has started viewing college students as adult learners rather than K-12 learners (Jamieson et al., 2005).

As previously discussed, students often spend time learning outside of the classroom and often use technology (Jamieson et al., 2005; Vavoula, 2005; Waxman, 2006). Similar trends have occurred in the corporate workplace and may provide a valuable reference for higher education. This trend is the advancement in technology that has changed the relevance of an office and allowed mobile alternatives to become more prevalent than ever before (Bechtel, Churchman, & McCoy, 2003). One such alternative, “mobile work”, allows employees the opportunity to work from various locations that are convenient and/or preferable to an office (Kurkland & Bailey, 1999). Mobile work now allows virtually any informal work space (i.e. cafés, libraries, restaurants, etc.) to become a place of business instead of the space dictating its functionality (Brown & O'Hara, 2003). Since both take place in non-traditional work setting, utilize technology, and involve completing some kind of task, it can be reasonably argued that mobile work may be a valuable reference to informal learning.

Using mobile work as a reference to informal learning in higher education, it is important for institutions to recognize the challenges that are associated with working remotely. Advantages include an increase in autonomy and flexibility while disadvantages include social isolation and reduced access to office resources (Kurkland & Bailey, 1999). It is important to understand how the physical design of a mobile work space can moderate these challenges in work settings (Kurkland & Bailey, 1999) especially in higher education, where students are generally able to choose from a variety of locations around their campus to complete their work (Chism, 2006). The concept of choice and how space affects students will be discussed in the following section.

### 2.3 Spatial Perception

This section will discuss the importance of understanding students' spatial perceptions regarding their learning spaces.

Higher education institutions should be aware of what messages their spaces are conveying and how students perceive their physical environments because, as Maxwell (2012) describes, "the physical environment of schools has the potential to communicate message...about what and who is valued in society" (p. 24). It is important to understand how students perceive their environment as well as the messages associated with those perceptions. Research has shown that students form opinions about their physical environment (Maxwell, 2000) and that students' perceptions are often affected by the physical and ambient characteristics of the environment (Yang, Becerik-Gerber, & Mino, 2013). Specifically, Yang et al. (2013) used two Likert scales to measure student satisfaction of classroom attributes and how those classroom attributes affected student performance of five classrooms at a single university. The survey measured student satisfaction levels of temperature, air quality, artificial lighting, daylight, acoustics, visual access to teaching media, furniture, room layout, hardware, and software; they then asked how each of these attributes affected students' performance. Statistical analysis of the results found that ambient attributes explained 28.98% of the variance in the data, temperature and air quality being the most important attributes, while spatial attributes, visual access to teaching media, furniture, and room layout, explained 31.25% of the variance in the data (Yang et al., 2013).

Student perceptions are important because perception of a school's physical environment has been linked to academic performance (Maxwell & Schechtman, 2012). For example, Maxwell and Schechtman (2012) used interviews and focus groups to study 105 middle and high

school students in five schools over three years to determine how they perceived the quality of their school's physical environment. Students' grade point averages were then compared to both their own perceptions of their school's quality as well as a researcher's objective assessment. Results indicate that students' perception of the quality of areas outside of the classroom (i.e. hallways, cafeteria, libraries) was a good indicator of academic performance. In focus groups, students went on to say that the quality of their school should be high so that they want "to come to school to learn" (Maxwell & Schechtman, 2012, p. 39). The perceived physical quality of a school is specifically relevant in higher education because the physical environment plays a role in students' selection of where to attend (Price, Matzdorf, Smith, & Agahi, 2003). Gow (1999) explicitly comments that 50% of students entering higher education will use the physical appearance of the campus to determine where they choose to attend school.

## 2.4 Student Population

This section will discuss the unique characteristics of the student population known as the Millennials.

As the Baby-Boomer generation phases out of the workplace, a new generation called the Millennials are taking their place (Howe & Strauss, 2000). Millennials are classified as those born between 1979 and 1994 and are unique because of their exposure to the World Wide Web (Smola & Sutton, 2002). This study is interested in the Millennial generation because the average age of a student in the Johnson School is 26 years old, well between the age range of 20-35 years that constitute the current age range for Millennials (Cornell University, 2014). Although popular media has opinions about who the Millennials are and how they function, little empirical

research exists regarding Millennials and the studies that do are often confusing and contradictory (Deal, Altman, & Rogelberg, 2010; Kowske, Rasch, & Wiley, 2010).

Despite the lack of existing, reliable research, it is important to understand how this new generation operates in an educational work setting because this generation is the first to grow up with the internet throughout their life. Although more research will need to be conducted regarding younger generations, understanding the Millennials is a crucial first step in understanding the evolving needs of students with the advent of the internet and an increase in technological resources.

Unique to the Millennials are certain distinguishing characteristics (Howe & Strauss, 2000). Some of the Millennials' presumed distinguishing traits include being sheltered by their parents, having self-confidence, being team-oriented, and being accountable for their actions (Kowske et al., 2010). Millennials are also more diverse than any other generation with 34% being minorities (McGlynn, 2005). One of the most unique characteristics of Millennials is that they are surrounded by more media and visual information than any generation before them (Considine, Horton, & Moorman, 2009). Generational differences are also important in an educational setting because students of all ages must interact with fellow classmates and professors who may be from several different generations.

In corporate environments, it is important for companies to understand that not all generations are the same and there are generational differences in work attitudes (Kowske et al., 2010). This understanding is also important in an educational setting because designers and school officials need to be aware of the different needs of all generations of students in order to design a space that can meet the needs of the student body as a whole. Millennial's differentiating personal, demographic, and technological characteristics are important in the



context of this study because their fundamental characteristics, as well as their individual preferences, may provide school officials and designers with information regarding how to design spaces to best meet the needs of the incoming students.

## 2.5 Summary

Research indicates that the physical environment is an important feature in higher education, as it has been shown to impact student performance. Additionally, there have been recent changes in learning styles, indicating that active learning is more effective than passive learning, which has created a need for more informal learning spaces. The relative location, ambient environment characteristics, group size capabilities, and technological resources have been found to be important characteristics in these informal learning spaces. The corporate workplace can be used as a reference to understand these spaces, as an increase in technological advances have caused an rise in mobile working and decreased the dependence of a traditional office space, similar to higher education's decreased dependence on classrooms for learning.

Research has also indicated that it is important to understand students' perceptions because the physical environment has been shown to convey certain messages to students. Although research has been conducted regarding K-12 education, there is a gap in research that looks at the specific needs and perceptions of higher education students. The student population that is currently in higher educational institutions is known as the Millennial generation. It is important to understand the needs of this cohort because of the unique characteristics (i.e. exposure to the internet) that they possess. The research described here provides a basis for the selected population and research questions that aim to shed light on the environmental preferences of students in their higher educational work environment.

### 3. Methods

This study was conducted in two phases: the first phase through survey and interview, and the second phase using non-traditional methodology in which participants were asked to submit photos using the internet. Both phases were approved by Cornell University's Institutional Review Board (IRB) before recruitment of participants started. Methods used in both phases will be discussed in this section.

#### 3.1 Phase I: Investigation

##### *Instrument 1: Survey*

The survey instrument was modeled after the Workplace Collaborative Environment Questionnaire, which used a 5-point Likert scale to assess office workers' satisfaction with collaboration experience with regard to their perceived support from workplace spatial settings (Hua, Loftness, Heerwagen, & Powell, 2011) . The survey developed in this study is used to understand students' perception of the importance of a series of design features of work spaces and students' satisfaction with the physical environment for work in higher education environment.

The key components of the survey (see Appendix A) are as follows:

- Demographic: Standing in the Johnson school, Age bracket, and Gender.
- Study preference: Locations in Sage Hall preferred to use for study, preferred study mode (individual vs. in group).
- Importance: For spaces where participants do work, the perceived level of importance of a series of design features of work environment, including visual privacy, sound privacy, seclusion of space, comfort of furniture, crowding of surrounding space, noise level,

flexibility of furniture layout, comfortable temperature, access to electric plugs, access to desktop computers and office equipment, access to desk/table, amount of work surface, accommodations for large group, access to black/white board, access to food/water, air quality, adequate light level, and access to natural light.

- Satisfaction: participants' level of satisfaction with different aspects of the current work spaces in Sage Hall, including the amount, quality, variety, and availability of group work space, individual work space, social space, and classroom space.
- Open-ended questions: following the "Importance" and "Satisfaction" sections, as well as at the end of the survey, asking about if there are additional characteristics that participants value in a work space, types of work spaces participants would like to see more, as well as additional general comments about group or individual work spaces in Sage Hall. The open-ended questions were also included in the survey to allow participants to note any information that they did not feel was captured by the 5-point scale. These questions were formulated to allow participants the flexibility to include as much information as they were willing and to expand on their numerical responses captured by the Likert scale.

During the procedure of developing this survey instrument, an electronic version of a preliminary survey was created and tested in the Commons of the Human Ecology Building, another campus building at Cornell. Based on the results of a pilot study (n=12) and feedback from the participants, the survey was reduced in length and some questions were reworded for better clarity.

## *Instrument 2: Interview*

### *Part A: Floor Plan Discussion*

After participants indicated that they finished answering the survey questions, they were given a packet consisting of 5 floor plans – one for each floor of Sage Hall (see Appendix B), and red and green crayons. Similar to the study conducted by Woolner et al (2010), participants were asked to verbally identify to the researcher which spaces they liked and did not like to work in and explain why they did or did not like these spaces. They were also asked to shade the spaces that they liked in green and spaces they did not like in red. If certain spaces had both positive and negative qualities, the participant was told they were able to shade the space in with both colors if necessary. Participants were also given the option to color no spaces if they did not feel strongly about any or all of the spaces in Sage Hall as work spaces.

During the discussion, participants were asked to elaborate on their responses when they provided curt or extensive answers. The following is the general prompt used and examples of how the researcher requested a participant to elaborate their answer:

- Prompt: Please tell me about which spaces you like to work in and which spaces you do not like within Sage Hall. For those spaces you like, please shade them on the floor plan as green. For those spaces you do not like, please shade them on the floor plan as red. If you do not have a strong preference for a given space, you do not have to shade that space any color. If you both like and dislike a space under different circumstances, please shade that space with both colors. As you shade in the spaces, please verbally explain to me why you like and/or dislike that space as a work space.

- Request for elaboration: What about that space do you like/dislike? Is there something that is particularly good/bad about that space? Why do you think you like/dislike that space?

### *Part B: Open-ended Questions*

Following the floor plan discussion, participants were asked a series of questions. Similar to the study conducted by Waxman (2006) questions were aimed at understanding participants' ideal work environments, experiences with Sage Hall, and perception of the Johnson School. Participants were asked a question and given time to verbally respond as openly and as in-depth as they would like. Questions regarding the relationship between students and the Johnson School were included in order to understand the culture of the program as well of the general physical environment. The following questions (also see Appendix C) were asked in the following order:

- Describe the work/study environments, in general, where you are most productive.
- Think of a memorable time you had while working/studying in Sage Hall. What about this experience made it memorable, where did it take place, and what made this possible/facilitated the event?
- Do you ever find yourself looking for space in Sage Hall that you can't find?
- What words would you use to describe the Johnson School experience?
- What do you think makes the Johnson School unique?
- What do you think of the relationship (or differences) between the Johnson School and Sage Hall?

### *Recruitment and Scheduling of Participants*

As previously mentioned, Master of Business Administration (MBA) students at the Johnson School on Cornell's main Ithaca campus were the population in this study. This specific group of students was chosen because of the nature of the relationship between the program and its physical environment: Sage Hall. The Johnson School is housed almost entirely within the Sage Hall with the exception of some administrative and financial support staff. Most Johnson School courses are housed in the building and students tend to remain within Sage Hall throughout the day, rather than permeating to other campus buildings. Additionally, because the building is predominantly used for business school classes, there is a decreased chance that non-business school students use the common spaces as frequently as business school students. Business school students, faculty, and staff are also the only members of campus who have access to the team breakout rooms within Sage Hall.

Based on the relationship between Sage Hall and the Johnson School, students within the Johnson School were chosen to participate in this study because they offered a unique case study opportunity. These students have constant exposure to the physical characteristics of Sage Hall and lack exposure to other buildings on campus since almost all Johnson courses are taught within Sage Hall. Although some students may take classes outside of Sage Hall, the tight relationship between the Johnson School and Sage Hall has a unique relationship that few other academic programs have with their physical space.

Participants were recruited through an email that explained the nature of the project and requested their participation. This email was disseminated to all business school students using a mailing list and students were invited to contact the researcher through email in order to schedule

a time to complete the study. Once scheduled, participants were instructed to meet the researcher in Sage Hall for a thirty-minute block of time.

Participants were also recruited using a sign in the atrium of Sage Hall. The sign prompted interested participants to approach the researcher in order to schedule a future meeting in person. This allowed students to immediately sign up for time slots and streamlined the scheduling process as compared to email communication.

### *Logistics*

During the scheduled meeting, after consent was obtained, participants were instructed that there would be two tasks to complete: a written survey and a follow-up interview consisting of a floor plan discussion and a series of questions. Participants were first given the written survey and asked to indicate when they finished. Once complete, the researcher collected the survey and participants were given the floor plan packet and instructed on how to use the red and green crayons as described above. Following the floor plan discussion, the researcher collected the floor plans and participants were asked the questions listed above one at a time. After all parts of the investigation were completed, the researcher provided compensation to the participant and they were thanked for their time and input.

### 3.2 Phase II: Online Photo Submission

The concept of providing participants with cameras has been previously used in research in the hospitality industry in order to collect data regarding guests' experience with hotels (Pullman & Robson, 2007). This study was interested in understanding what aspects of a hotel's physical design left an impression on guests in a way that surveys and interviews could not

capture. There was also previous research in which students used annotated photograph as a method of data collection (Woolner et al., 2010). In this study, emails were used to reach out to current business school students and invited them to submit via email photos of any physical spaces or features that they either liked or disliked. The use of email as a form of data submission intended to encourage participant responses because of the prevalence and accessibility of cell phones with built-in cameras and internet access.

Response rate for Phase II was very low (n=5) using this new data collection method. Due to a lack of participation, there are no meaningful results to report at this time.



## 4. Results

### 4.1 Participant Demographics

Demographic results of the thirty participants (n=30) regarding class standing, age, and gender are shown in Figure 4.1. These results indicate a gender ratio of 60% male to 40% female. Participant's age was categorized into three age ranges: 20-24, 25-29, and 30-34 years old. The majority of participants (54%) were between the ages of 25-29 years old. Thirty-three percent of participants were between 30-34 years old and 13% were between 20-24 years old. Responses also indicated that 43% were 1<sup>st</sup> years, 7% were 1<sup>st</sup> year accelerated MBA (AMBA), and 50% were 2<sup>nd</sup> year students within the business school. Figure 4.2 combines these demographics into one cohesive representation.

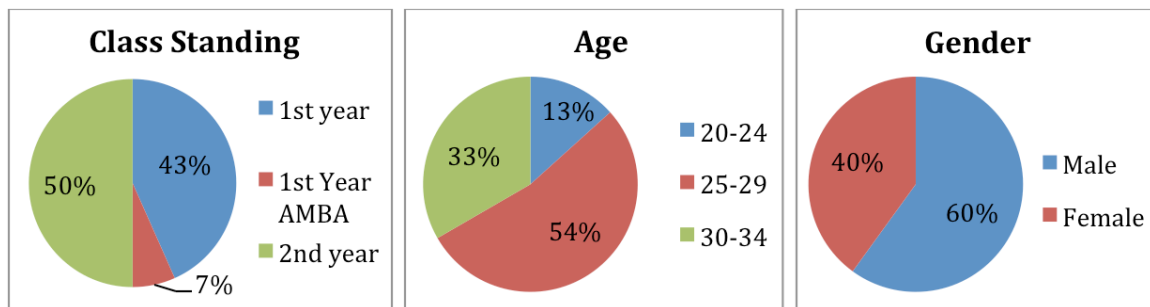


Figure 4.1 Individual participant demographics

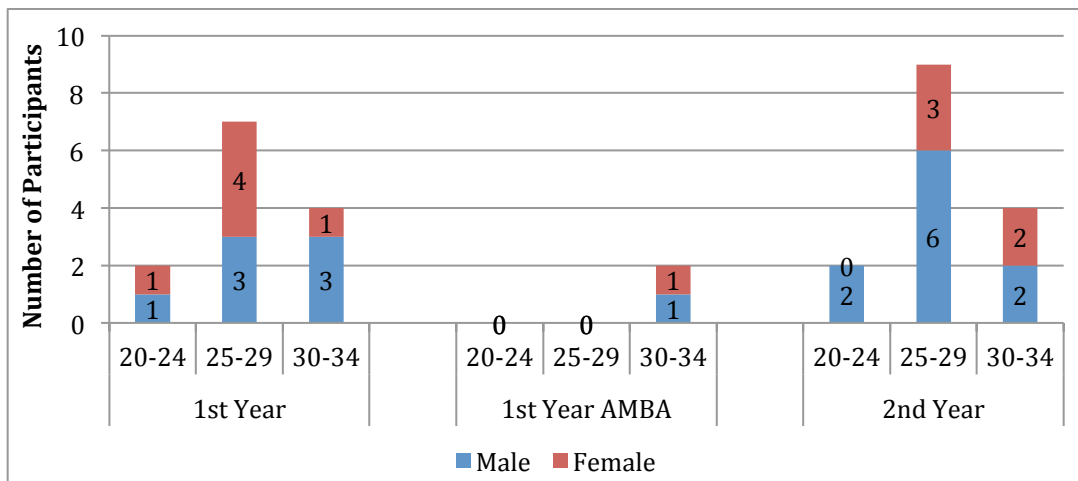


Figure 4.2 Combined participant demographics

## 4.2 Logistic Study Preferences

As is shown in Figure 4.3, survey results show that 54% of participants prefer to study alone, 13% prefer groups, and 33% indicated that study size is dependent on the type of work being covered and their familiarity with the subject. Over 70% of participants responded that their preferred study locations were the home and academic buildings, represented in Figure 4.4

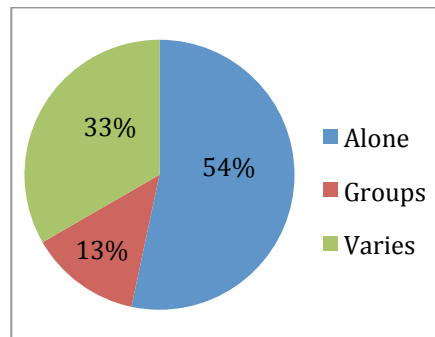


Figure 4.3 Study size preference

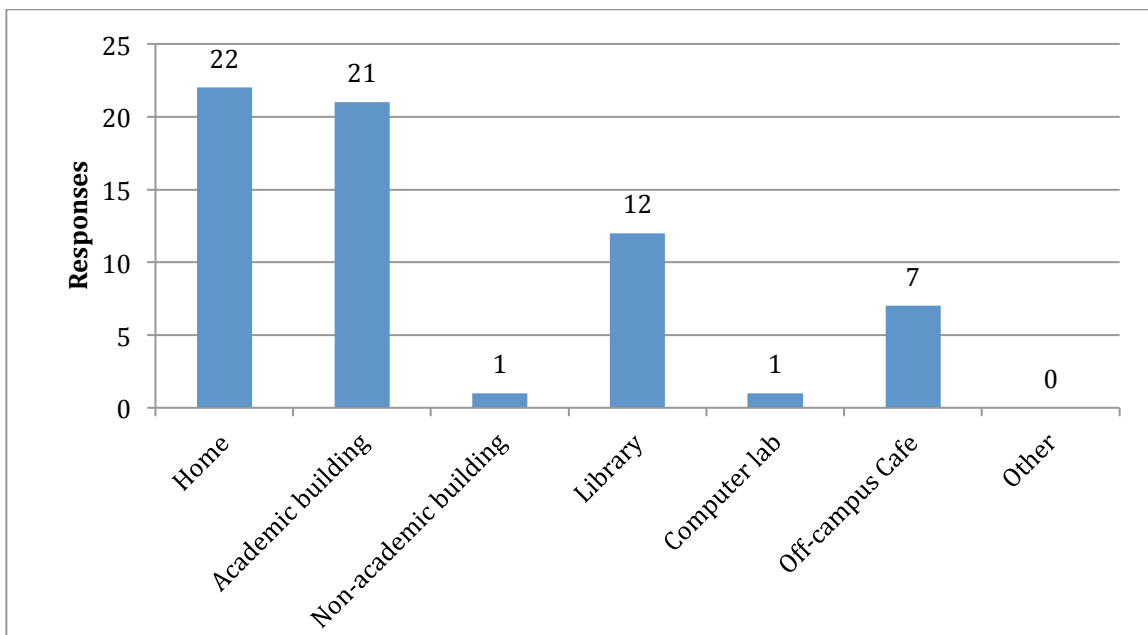


Figure 4.4 Average study location preferences

### 4.3 Importance of Work Space Characteristics

Participants were asked to use a 5-point Likert scale to rate how important they considered certain characteristics of spaces in which they work. A value of 1 indicates a “very unimportant” rating while a value of 5 indicates a “very important” rating. Figure 4.5 illustrates the breakdown of how all thirty participants rated each characteristic. The mean value for each characteristic was also calculated and are shown in Figure 4.6. On average, the top three rated characteristics were adequate light levels, access to a desk/table, and noise level.

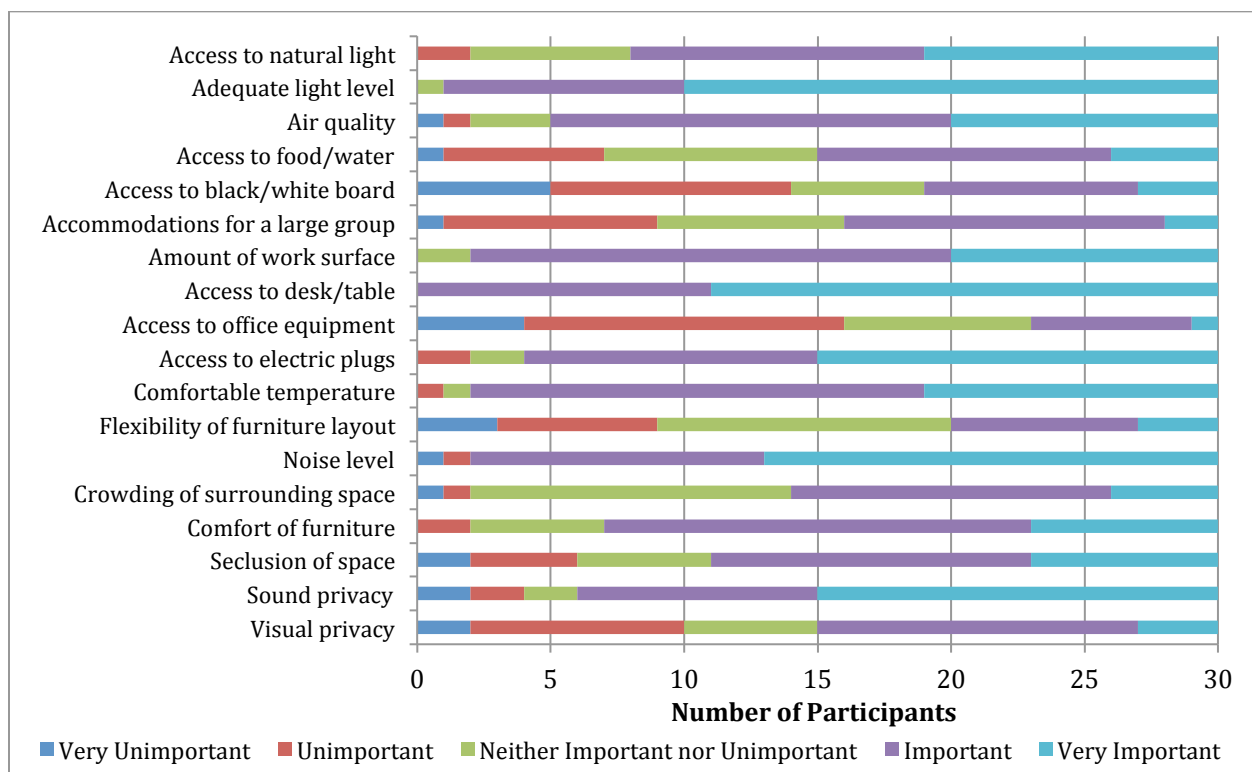


Figure 4.5 Importance breakdown of work space characteristics

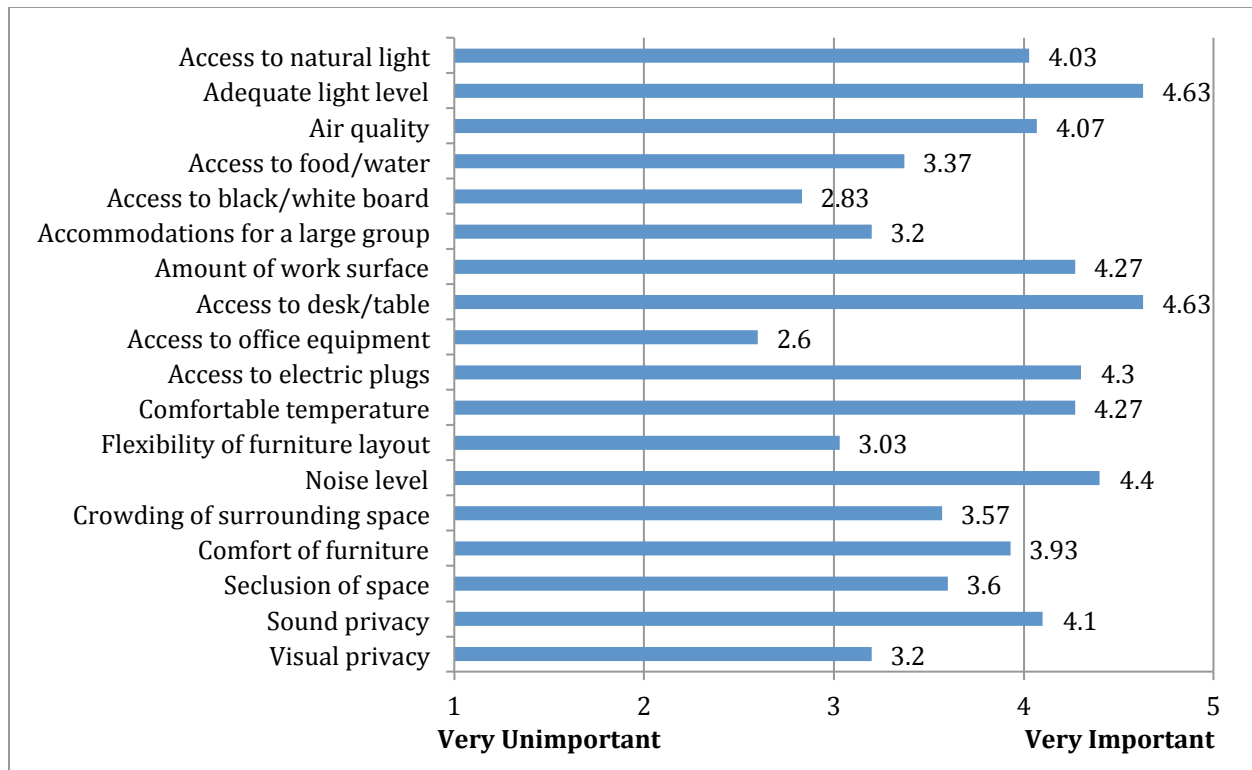


Figure 4.6 Average importance of work space characteristics

#### 4.4 Satisfaction with Current Work Spaces

Using a similar approach as with importance, participants were asked to use a 5-point Likert scale to rate how satisfied they were with the quality, variety, amount (quantity), and availability of current work spaces within Sage Hall in which they work. The current work spaces that were included in this study were social space (Figure 4.7), individual work space (Figure 4.8), group work space (Figure 4.9), and classroom space (Figure 4.10). Classroom space amount and availability information was not recorded because classrooms were not considered as dedicated work spaces for students.



Figure 4.7 Example of social space



Figure 4.9 Example of group work space



Figure 4.8 Example of individual work space



Figure 4.10 Example of classroom space

On the handwritten survey taken by participants, a value of 1 indicated a “very satisfied” rating while a value of 5 indicated a “very unsatisfied” rating. In order to avoid confusion when reviewing the data, these values were recoded after data collection such that the more positive and negative responses matched the scale mentioned in the previous section when rating importance values. Consequently, the new values were recoded such that a 1 indicated a “very unsatisfied” rating and a 5 indicates a “very satisfied” rating. Figure 4.11 illustrates the breakdown of how all thirty participants rated each space. The mean value for each space was

calculated and shown in Figure 4.12. On average, participants tended to be most satisfied with the quality and least satisfied with the availability of current spaces. Participants were the least satisfied with the availability of group work spaces and were most satisfied with the quality of classrooms on average. Additionally, the combined average of each individual characteristic for each space can be seen in Table 4.1. This table indicates that participants tended to be the most satisfied with the current classroom space and progressively less satisfied with the current social space, individual work space, and group work space within Sage Hall.

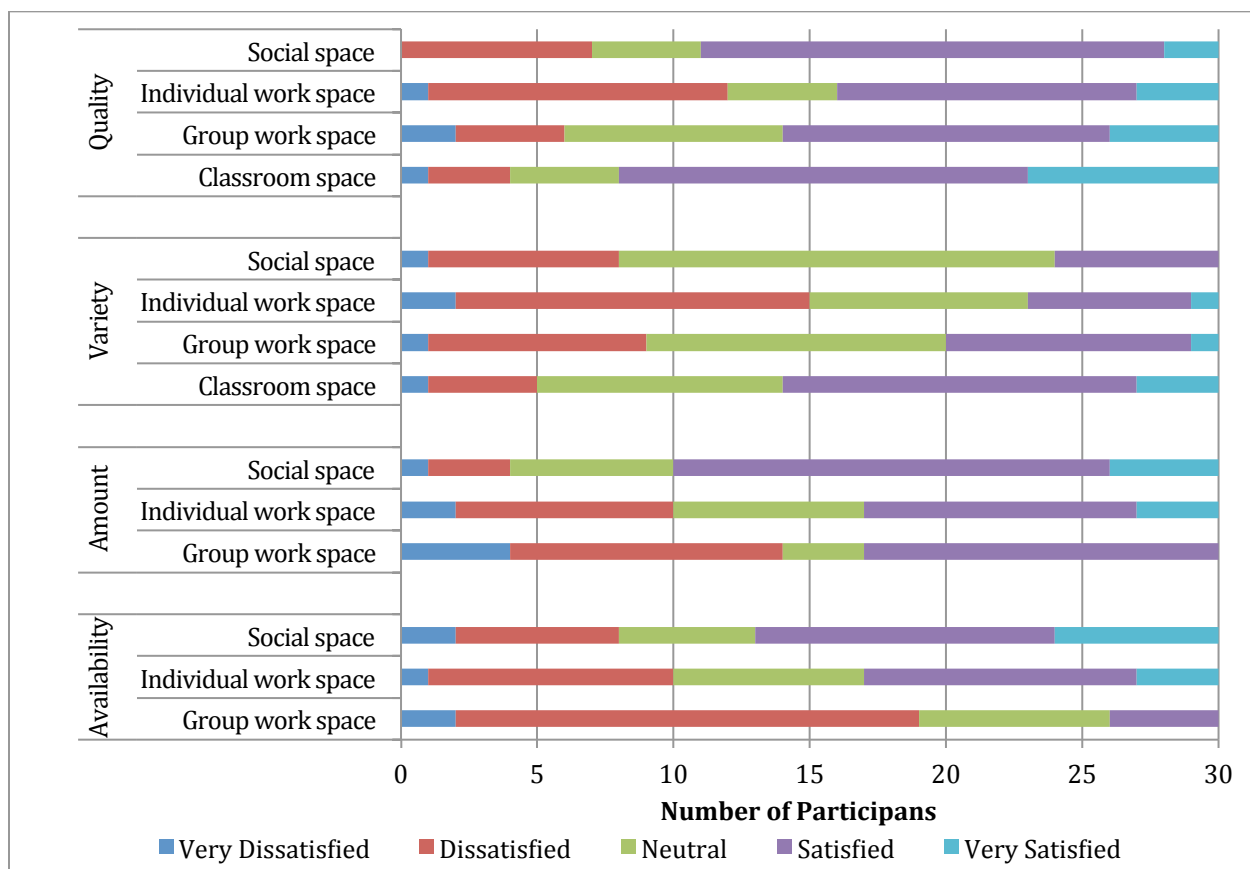


Figure 4.11 Satisfaction breakdown of current work spaces within Sage Hall

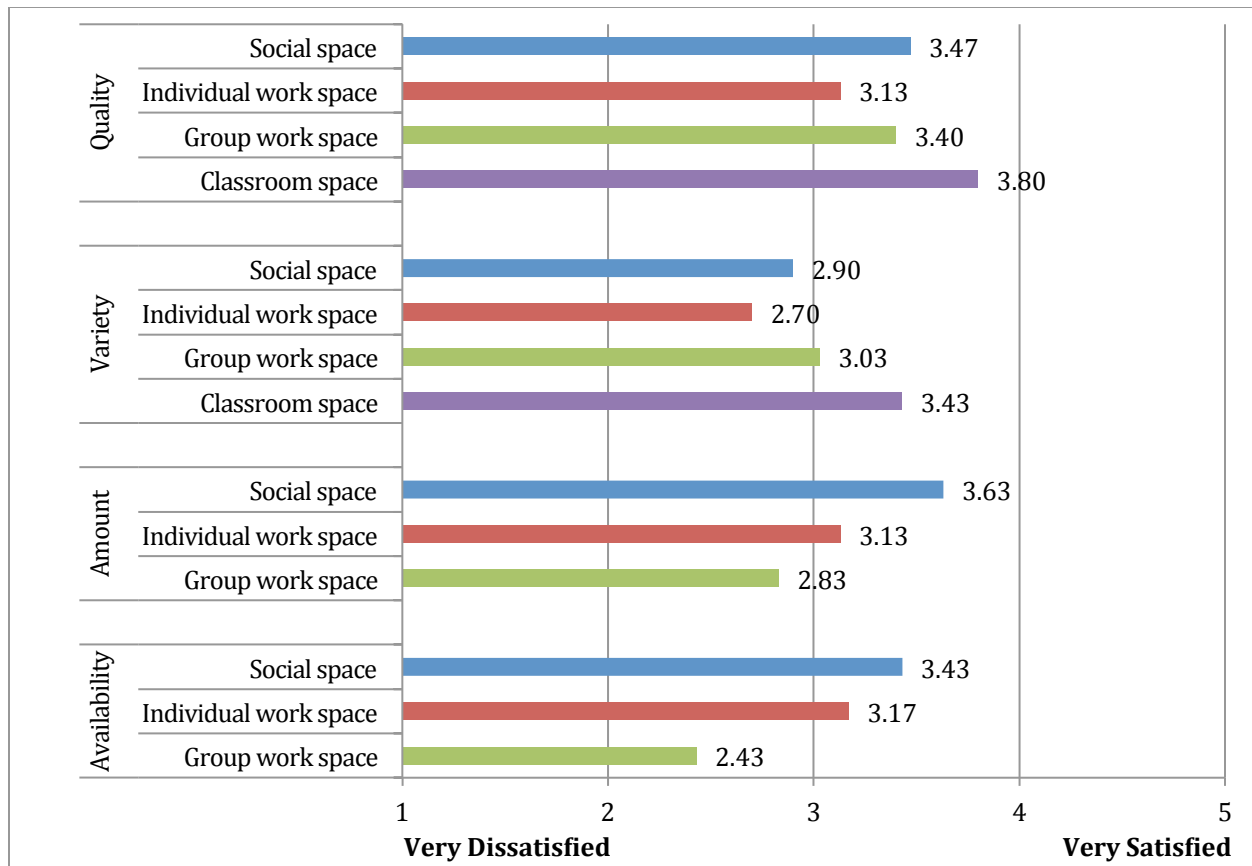


Figure 4.12 Average satisfaction of current work spaces within Sage Hall

Table 4.1 Average of individual characteristic means

Current Space	Individual Characteristics	Satisfaction Mean	Standard Deviation	Average of Individual Characteristic Means
Social space	Quality	3.47	6.67	3.36
	Variety	2.90	6.36	
	Amount	3.63	5.87	
	Availability	3.43	3.24	
Individual work space	Quality	3.13	4.69	3.03
	Variety	2.70	4.85	
	Amount	3.13	3.39	
	Availability	3.17	3.87	
Group work space	Quality	3.40	4.00	2.92
	Variety	3.03	4.69	
	Amount	2.83	5.34	
	Availability	2.43	6.67	
Classroom space	Quality	3.80	5.48	3.62
	Variety	3.43	4.90	

#### 4.5 Mean Analysis

An independent-samples T-test was used to compare the means between males and females as well as students who identified that they either did or did not use an academic building, computer lab, home, library, non-academic building, or off-campus café to study. These mean differences were analyzed for each of the satisfaction and importance categories.; however, only the locations that contained a significant relationship is shown in Table 4.2. This method was chosen because of its ability to compare the means of those who selected one of two possible responses; however, it should be noted that the sample size is relatively low ( $N=30$ ) for this type of analysis.

This analysis indicates that certain categories are significantly related to gender and the use of certain building types. For example, the importance of accommodations for large groups is significantly related to the use of academic buildings as a study space. Students who indicated that they used academic buildings as a study location reported the importance of accommodations for large groups as higher ( $\bar{x} = 3.50$ ) compared to those who did not use the location ( $\bar{x} = 2.60$ ). Also, satisfaction with the variety of group work space significantly related to gender. Male students tended to be more satisfied ( $\bar{x} = 3.33$ ) with the variety of group work spaces than female students ( $\bar{x} = 2.58$ ). Gender was also found to be significantly related to satisfaction with availability of individual work space. Male students tended to be less satisfied ( $\bar{x} = 2.72$ ) with the availability of individual work spaces than female students ( $\bar{x} = 3.83$ ).



Table 4.2 Independent-samples T-test

Category	Sig. (2-tailed)	Variable	Response	N	Mean	Standard Deviation
Importance of accommodations for large group	.021	Academic Building	Does not use location	10	2.60	.966
			Does use location	20	3.50	.946
Satisfaction with variety of group work space	.027	Gender	Male	18	3.33	.840
			Female	12	2.58	.900
Satisfaction with availability of individual work space	.004		Male	18	2.72	1.07
			Female	12	3.83	.718
Satisfaction with availability of individual work space	.028	Home	Does not use location	8	3.88	.641
			Does use location	22	2.91	1.11
Satisfaction with variety of classroom space	.015	Library	Does not use location	18	3.78	.808
			Does use location	12	2.92	.996
Satisfaction with variety of social space	.008	Non-Academic Building	Does not use location	29	2.97	.680
			Does use location	1	1.00	.000
Satisfaction with variety of individual work space	.023	Off-Campus	Does not use location	23	2.48	.947
			Does use location	7	3.43	.787

#### 4.6 One-Way ANOVA Test

A one-way ANOVA test was used to assess the between groups significance for the variables of study size preference and age. These variables were selected because they had more than two possible responses. All variables that had two possible responses were analyzed using the independent-samples T-test as discussed above. The significant results are shown in Table 4.3 (a full tables can be found in Appendix D). This method was chosen because it tests the significance of the variation in a continuous variable; however, it should be noted that the sample size is relatively low (N=30) for this type of analysis.

This analysis indicates that there is a significant relationship between study size preference and accommodations for a large group. Satisfaction with air quality and the quality of classroom space was also found significantly different across different age groups.

Table 4.3 One-way ANOVA test

Variable	Category	Sum of Squares	df	Mean Square	F	Sig.
Study Size Preference	Accommodations for a large group	8.55	2	4.28	5.19	.012
Age	Air quality	5.53	2	2.77	3.67	.039
	Quality of classroom space	6.45	2	3.23	3.58	.042

#### 4.7 Correlation Matrices

Two correlation matrices were produced based on the survey data. Table 4.4 shows the correlation among the perceived importance of work space characteristics. As shown in the table, the importance of flexibility of furniture is significantly and positively correlated with the importance of comfort of furniture. The importance of sound privacy is significantly and positively correlated with the importance of visual privacy, seclusion of space, and noise level while significantly and negatively correlated with importance of access to office equipment. The importance of access to electrical plugs is significantly and positively correlated with the importance of accommodation for a large group, access to a white/black board, access to office equipment, and having a comfortable temperature while significantly and negatively correlated to the importance of seclusion of space. The importance of having access to accommodations for a large space is significantly and positively correlated with the importance of access to a white board, and access to electric plugs while significantly and negatively correlated with the importance of seclusion of space.

The second matrix (Table 4.5) shows the correlation among satisfaction of current work spaces. Within each category of room, there was a statistically significant relationship ( $p < 0.01$ ) between the satisfaction rating of the variety and quality of a space. Participants who report a high level of satisfaction with the variety of a space also tended to report a high level of satisfaction with the quality of that space. This trend was also present generally between the other characteristics of the space. There tended to be a statistically significant relationship ( $p < 0.05$ ) within each category between the amount, quality, variety, and availability. Participants who rated one characteristic as high also tended to rate other characteristics as high. This trend is visible in Table 4.5 in the form of significant values clustered along the diagonal line. Also

shown in Table 4.5 students who were satisfied with the amount of group space also tended to be satisfied with the amount of social space.

Table 4.4 Importance rating correlation matrix

		Importance Rating																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	22	
1	Visual privacy																			
2	Sound privacy	.452 <sup>*</sup>																		
3	Seclusion of space	.235	.386 <sup>*</sup>																	
4	Comfort of furniture	-.130	-.096	-.168																
5	Crowding of surrounding space	.286	.104	.155	.053															
6	Noise level	.211	.604 <sup>**</sup>	.552 <sup>**</sup>	-.143	.338														
7	Flexibility of furniture layout	-.322	-.179	-.195	.556 <sup>**</sup>	.117	-.079													
8	Comfortable temperature	-.069	-.197	-.201	.213	.081	-.332	-.012												
9	Access to electric plugs	-.163	-.288	-.409 <sup>*</sup>	.266	-.004	-.278	.338	.375 <sup>*</sup>											
10	Access to office equipment	-.072	-.446 <sup>*</sup>	-.292	.358	-.043	-.491 <sup>**</sup>	.297	.429 <sup>*</sup>	.573 <sup>**</sup>										
11	Access to desk/table	-.049	.296	-.024	.108	.097	.257	-.164	.197	.185	-.158									
12	Amount of work surface	-.082	.058	-.040	.181	.162	-.076	-.119	.416 <sup>*</sup>	.310	.232	.354								
13	Accommodations for a large group	-.208	-.237	-.410 <sup>*</sup>	.097	-.239	-.122	.320	-.029	.504 <sup>**</sup>	.169	-.123	.080							
14	Access to black/white board	-.046	-.165	-.404 <sup>*</sup>	.086	-.154	-.144	.359	.090	.534 <sup>**</sup>	.225	.064	.107	.623 <sup>**</sup>						
15	Access to food/water	-.285	-.349	-.342	-.128	-.225	-.291	.190	.284	.542 <sup>**</sup>	.435 <sup>*</sup>	.134	.281	.339	.498 <sup>**</sup>					
16	Air quality	-.170	-.006	.116	.006	-.209	-.031	-.002	.077	-.150	.164	-.094	.280	-.050	.066	.386 <sup>*</sup>				
17	Adequate light level	-.204	-.148	.083	.170	.085	-.239	.020	.263	.163	.267	.122	.524 <sup>**</sup>	-.048	.056	.293	.573 <sup>**</sup>			
22	Access to natural light	.026	-.187	-.081	-.042	.018	-.096	.196	-.068	.326	.257	.104	.174	.209	.495 <sup>**</sup>	.371 <sup>*</sup>	.273	.292		
		* Correlation is significant at the 0.05 level (2-tailed)																		
		** Correlation is significant at the 0.01 level (2-tailed)																		

Table 4.5 Satisfaction rating correlation matrix

		Satisfaction Rating															
		1	2	3	4	5	6	7	8	9	10	11	12	13	18		
1	Amount of group work space																
2	Quality of group work space	.300															
3	Variety of group work space	.200	.661**														
4	Availability of group work space	.448*	.375*	.208													
5	Amount of individual work space	.123	.121	.159	.047												
6	Quality of individual work space	.176	.314	.388*	.121	.466**											
7	Variety of individual work space	-.015	.336	.425*	-.090	.436*	.590**										
8	Availability of individual work space	.051	.115	.165	.149	.680**	.512**	.338									
9	Amount of social space	.535**	.240	.091	.340	.392*	.298	.279	.225								
10	Quality of social space	.460*	.214	.140	.087	.296	.458*	.454*	.192	.730**							
11	Variety of social space	.337	.503*	.446*	.072	.256	.296	.419*	.021	.467**	.553**						
12	Availability of social space	.225	.328	.200	.358	.379*	.180	.083	.359	.607**	.329	.494**					
13	Quality of classroom space	.087	.589**	.692**	.229	.171	.318	.210	.154	.271	.136	.282	.427*				
18	Variety of classroom space	-.026	.219	.328	.146	.289	.196	.140	.158	.028	-.078	.201	.359	.572**			
* Correlation is significant at the 0.05 level (2-tailed)																	
** Correlation is significant at the 0.01 level (2-tailed)																	

## 4.8 Floor plan Assessment

Twenty-five out of the thirty participants elected to participate in the floor plan assessment exercise during their interviews. Based on the collected responses, three scenarios emerged: the first was a space in which 0% of participants used red shading, the second was a space in which 0% of participants used green shading, and the third was a space in which there was a percentage of participants who used both green and red shading. As mentioned in Section 3, participants were asked to use green to indicate spaces that they liked and red to indicate spaces that they did not like.

In order to visually express the data, a bivariate choropleth for each floor plan was created. A choropleth was used for this study as an exploratory method of displaying floorplan information because of its ability to visually display information in a way that does not require training in order to read the information. The goal of using this method was to convey the information to a variety of different people using the same visual.

To create these choropleths, a 9-square color scheme matrix (Figure 4.13) based on the range of data responses collected was produced using the maximum and minimum percentages of like and dislike responses for each room.

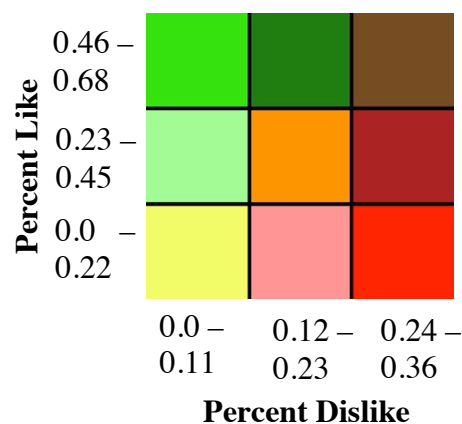


Figure 4.13 Bivariate color scheme matrix

The percent of participants who liked a space ranged from 0-0.68% and the percent of participants who disliked a space ranged from 0-0.36%. Each range was then divided into thirds and these smaller ranges were assigned to one of the three squares along the vertical and horizontal axis of the bivariate matrix to visually distinguish the percentage of participants' like and dislike respectively. Colors were then assigned to each square and each room that received a response was color-coded based on the matrix.



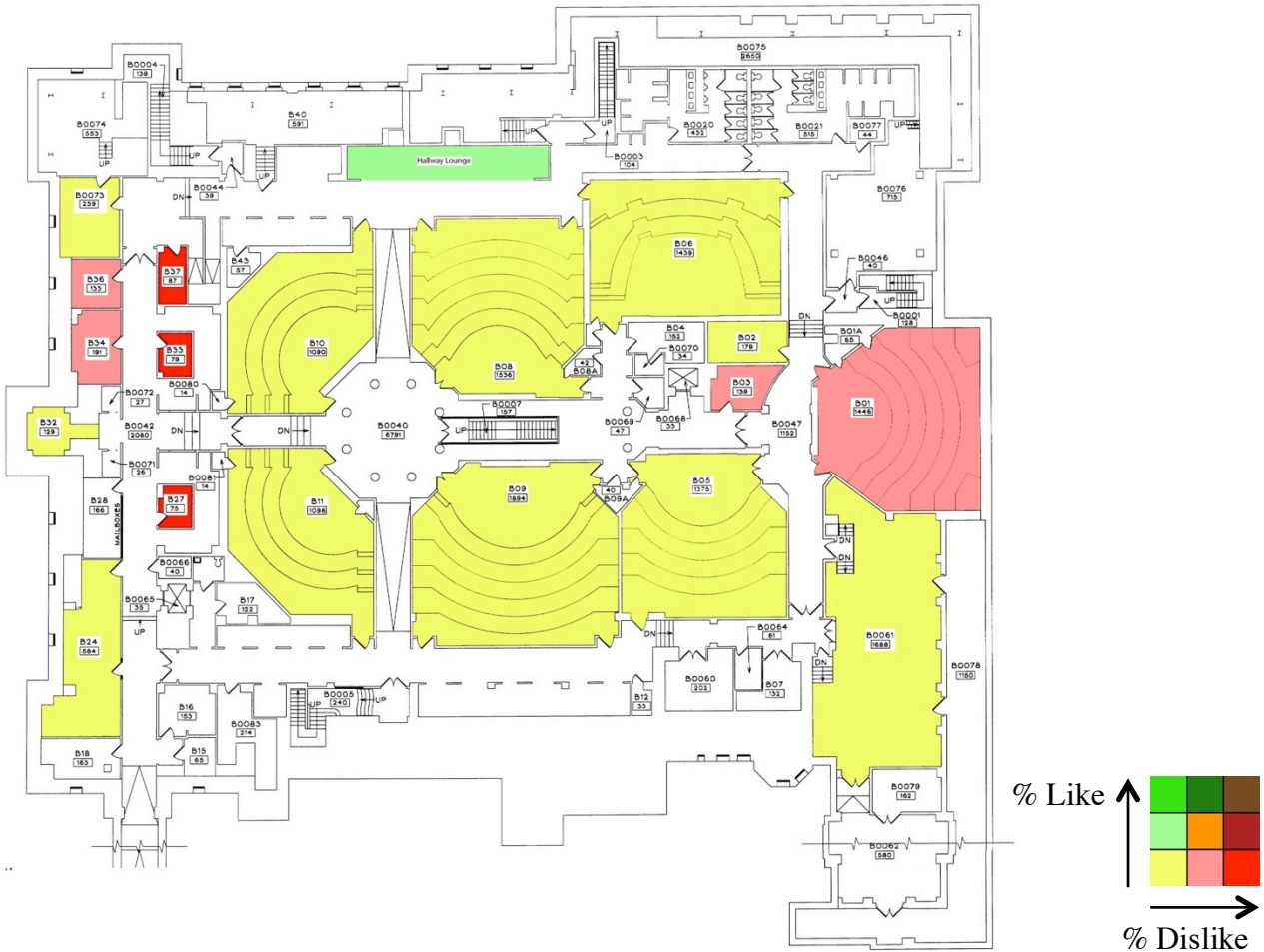


Figure 4.14 Basement floor showing color-coded response percentages

Figure 4.14 highlights participants' overall mixed preferences and low response rate towards the basement floor. As shown in Table 4.6 all but two rooms received a mixture of positive and negative feedback. Interviews revealed that the main critique of this floor was the lack of natural light and an overall feeling of being underground and confined. This trait was deemed positive or negative depending on the type of work participants were doing in the space. Some participants preferred the privacy when they were doing work that required concentration while others disliked the isolation when they were doing less intense work.

Table 4.6 Basement floor preference percentages

<b>Room</b>	<b>% Like</b>	<b>% Dislike</b>
B01	16%	12%
B02	20%	8%
B03	8%	12%
B05	20%	4%
B06	16%	4%
B08	20%	8%
B09	20%	8%
B10	20%	4%
B11	20%	4%
B24	4%	4%
B27	8%	28%
B32	4%	0%
B33	12%	36%
B34	12%	16%
B36	16%	20%
B37	4%	32%
B61	4%	0%
B0073	12%	8%
Hallway Lounge	40%	8%



Figure 4.15 First floor showing color-coded response percentages

As shown in Table 4.7 and Figure 4.15, various rooms on the first floor received only positive or negative reviews while others received a mixture of both positive and negative reviews. The only rooms to receive no positive feedback were rooms 128 and 130. Participants noted that these rooms are very small (holding no more than two people comfortably), the door has no windows into the corridor, and there are no windows to the outside. The atrium received a mixture of reviews. Many participants noted that the space was appropriate for short, casual work yet was not suitable for work that required concentration. The most positive feature of the atrium mentioned through interviews was the skylight and the overall feeling of openness. The

most negative feature mentioned was the acoustics and the lack of electrical outlets. Participants also noted that they liked the breakout rooms on the north side of the atrium because they had windows that looked out onto the atrium. The library also received mixed reviews. Some participants liked the access to printers and desktop computers while others disliked the high pedestrian traffic located around the front desk. Participants also mentioned that they wished the library had extended hours and that it was restricted to business students exclusively. Positive feedback included the natural light and private workstations. Room 104 (the Ramin Parlor) received positive feedback as participants noted that it was one of the few rooms that felt “Ivy” and historic. Negative feedback regarding room 104 included the inconsistent schedule of the room and participants were often unsure when they were allowed to use the room.

Table 4.7 First floor preference percentages

Room	% Like	% Dislike
102	16%	28%
103	12%	16%
104	20%	0%
121	52%	0%
123	52%	0%
125	52%	0%
127	32%	0%
128	0%	32%
130	0%	36%
131	16%	0%
134	16%	4%
135	20%	0%
136	24%	4%
138	28%	4%
140	12%	8%

Room	% Like	% Dislike
141	12%	0%
146	32%	4%
107 through 117	4%	8%
110 through 114	4%	4%
142A	4%	4%
142B	4%	0%
142C	4%	0%
142D	4%	0%
Library 1	4%	0%
Library 2	52%	24%
Library 3	36%	28%
Atrium	68%	36%



lounge, was noted as being a good place to rest and relax but was not conducive to work that required concentration. Room 201C, the reading room, received mixed reviews. The most repeated positive comment was that the space is a designated quiet space which allows for concentration. Some participants did not like the quietness and preferred more trafficked location.

Table 4.8 Second floor preference percentages

Room	% Like	% Dislike
201	16%	8%
207	4%	0%
208	12%	12%
209	24%	0%
210	12%	12%
211	48%	12%
212	16%	8%
213	48%	8%
214	16%	8%
215	52%	8%
217	44%	12%
230	4%	4%
233	36%	0%
234	4%	4%
236	4%	4%
240	16%	4%
241	40%	20%
242	12%	8%

Room	% Like	% Dislike
243	48%	4%
245	48%	4%
247	48%	4%
249	48%	4%
251	48%	4%
254	8%	4%
257	4%	4%
201C	64%	28%
201E	64%	4%
205A	36%	4%
205B	28%	4%
205C	48%	8%
205D	28%	12%
216A	16%	8%
248A	8%	4%
248B	8%	8%
253A	48%	4%

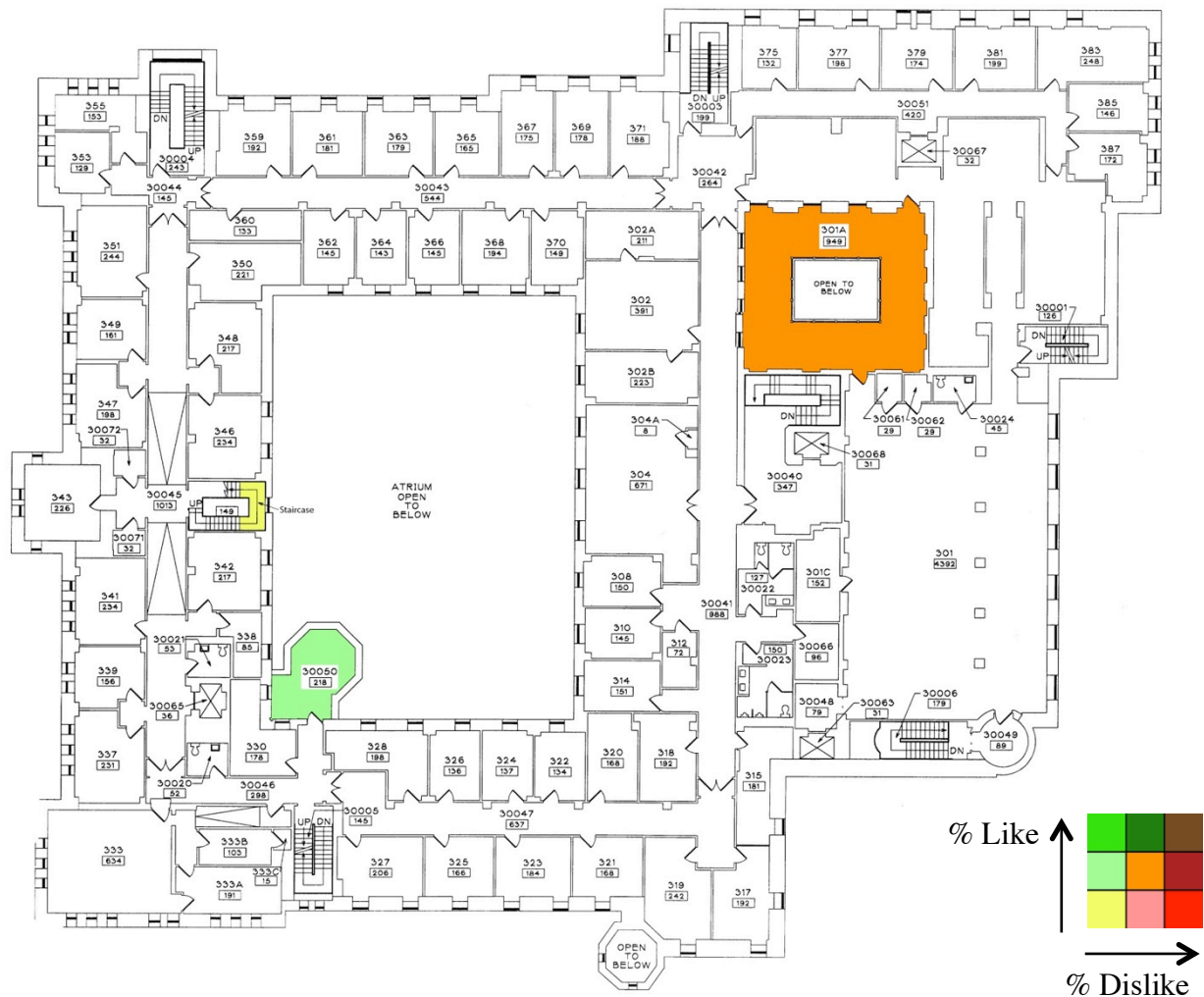


Figure 4.17 Third floor showing color-coded response percentages

As shown in Figure 4.17 and Table 4.9, participants noted a mixture of preferences to room 30050 – an area at the top of the tower inside the atrium that looks over the entire atrium (Figure 4.18). Participants also gave mixed reviews to room 301A as well as the staircase space (Figure 4.19). Positive feedback regarding room 301A included the quiet noise level and ability to find space. Some students reported that the space was too quiet and hard to access because it was on the third floor. Participants reported that the stairway was private and was good for



independent work that did not require a surface, such as reading. The overall theme of the third floor was the ability to find privacy within Sage Hall.



Figure 4.18 View from room 30050



Figure 4.19 Third floor staircase space

Table 4.9 Third floor preference percentages

Room	% Like	% Dislike
30050	32%	4%
301A	32%	12%
Staircase	16%	4%



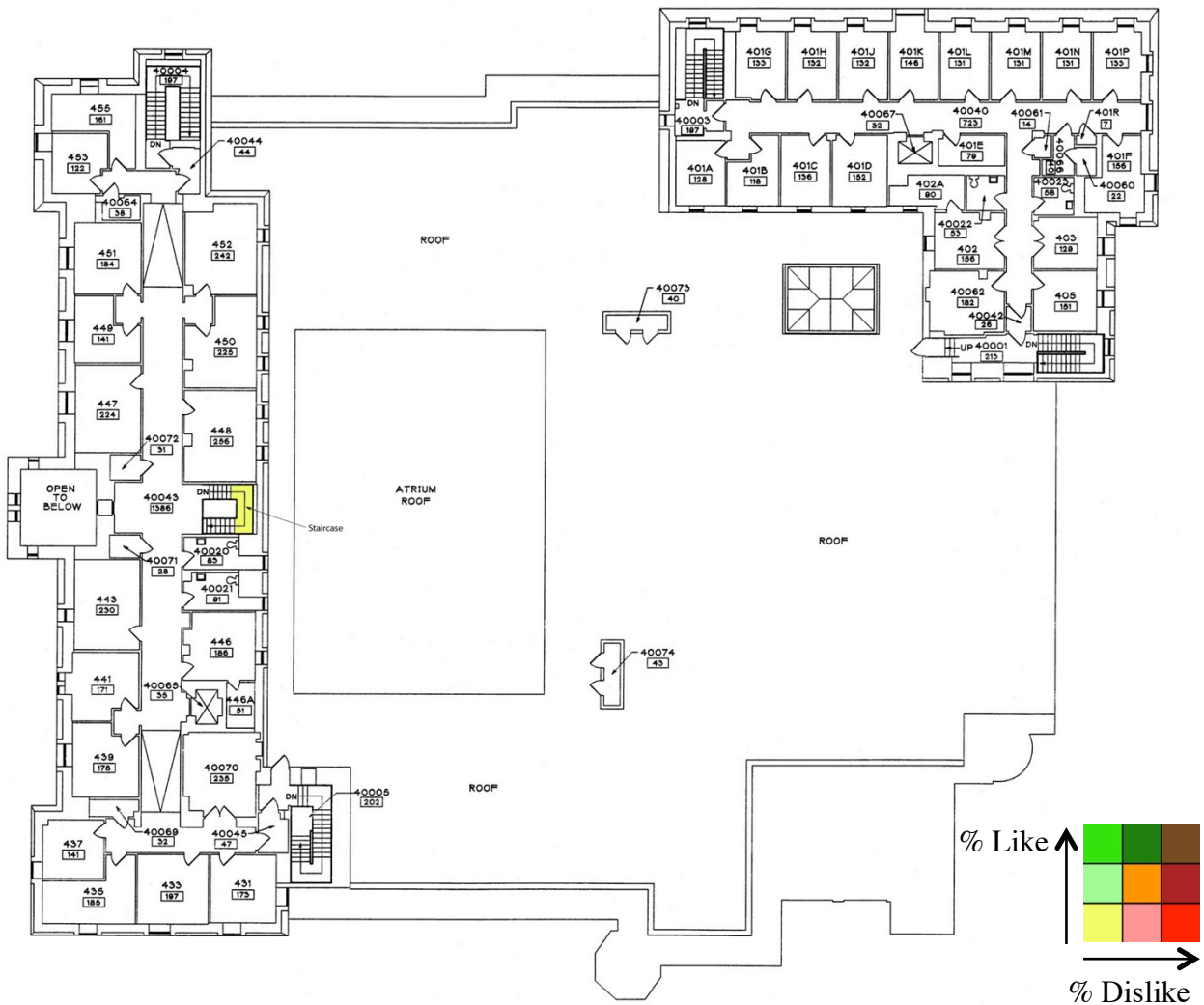


Figure 4.20 Fourth floor showing color- coded response percentages

Only one space was mentioned on this floor as shown in Figure 4.20 and Table 4.10. The staircase (Figure 4.21) was noted to be a private space that offered a reprieve from the rest of Sage Hall and offered a space that was suitable for independent work.



Figure 4.21 Fourth floor staircase space

Table 4.10 Fourth floor preference percentages

Room	% Like	% Dislike
Staircase	12%	4%

## 4.9 Interview Summaries

Results from the floor plan discussion (Table 4.11) and open-ended questions (Table 4.12) are summarized below. Common themes include convenient access to common areas, access to natural light, feeling of openness, access to technology, noise level, overall ambience, surface space, and perceived intent of space. An interesting comment was that participants noted that they did not like the third and fourth floor because those floors were not meant for student use. This does not necessarily indicate that students prefer spaces that as intended for them but it is important to note that those spaces that are actively designated for other uses (i.e. faculty and staff offices) are not appealing to students.

Table 4.11 Summary of responses during floor plan discussion

<b>Floor</b>	<b>Summary of Positive Feedback</b>	<b>Summary of Negative Feedback</b>
Basement	Easy access to locker bay, classrooms good place to work after hours when available, student lounge good for casual work and socializing	Feels like a dungeon, no natural light, very small breakout rooms, hallways too narrow, very crowded
1 <sup>st</sup>	Atrium is social center with lots of natural light, comfortable chairs in library, rooms with view to atrium or outside, room 104 feels “Ivy,” breakout rooms decent size	Atrium too loud and allows too many distractions, old furniture in atrium is unprofessional, lack of outlets in atrium, café too loud and cramped, front of library too crowded and loud,
2 <sup>nd</sup>	Reading room is quiet with quality individual study space, rooms with view to atrium or outside, breakout rooms decent size, room 201E is private with great windows, “nobody knows about room 201E”	Breakout room walls too thin, TV cables disorganized and look unprofessional, room 241 used for sleeping
3 <sup>rd</sup>	Reading room quiet, room 30050 is private with good view, quiet and private seating area on staircase,	Too out of the way, not meant for student use
4 <sup>th</sup>	Quiet and private seating area on staircase	Too out of the way, not meant for student use

Table 4.12 Summary of open-ended question responses

Question	Summary of Responses
Describe the work/study environments, in general, where you are most productive.	Coffee shop atmosphere, social, lots of natural light, sturdy furniture, large work surface, open, access to office equipment, flat screen TV, lots of outlets, space for group work, white board, comfortable temperature, access to food/kitchen, private, windows that open, couch available, adjustable lights, clean, quiet
Think of a memorable time you had while working/studying in Sage Hall. What about this experience made it memorable, here did it take place, and what made this possible/facilitated the event?	Negative experiences working in basement especially late at night, 2 <sup>nd</sup> floor reading room is reliably quiet, Dean's suite (room 233) has great access to technology, stuck in various rooms for long hours working on group assignments, atrium is great place to be social and see friends, took over classroom for entire night and was able to use projector and spread out
Do you ever find yourself looking for space in Sage Hall that you can't find?	Space for quiet phone calls/interviews, individual work areas, room for spontaneous interaction in hallways, charging station for electronics, dry cleaning service, breakout rooms that don't require advanced reservations
What words would you use to describe the Johnson School experience?	Intense, recruiting, fun, collaborative, isolated location, friendly, social, busy, diverse, challenging, enriching, humbling, fast-paced, dynamic , overwhelming, competitive
What do you think makes the Johnson School unique?	Strong sense of community, support from classmates, high participation, small class size
What do you think of the relationship (or differences) between the Johnson School and Sage Hall?	Atrium adds to the feeling of community, lots of group rooms add to idea of collaboration, social atmosphere restricted by narrow hallways that don't allow for spontaneous interaction, Johnson has adapted to fit Sage Hall, no large auditorium to host speakers yet project image of professionalism, "Johnson is Sage," disconnect of progressive program yet outdated technology

## 5. Discussion

This study was aimed at capturing and understanding the preferences of business school students with regards to their learning environment. In order to better understand and organize these preferences, five research questions were proposed. This section reports findings related to each of these research questions and offers design recommendations.

### 5.1 Research Questions

*RQ 1: What are the design features of the informal work spaces in the Sage Hall that are recognized as important by its users?*

Overall it was found that access to technology, particularly electrical outlets, and natural light were the most important design features for students; however, there was mixed results regarding the importance of circulation paths and group work space. The ambient environment was also found to be important and introduced the concept of control over the environment.

*RQ 2: What attributes of a space affect user satisfaction with current spaces within Sage Hall?*

It was found that the quality and variety of current spaces affect students' satisfaction with current spaces as these two attributes were significantly correlated.

### 5.2 Research Question Sub-Components

*RQ 1.1: It is important to students that work spaces are close to main circulation paths*

Overall, data analysis shows mixed preferences regarding the relative location to pedestrian traffic. Participants were asked to rate how important they considered specific characteristics related to being secluded from pedestrian traffic including noise level ( $\bar{x} = 4.4$ ),

sound privacy ( $\bar{x} = 4.1$ ), seclusion of space ( $\bar{x} = 3.6$ ), crowding of surrounding space ( $\bar{x} = 3.6$ ), and visual privacy ( $\bar{x} = 3.2$ ). All of these characteristics are of moderate to high importance to participants, suggesting that participants do not prefer to be in the path of pedestrians and refuting the research question.

However, data also does support the research question. The importance of seclusion of space is significantly and negatively correlated with access to electrical outlets. This is an important relationship because 87% of participants rated access to electrical outlets as important or very important. An implication of this result is that although participants may prefer to be separated from pedestrian traffic, they may be willing to give up some separation in order to have access to electrical outlets. The importance of electrical outlets has also been found in previous research involving college students (Waxman, 2006).

Participant interview data provides additional information for understanding these numerical results and discrepancies. The floor plan of the first floor highlights the positive feedback given to the rooms along the north side of the atrium that have windows looking directly look into the main atrium space. Participants noted that they preferred these rooms because they could visually see the activity inside of the atrium yet were partially removed from the activity so that they were not as easily distracted. This supports previous research that found that circulation paths were preferred because of the ability to view pedestrian traffic (Pasalar, 2003). This idea of watching activity from a removed area was echoed on the 2<sup>nd</sup> floor as students mentioned their preference for room 201E in the northeast corner of the building. This room has large windows (Figure 5.1) that allows students to view the bus stop and sidewalk outside (Figure 5.2) while being physically removed from the traffic flow and noise. Participants

also reported their dislike for rooms that did not have any windows to the corridor, such as room 130 (Figure 5.3), because they felt too secluded and removed from the activity of the building.



Figure 5.1 Room 201E



Figure 5.2 View from room 201E



Figure 5.3 Room 130

Although the data does not provide a decisive answer to the research question, design recommendations can be made in order to make sense of the recorded preferences. Based on the importance values placed on the specific characteristics that were related to privacy, the first design recommendation is to include more outlets in areas of the building that are away from pedestrian traffic so that students do not have to sacrifice their access to electrical outlets in order to remain in more private locations. Alternatively, since students may be willing to sacrifice their location for access to electrical outlets, semi-secluded work areas may be added in order to reduce the need for completely private work spaces and increase the space use efficiency of the floor plan. That is, it may be appropriate to eliminate entirely private locations and transition them into semi-private spaces in order to maximize the spatial efficiency of a building and to reduce the number of outlets required to meet student preferences. Another design

recommendation would be to include more spaces in which students are away from pedestrian traffic but have the ability to visually see the activity around them.

*RQ 1.2: Access to technology in a work space is important to students*

In this context, access to technology refers to a participant's ability to obtain technological resources such as printers, fax machines, electrical outlets, etc. This research question is partially supported. As previously mentioned, 87% of participants rated access to electrical outlets as important or very important ( $\bar{x} = 4.3$ ) which supports previous research (Waxman, 2006). However, only 23% of participants rated access to office equipment as importance or very important ( $\bar{x} = 2.6$ ). This implies that electrical outlets are more important to students than access to equipment such as printers, scanners, and fax machines. Data collected through interviews also support this numerical data. Participants noted that electrical outlets were of the highest importance and access to printers was not an immediate necessity. Participants also noted that power strips are currently being used in the atrium because there is not sufficient access to electrical outlets as seen in Figure 5.4. In addition to electrical outlets, interview data also supported this research question in that participants expressed the importance of television monitors that could be connected to computers, however, participants also noted that the current TV monitors in breakout rooms tend to have extraneous cords that create a disheveled appearance as seen in Figure 5.5. Based on numerical data and data collected through interviews, this research question is supported.





Figure 5.4 Power strips used in Atrium



Figure 5.5 TV monitor and extraneous cords

Correlation information may be useful in determining design recommendations due to the importance of having more electrical outlets closed to the seating areas. Correlation data shows that those participants rated electrical outlets as important also tended to rate many other amenities important; specifically, accommodation for a large group, access to a white/black board, access to office equipment, and having a comfortable temperature are significantly and positively correlated with access to electrical outlets. That is, those participants who consider access to electric outlets as important also tend to desire several other physical design features in a space. Additionally, access to electrical outlets was negatively correlation with seclusion of space which suggests that participants may be willing to be in more sacrifice some privacy for electrical outlets. A design recommendation based on these trends would be to design spaces to have varying levels of privacy and group accommodations while also incorporating additional electrical outlets to meet demand. Although access to electrical outlets was rated to be the most important technology, other forms of technology, such as television monitors, may also be added to designs to increase student satisfaction with a space. This practice may be successful at incorporating design characteristics that are important to students for the lowest cost.

*RQ 1.3: A comfortable ambient environment in a work space is important to students*

The ambient environment refers to the characteristics that are not physically tangible within a space such as light, temperature, and air quality. Participants rated the importance of various ambient environment characteristics as seen in Table 5.1. These ratings support the research question that the ambient environment is important to students because all of the characteristics received an average rating of above 3 where a value of 3 indicates neutral importance. Participant interviews also supported this research question. Participants expressed positive feedback for room 201E in the northeast corner of the 2<sup>nd</sup> floor (Figure 5.1) based on the full length windows which provide large amounts of natural light and views to the outside. Several participants also noted that not many students know about this space and that they would like more spaces that use large windows. Access to natural light has also been found in several research studies (Waxman, 2006; Maxwell, 2012; Yang, 2013).

Participant interviews also introduced the idea that not only was the ambient environment important, but control of the ambient environment was also important. Figure 4.16 visually depicts a relatively positive participant response for second floor rooms along the exterior walls. Through interviews, participants noted that these rooms were preferable because they have direct access to outside air and participants were able to control their temperature and air quality themselves. Since the idea of control over the ambient environment was not an initial research question, further research would need to be conducted in order to explore this concept. Although more research would be needed, the present results suggest that adding more levels of control over the ambient environment may increase student satisfaction with their work space. This may involve windows that open to allow fresh air, individual thermostats inside rooms, or enlarged windows with blinds to allow for the option of more natural light.

Table 5.1 Average ambient environment characteristics

<b>Ambient Environment Characteristic</b>	<b>Average Importance Rating</b>
Adequate light level	4.6
Noise level	4.4
Comfortable temperature	4.3
Sound privacy	4.1
Air quality	4.1
Access to natural light	4.0
Visual privacy	3.2

*RQ 1.4: Students rate work spaces that offer groups of students the ability to work together as important*

Numerical and anecdotal information show mixed results regarding the importance of group work space. As previously mentioned, survey results showed that 54% of participants prefer to study alone, 13% prefer groups, and 33% indicated that study size is dependent on the type of work being covered and their familiarity with the subject. This result does not support previous research, which highlights the importance of group work (Thorley & Grgory, 1994; Harvey et al, 1997). However, this research question only considered study preferences, only one type of work, not the overall work preferences of student which includes all types of tasks related to academics; this narrow view may account for the unsupportive results. Participants also reported that a space having accommodations for a large group was of an average importance level of 3.2. This result also does not support the research question because an average rating of 3.2 indicates that this characteristic was only important to about half of the participants and the other half viewed it as unimportant. However, floor plan results show that participants tended to favor the larger breakout rooms. Interviews also support the research question because many participants noted how the small breakout rooms were not conducive to group work and they

preferred rooms where they could have enough room to move the table and chairs to practice giving presentations.

Although there is mixed results supporting this research question, there is correlation data that creates a more complete picture as to how study size preference and having accommodations for a large group are interrelated with other characteristics. The characteristic of a space having accommodations for a large group is significantly and positively correlated with access to a white board, access to electric plugs, and study size preference while significantly and negatively correlated with seclusion of space. This implies that privacy may not be as important while working in a group setting or that participants may be willing to give up some privacy in exchange for larger spaces and amenities. Additionally, study size preference was significantly and positively correlated with flexibility of furniture. That is, participants who reported that they preferred working in larger groups also tended to report that the flexibility of furniture was an important physical characteristic. Flexibility of furniture is an important design implementation because it allows for the space to serve multiple purposes: smaller groups and larger groups depending on the arrangement. It also may allow large groups to rearrange furniture in order to practice giving presentations which was highlighted during participant interviews. This is important specifically in academic buildings because participants who reported that they used academic buildings rated the importance of group accommodations as higher on average.

Although more research would need to be conducted to identify the needs of group space, one design recommendation would be to replace the existing furniture with furniture that was more flexible in terms of layout and function. This may be as simple as adding more chairs that are stackable or have wheels so that students can rearrange their work rooms to fit their needs or

as complex as having the walls of rooms be removable so that small rooms can become bigger rooms on demand.

*RQ 2.1: Students' satisfaction with the quality of work spaces is associated with their satisfaction with the variety of spaces/work settings*

Correlation data supports this research question in that there was a positive correlation between participants' satisfaction with the quality and the variety of their current spaces. This result supports previous research that found that students' satisfaction levels were impacted by factors such as the quality of a physical environment (Yang et al., 2013). This pattern was true for all four types of spaces: group work space, individual work space, social space, and classroom space. This suggests that students may perceive a space to be of a higher quality based on the variety of the types of spaces available. A design implication based on this information is to include a variety of options for students to choose from in order to increase their perceived satisfaction with the quality of those spaces, e.g. multiple types of individual work spaces ranging in levels of privacy or size. By including a variety of types of spaces, student may perceive the overall quality of those spaces to be higher simply by adding variety. Increasing use of technology and mobile work also contributes to the variety of environments that have the necessary support for work needs (Brown & O'Hara, 2003).

### 5.3 Including Students in the Design Process

The design process is also often centered around the service and operational needs of a space rather than considering the types of learning that should happen in that space (Bennett, 2007). However, when students are included in the design process, students are often only asked

about their opinions after the space has been occupied (Lee & Tan, 2013). There are differing opinions regarding the benefits of including the student perspective in the design process as some studies relate the goals of the study directly to the benefit of students while others relate to the benefits of the building itself (Flutter, 2006). This study aimed to bridge this gap and include students in the design process by asking for their preferences regarding their work spaces. The results gathered from this study may be used to provide the Johnson School and Sage Hall facilities management with information and design recommendations as they consider renovations in the future.

#### 5.4 Summary

This study has provided an analysis of student preferences of their learning spaces. It was found that access to technology, particularly electrical outlets, and natural light are important to students. Utilizing students as the population adds to the limited body of research that considers the student perspective rather than staff or faculty opinions. This work also adds to the limited research that looks at higher education facilities. Multiple studies have used the student perspective as it relates to K-12 education but few solely focus on students in higher education. This research also adds to the limited body of research that utilizes students' self-reporting their perspectives of their learning spaces. As noted, students are often left out of the design discussion yet they are generally the primary users of many of the spaces within their academic buildings.

This research uncovered an unanticipated theme with regards to control over the environment. This theme was present in numerous interviews but was not accounted for in the written survey and should be addressed in future research. Specifically, participants noted that

they preferred spaces in which they could open windows, adjust temperature, and organize clutter. This theme is particularly interesting because it may be related to the trend of mobile working in that people are now able to control where they do work and therefore expect control over the environments in which they work. Control over the environment may also be related to the flexibility of that environment. Flexibility may be found to be a subcategory of control or an independent variable. Further research would need to study the relationship between these two factors before identifying a common trend.

A new method of displaying floor plan information, the bivariate choropleth, was also introduced in this study. These choropleths may be used by a variety of people of all skills levels as a way to initiate conversation about what spaces are liked and disliked. This visual aid is useful as it is intended to be used by people of various skill levels so that many different people can be part of the design discussion. Such uses of this tool include identifying which spaces are not liked or disliked by students and determining why the opinion levels are low. Additionally, this tool could be used to visually identify usage information instead of preference information.

## **6. Limitations and Future Work**

### **6.1 Limitations of Current Study**

As a pilot study on this topic, the current study was limited by a relatively low number of participants. This was predominantly due to time constraints and availability of eligible participants. As with all students pursuing a higher education, the population of students eligible for this study was very limited on time. The small sample size limited the use of various statistical tests and the ability to draw overarching conclusions based on the statistical validity.

Another limitation to this study was the population selected for this study. This study looked solely at Cornell MBA students and did not take into account the perspectives of any students studying other disciplines at Cornell or students' perspectives regarding any other building. The focus on the Millennial generation is also limiting because it focuses on a narrow range of individuals and may not be characteristic of future generations' perspectives.

### **6.2 Future Work**

Based on the stated limitations, future work should be conducted to expand on this study. This study should be seen as a pilot study for further research on the themes. In order to create a robust, full-scale study, a larger, more diverse sample is necessary in order to strengthen the validity of this study. Additionally, a larger sample size would provide enough data to complete statistical tests such as a factor analysis to interpret correlation matrices similar to the ones produced in this study. Although the current study uses a case study approach to determine the needs and desires of Cornell business school students specifically, this study can be used as a model that could be applied to other buildings in order to determine the design recommendations to meet that building's specific user group. A computer-based survey may be developed as a way



to reach more participants and increase the number of responses. Using an alternative collection method should also be used to compare the similarities and differences between using a paper-based or computer based floor plan exercise. Future work should also test a different or more broadly defined population such as undergraduate, masters, doctor of philosophy, and post-doctoral students from all disciplines. Additionally, buildings of different types and ages should also be tested and compared to the results found in this study.

More work should also be done to continue the development of the survey tool used in this study. Specifically, more research should be incorporated into the survey regarding the ambient environment, control over the environment, and flexibility of spaces. An expanded survey should include more pointed questions designed to further explore the themes brought out through the floor plan coloring exercise such as the idea of students having personal control over their environment. For example, students should be asked how often they use certain spaces, if their use varies throughout the year, do they prefer spaces that offer them levels of control, what types of control is important to them (e.g. temperature, lighting, air quality, etc.), and how students cope with spaces that they do not like but sometimes use (i.e. small breakout rooms). The idea of personal control could also be expanded upon to create a completely separate study. This could involve looking at how student perceive spaces they can or cannot control and if these spaces have an affect on student preference or attitude. When doing this, it may be interesting to compare the actual and perceived control. For example, does providing a thermostat inside a room have an affect on the perceived control of a space even if that thermostat is not functional? Additionally, a study could look at the relationship between mobile working and the desire for control over the environment. Flexibility of a space should also be researched in order to determine if it is a subcomponent to control or if it is an independent variable.

Future studies should also focus on performing post-occupancy evaluations with the goal of determining the effectiveness of the design implementations after a period of student use. Ideally, a study similar to this study would be conducted in order to develop design recommendations. Post-occupancy evaluations would then be especially valuable in order to determine the effectiveness of the student perspectives when designing the building. It would be interesting to study if students are satisfied with a new space if their preferences are used to develop design suggestions or if students change their preferences once they experience a new space. For example, students may think they want an open layout, however, when they are given a new building with an open layout they change their preference because they now want more privacy. In general, a full-scale study could include behavior variables, in addition to perceived importance and satisfaction variables. This suggests that the research methods could be further developed to include observation and behavior mapping to assess these trends in behavior.

## **7. Appendix**

## 7.1 Appendix A: Survey Instrument

Participant Identification Number: \_\_\_\_\_

Select your standing in the Johnson School

- ☐ 1st year
- ☐ 1st Year AMBA
- ☐ 2nd year

Select your age bracket

- ☐ 20-24
- ☐ 25-29
- ☐ 30-34
- ☐ 35-40
- ☐ 41+

Gender

- ☐ Male
  - ☐ Female
  - ☐ Prefer not to answer
- 

Where do you prefer to do work? (Select all that apply.)

- ☐ Home
- ☐ Academic building
- ☐ Non-academic building on campus (Big Red Barn, Willard Straight, etc.)
- ☐ Library
- ☐ Computer lab
- ☐ Off-campus Cafe
- ☐ Other (please explain) \_\_\_\_\_

How do you prefer to study? (Select one.)

- ☐ Alone
- ☐ Groups
- ☐ Depends on nature of work (please explain) \_\_\_\_\_

**For a space where you do work, how important are the following characteristics?**

	Very Unimportant	Unimportant	Neither Important nor Unimportant	Important	Very Important
Visual privacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sound privacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seclusion of space (spaces away from main circulation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comfort of furniture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Crowding of surrounding space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Noise level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flexibility of furniture layout	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comfortable temperature	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to electric plugs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to desktop computers, projectors, or other forms of stationary technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to desk/table	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amount of work surface	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accommodations for a large group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to black/white board	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to food/water	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Air quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adequate light level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Access to natural light	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Are there any other characteristics that you value in a work space? Please explain.

**What is your satisfaction with the following characteristics of spaces in Sage Hall.**

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Amount of group work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of group work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Variety of group work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of group work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amount of individual work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of individual work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Variety of individual work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of individual work space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amount of social space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of social space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Variety of social space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of social space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of classroom space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Variety of classroom space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What types of study spaces would you like to see more of at Cornell? Please explain.

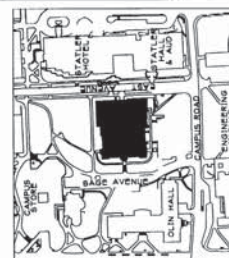
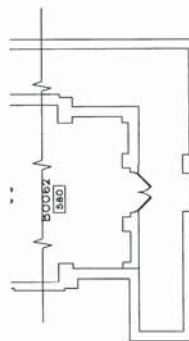
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Do you have any overall comments about group, individual, or social work spaces in Sage Hall? Please explain.

## 7.2 Appendix B: Original Floorplans



75



300'2 - BASEMENT FLOOR PLAN

$$z \oplus$$

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J.W. HUMPHREY'S SERVICE BUILDING



REVISIONS: IGI 1/01, 4/03 EQ, 4/06

DRAWN BY:

DRAWING NO.:

1

NAME:

ERDMAN

104

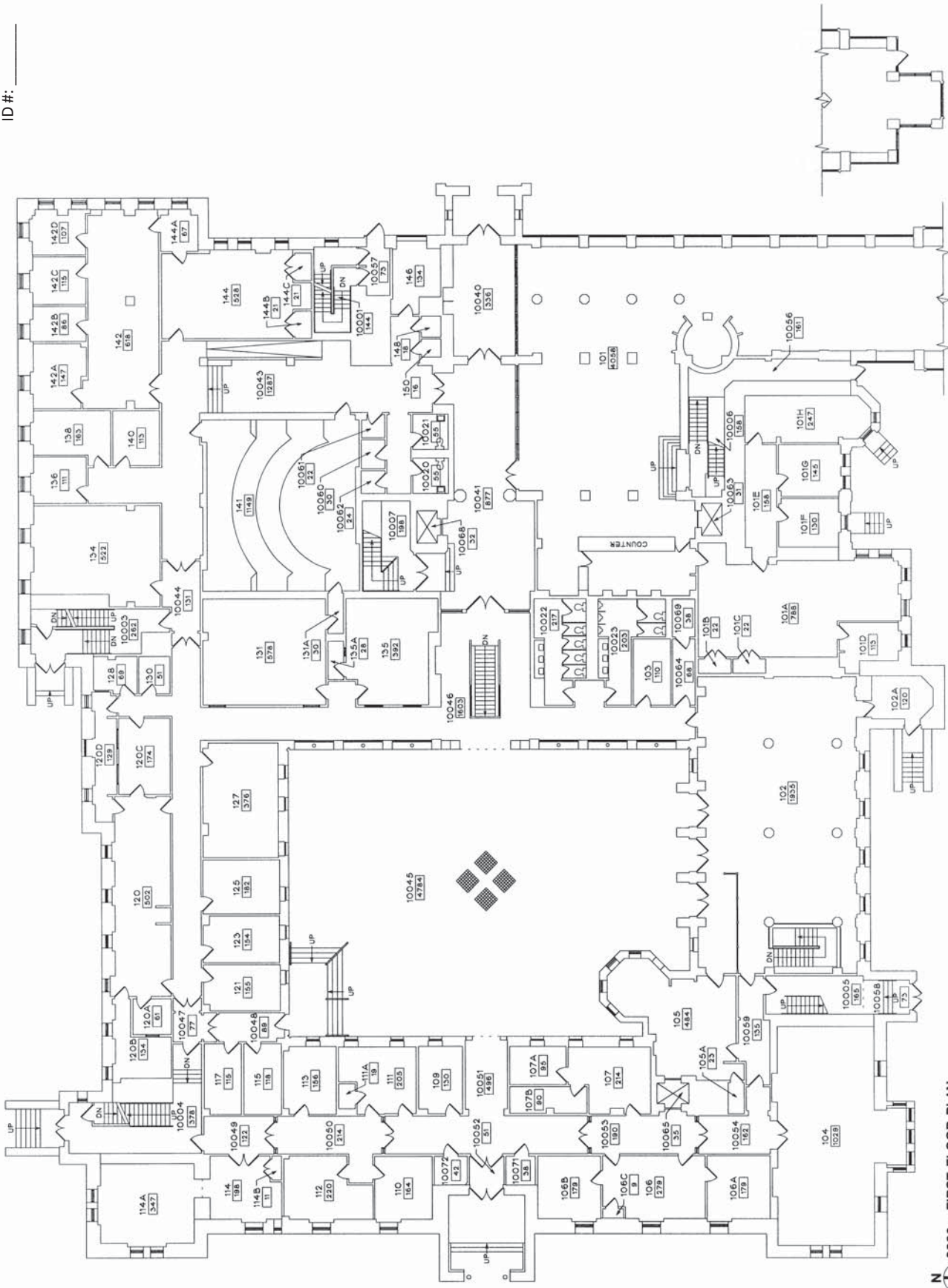
5

SAGE HALL

BUDG NO:

3002

ID #: \_\_\_\_\_



N 3002 - FIRST FLOOR PLAN  
GROSS AREA • 37,935 SQ. FT.



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SHOULD NOT BE RELIED UPON FOR ANY OTHER PURPOSE.

REVISIONS:  
4/03 EQ, 3/05 EQ  
SCALE:  
0 8 16 32  
1" = 1'-0"

DRAWN BY: ERDMAN A.  
CHECKED BY: AGE

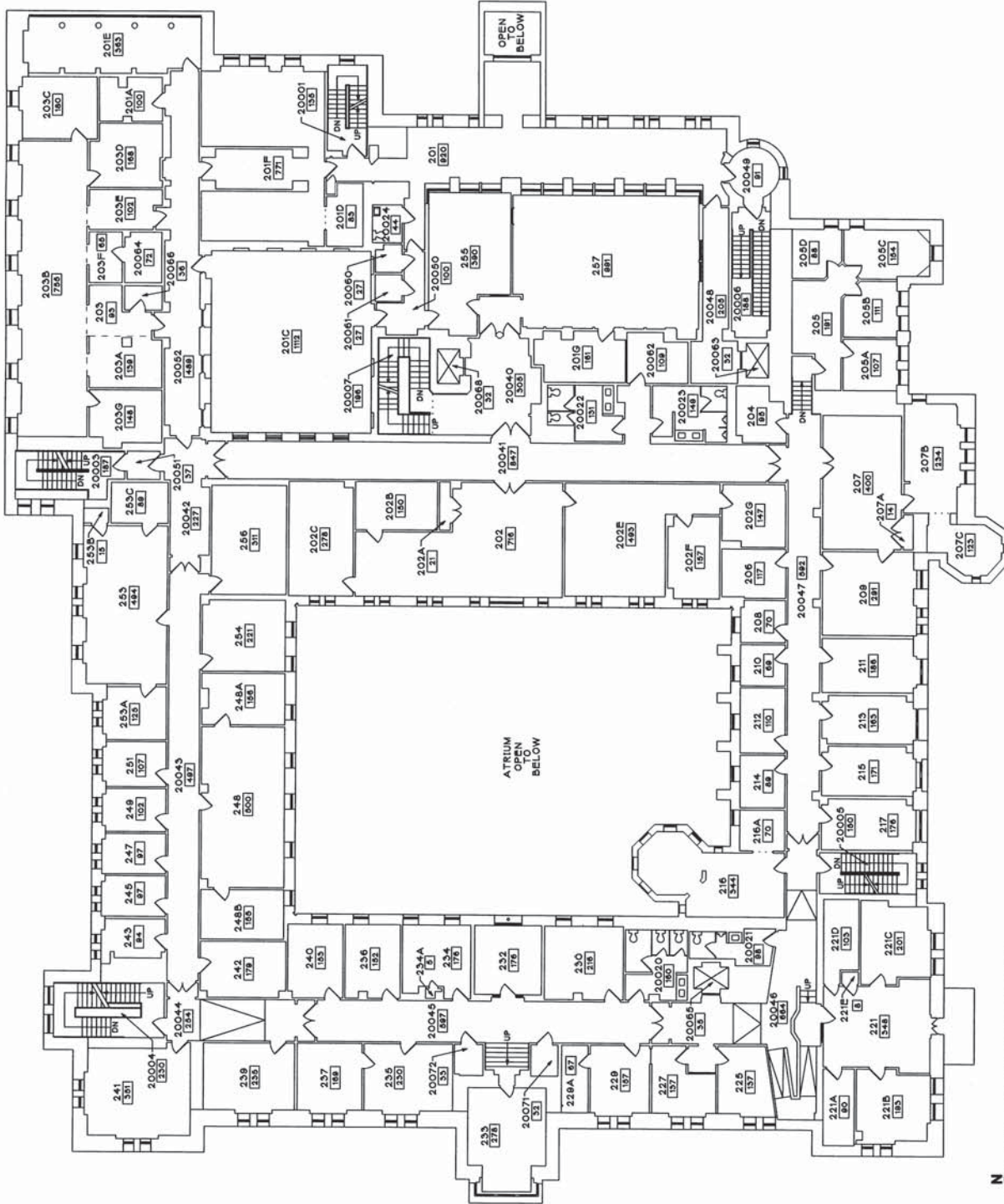
DRAWING NO.: 2 OF 5  
DATE: 030599

PLAN LEVEL: 1  
TOTAL BLDG. GROSS SQ. FT.: SEE SHEET 1

BLOG NAME: SAGE HALL  
BLOG NO: 3002



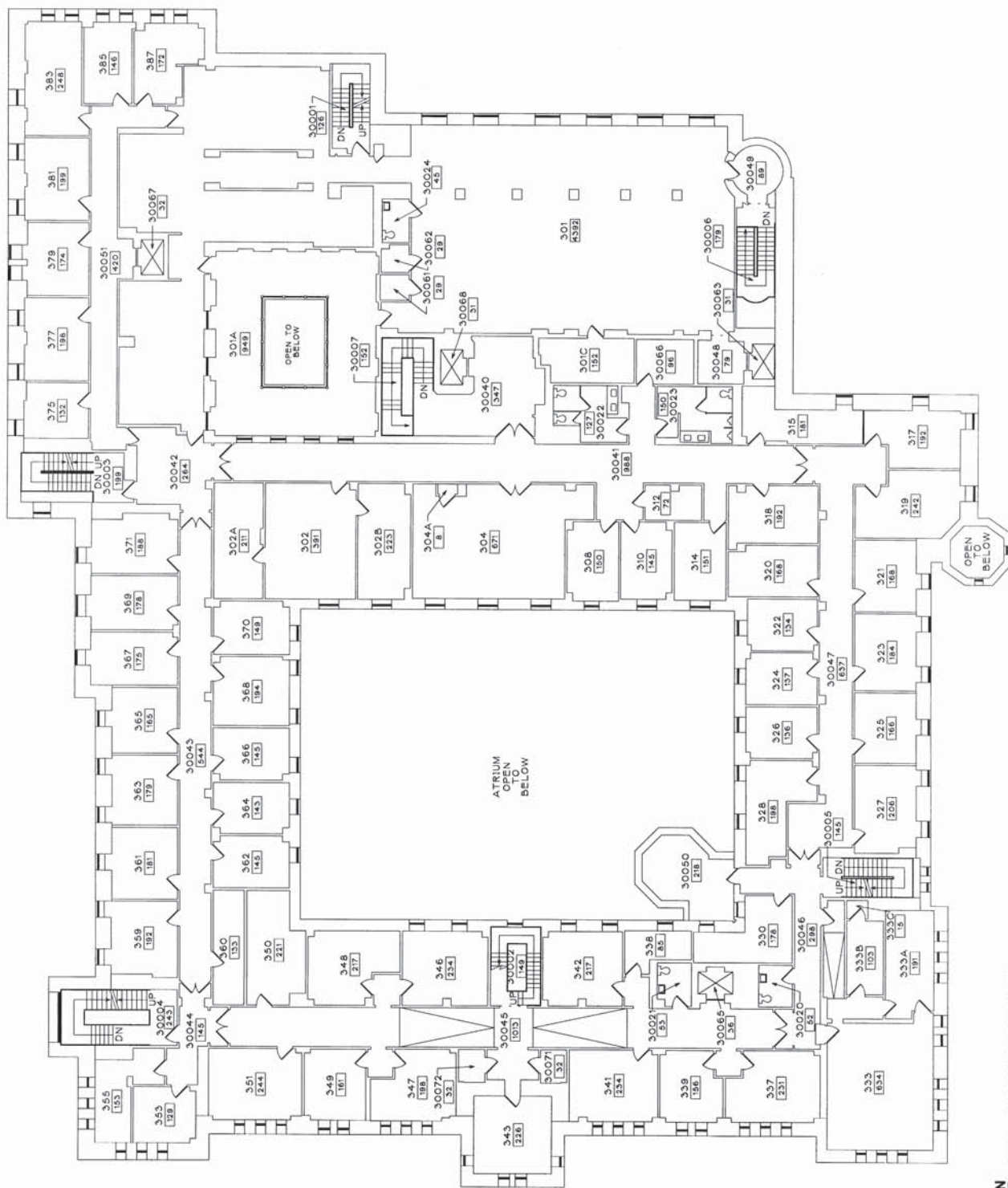
ID #:



**3002 - SECOND FLOOR PLAN**  
GROSS AREA = 30,631 SQ. FT.

	<b>CORNELL UNIVERSITY</b> FACILITIES INVENTORY JAN. 1992 (REV. 1/90)	<b>DRAWING DISCLAIMER</b> THESE DRAWINGS AND THE ASSOCIATED MATHEMATICAL FILES HAVE BEEN PRODUCED FOR THE PURPOSE OF SPACE INVENTORY. CAMPUS BUILDINGS FEATURES SHOWN ARE INCIDENTAL TO THIS PURPOSE AND DEPICT CONDITIONS AT THE TIME THE DRAWINGS WERE PRODUCED. THE DRAWINGS SHOULD NOT BE RELIED UPON FOR ANY OTHER PURPOSE.	REVISIONS: 0/00 EQ, 101 V01, 4/03 EQ, 3/08 EQ 12/01 EQ	DRAWN BY: <b>ERDMAN A.</b> CHECKED BY: <b>AGE</b>	DATE: 03/05/99	DRAWING NO: 3 OF 5	PLAN LEVEL: 2	BLDG. NAME: <b>SAGE HALL</b>	BLDG. NO: 3002
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ID #: \_\_\_\_\_



N  
3002 - THIRD FLOOR PLAN  
GROSS AREA = 23,191 SQ. FT.



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ITHACA, NY 14850

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REVISIONS: 01/01, 3/07 EQ  
SCALE:  
0 5 10 20  
1" = 1'-0"

DRAWN BY:  
ERDMAN A.  
CHECKED BY:  
AGE

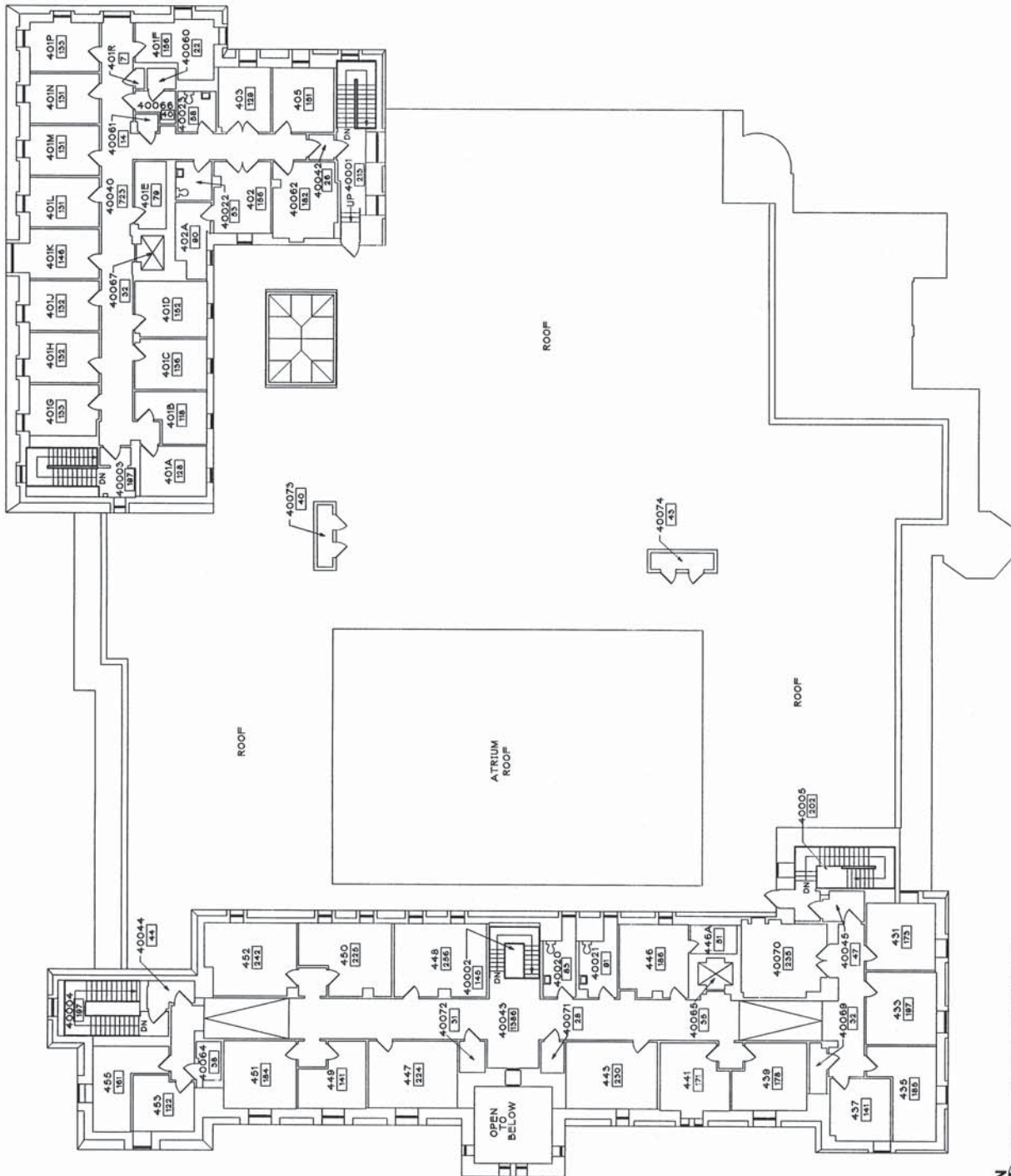
DRAWING NO.  
4 OF 5  
DATE:  
03/05/99

PLAN LEVEL:  
3  
TOTAL BLDG  
GROSS SQ. FT.


SEE SHEET 1

BLOG NO.  
3002  
SAGE HALL  
3002/3002.103

ID #: \_\_\_\_\_



**3002 - FOURTH FLOOR PLAN**  
GROSS AREA = 12,138 SQ. FT.

 <p><b>CORNELL UNIVERSITY</b> FACILITIES INVENTORY ANALYSIS SERVICES ITHACA, NY 14850</p>	<p>REVISIONS: 01/01, 1/09 EQ</p> <p>SCALE: 0 5 10 20 1" = 1'-0"</p>	<p>DRAWN BY: <b>ERDMAN A.</b></p> <p>CHECKED BY: <b>AGE</b></p>	<p>DRAWING NO: <b>5 OF 5</b></p> <p>DATE: <b>030599</b></p>	<p>PLAN LEVEL: <b>4</b></p> <p>TOTAL BLDG GROSS SQ. FT.: <b>SEE SHEET 1</b></p>	<p>BLDG NAME: <b>SAGE HALL</b></p> <p>BLDG NO: <b>3002</b></p>
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### 7.3 Appendix C: Pointed Questions

1. Describe the work/study environments, in general, where you find you are most productive. This can include work experiences, other collegiate experiences, and even homes, restaurants, coffee shops, community centers, etc.
2. Think of a memorable time you had while working/studying in Sage Hall. What about this experience made it memorable? Where did these events take place? What made this possible/facilitated the event?
3. Do you ever find yourself looking for a space in Sage Hall that you can't find? (e.g. Making a private phone call, studying in a particular way, having a lunch meeting, charging a laptop, etc.). Do you use other spaces on campus, in college town, downtown Ithaca, or home to meet these needs instead of Sage? If so, why?
4. What are words you use to describe the Johnson experience?
  - a. What do you think makes Johnson unique?
5. What do you think of the relationship (or differences) between Johnson and Sage Hall?

## 7.4 Appendix D: Complete ANOVA Tables



## ANOVA - Age

		Sum of Squares	df	Mean Square	F	Sig.
Visual privacy	Between Groups	1.400	2	.700	.505	.609
	Within Groups	37.400	27	1.385		
	Total	38.800	29			
Sound privacy	Between Groups	.113	2	.056	.036	.965
	Within Groups	42.588	27	1.577		
	Total	42.700	29			
Seclusion of space	Between Groups	.613	2	.306	.204	.817
	Within Groups	40.588	27	1.503		
	Total	41.200	29			
Comfort of furniture	Between Groups	3.517	2	1.758	2.904	.072
	Within Groups	16.350	27	.606		
	Total	19.867	29			
Crowding of surrounding space	Between Groups	2.179	2	1.090	1.388	.267
	Within Groups	21.188	27	.785		
	Total	23.367	29			
Noise level	Between Groups	.050	2	.025	.027	.974
	Within Groups	25.150	27	.931		
	Total	25.200	29			
Flexibility of furniture layout	Between Groups	4.129	2	2.065	1.698	.202
	Within Groups	32.838	27	1.216		
	Total	36.967	29			
Comfortable temperature	Between Groups	.267	2	.133	.265	.769
	Within Groups	13.600	27	.504		
	Total	13.867	29			
Access to electric plugs	Between Groups	2.113	2	1.056	1.413	.261
	Within Groups	20.188	27	.748		
	Total	22.300	29			
Access to technology	Between Groups	2.450	2	1.225	1.076	.355
	Within Groups	30.750	27	1.139		
	Total	33.200	29			
Access to desk/table	Between Groups	.717	2	.358	1.548	.231
	Within Groups	6.250	27	.231		
	Total	6.967	29			
Amount of work surface	Between Groups	1.267	2	.633	1.988	.156
	Within Groups	8.600	27	.319		
	Total	9.867	29			

Accommodations for a large group	Between Groups	5.863	2	2.931	3.174	.058
	Within Groups	24.938	27	.924		
	Total	30.800	29			
Access to black/white board	Between Groups	4.017	2	2.008	1.228	.309
	Within Groups	44.150	27	1.635		
	Total	48.167	29			
Access to food/water	Between Groups	1.379	2	.690	.589	.562
	Within Groups	31.588	27	1.170		
	Total	32.967	29			
Air quality	Between Groups	5.529	2	2.765	3.670	.039
	Within Groups	20.338	27	.753		
	Total	25.867	29			
Adequate light level	Between Groups	.467	2	.233	.741	.486
	Within Groups	8.500	27	.315		
	Total	8.967	29			
Access to natural light	Between Groups	.467	2	.233	.257	.775
	Within Groups	24.500	27	.907		
	Total	24.967	29			
Amount of group work space	Between Groups	.317	2	.158	.113	.894
	Within Groups	37.850	27	1.402		
	Total	38.167	29			
Quality of group work space	Between Groups	5.513	2	2.756	2.507	.100
	Within Groups	29.688	27	1.100		
	Total	35.200	29			
Variety of group work space	Between Groups	4.279	2	2.140	2.792	.079
	Within Groups	20.688	27	.766		
	Total	24.967	29			
Availability of group work space	Between Groups	.117	2	.058	.082	.922
	Within Groups	19.250	27	.713		
	Total	19.367	29			
Amount of individual work space	Between Groups	3.029	2	1.515	1.187	.320
	Within Groups	34.438	27	1.275		
	Total	37.467	29			
Quality of individual work space	Between Groups	5.617	2	2.808	2.381	.112
	Within Groups	31.850	27	1.180		
	Total	37.467	29			
Variety of individual work space	Between Groups	2.400	2	1.200	1.251	.302
	Within Groups	25.900	27	.959		
	Total	28.300	29			

Availability of individual work space	Between Groups	1.267	2	.633	.520	.600
	Within Groups	32.900	27	1.219		
	Total	34.167	29			
Amount of social space	Between Groups	.067	2	.033	.033	.967
	Within Groups	26.900	27	.996		
	Total	26.967	29			
Quality of social space	Between Groups	.067	2	.033	.035	.965
	Within Groups	25.400	27	.941		
	Total	25.467	29			
Variety of social space	Between Groups	.600	2	.300	.503	.610
	Within Groups	16.100	27	.596		
	Total	16.700	29			
Availability of social space	Between Groups	.579	2	.290	.183	.834
	Within Groups	42.788	27	1.585		
	Total	43.367	29			
Quality of classroom space	Between Groups	6.450	2	3.225	3.576	.042
	Within Groups	24.350	27	.902		
	Total	30.800	29			
Variety of classroom space	Between Groups	1.529	2	.765	.799	.460
	Within Groups	25.838	27	.957		
	Total	27.367	29			

## ANOVA - Study Size Preference

		Sum of Squares	df	Mean Square	F	Sig.
Visual privacy	Between Groups	4.763	2	2.381	1.889	.171
	Within Groups	34.038	27	1.261		
	Total	38.800	29			
Sound privacy	Between Groups	1.613	2	.806	.530	.595
	Within Groups	41.088	27	1.522		
	Total	42.700	29			
Seclusion of space	Between Groups	2.850	2	1.425	1.003	.380
	Within Groups	38.350	27	1.420		
	Total	41.200	29			
Comfort of furniture	Between Groups	.679	2	.340	.478	.625
	Within Groups	19.188	27	.711		
	Total	19.867	29			
Crowding of surrounding space	Between Groups	.529	2	.265	.313	.734
	Within Groups	22.838	27	.846		
	Total	23.367	29			
Noise level	Between Groups	2.600	2	1.300	1.553	.230
	Within Groups	22.600	27	.837		
	Total	25.200	29			
Flexibility of furniture layout	Between Groups	5.129	2	2.565	2.175	.133
	Within Groups	31.838	27	1.179		
	Total	36.967	29			
Comfortable temperature	Between Groups	1.429	2	.715	1.551	.230
	Within Groups	12.438	27	.461		
	Total	13.867	29			
Access to electric plugs	Between Groups	2.963	2	1.481	2.068	.146
	Within Groups	19.338	27	.716		
	Total	22.300	29			
Access to technology	Between Groups	3.763	2	1.881	1.725	.197
	Within Groups	29.438	27	1.090		
	Total	33.200	29			
Access to desk/table	Between Groups	.117	2	.058	.230	.796
	Within Groups	6.850	27	.254		
	Total	6.967	29			
Amount of work surface	Between Groups	1.079	2	.540	1.658	.209
	Within Groups	8.788	27	.325		
	Total	9.867	29			

Accommodations for a large group	Between Groups	8.550	2	4.275	5.188	.012
	Within Groups	22.250	27	.824		
	Total	30.800	29			
Access to black/white board	Between Groups	6.979	2	3.490	2.288	.121
	Within Groups	41.188	27	1.525		
	Total	48.167	29			
Access to food/water	Between Groups	4.617	2	2.308	2.198	.130
	Within Groups	28.350	27	1.050		
	Total	32.967	29			
Air quality	Between Groups	.267	2	.133	.141	.869
	Within Groups	25.600	27	.948		
	Total	25.867	29			
Adequate light level	Between Groups	.717	2	.358	1.173	.325
	Within Groups	8.250	27	.306		
	Total	8.967	29			
Access to natural light	Between Groups	1.117	2	.558	.632	.539
	Within Groups	23.850	27	.883		
	Total	24.967	29			
Amount of group work space	Between Groups	3.267	2	1.633	1.264	.299
	Within Groups	34.900	27	1.293		
	Total	38.167	29			
Quality of group work space	Between Groups	1.663	2	.831	.669	.520
	Within Groups	33.538	27	1.242		
	Total	35.200	29			
Variety of group work space	Between Groups	1.317	2	.658	.752	.481
	Within Groups	23.650	27	.876		
	Total	24.967	29			
Availability of group work space	Between Groups	.579	2	.290	.416	.664
	Within Groups	18.788	27	.696		
	Total	19.367	29			
Amount of individual work space	Between Groups	.867	2	.433	.320	.729
	Within Groups	36.600	27	1.356		
	Total	37.467	29			
Quality of individual work space	Between Groups	2.067	2	1.033	.788	.465
	Within Groups	35.400	27	1.311		
	Total	37.467	29			
Variety of individual work space	Between Groups	.763	2	.381	.374	.692
	Within Groups	27.538	27	1.020		
	Total	28.300	29			

Availability of individual work space	Between Groups	1.067	2	.533	.435	.652
	Within Groups	33.100	27	1.226		
	Total	34.167	29			
Amount of social space	Between Groups	.817	2	.408	.422	.660
	Within Groups	26.150	27	.969		
	Total	26.967	29			
Quality of social space	Between Groups	1.679	2	.840	.953	.398
	Within Groups	23.788	27	.881		
	Total	25.467	29			
Variety of social space	Between Groups	.200	2	.100	.164	.850
	Within Groups	16.500	27	.611		
	Total	16.700	29			
Availability of social space	Between Groups	1.267	2	.633	.406	.670
	Within Groups	42.100	27	1.559		
	Total	43.367	29			
Quality of classroom space	Between Groups	3.800	2	1.900	1.900	.169
	Within Groups	27.000	27	1.000		
	Total	30.800	29			
Variety of classroom space	Between Groups	5.429	2	2.715	3.341	.051
	Within Groups	21.938	27	.813		
	Total	27.367	29			

## 8. References

- Bechtel, R., Churchman, A., & McCoy, J. (2003). Work environments. *Handbook of environmental psychology* (pp. 443-460) John Wiley & Sons.
- Bennett, S. (2007). First questions for designing higher education learning spaces. *The Journal of Academic Librarianship*, 33(1), 14-26. doi:<http://dx.doi.org/10.1016/j.acalib.2006.08.015>
- Blincoe, J. M. (2008). *The age and condition of texas high schools as related to student academic achievement* ProQuest.
- Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. 1991 ASHE-ERIC higher education reports. ERIC.
- Bransford, J., Brown, A. L., Cocking, R. R., & National Research Council. (1999). *How people learn : Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.
- Brown, B., & O'Hara, K. (2003). Place as a practical concern of mobile workers. *Environment and Planning A*, 35(9), 1565-1588.
- Brown, M., & Lippincott, J. (2003). Learning spaces: More than meets the eye. *EDUCAUSE Quarterly*, 26(1), 14-17.
- Brown, M., & Long, P. (2006). Trends in learning space design. In D. Oblinger (Ed.), *Learning spaces* (pp. 9.1-9.11) Educause.
- CABE. (2002). *The value of good design: How buildings and spaces create economic and social Value*. London, UK: CABE Publications.

- Chism, N. (2006). Challenging traditional assumptions and rethinking learning spaces. *Learning spaces* (pp. 2.1-2.12) Educause.
- Chism, N., & Bickford, D. J. (2002). Improving the environment for learning: An expanded agenda. *New Directions for Teaching & Learning*, 2002(92), 91.
- Considine, D., Horton, J., & Moorman, G. (2009). Teaching and reading the millennial generation through media literacy. *Journal of Adolescent and Adult Literacy*, 52(6), 471-481.
- Cornell University, J. S. (2014). Compare our programs. Retrieved, 2014, Retrieved from <http://www.johnson.cornell.edu/Academic-Programs/Compare-Our-Programs.aspx>
- Deal, J., Altman, D., & Rogelberg, S. (2010). Millennials at work: What we know and what we need to do (if anything). *Journal of Business & Psychology*, 25(2), 191-199.  
doi:10.1007/s10869-010-9177-2
- Durán-Narucki, V. (2008). School building condition, school attendance, and academic achievement in new york city public schools: A mediation model. *Journal of Environmental Psychology*, 28(3), 278-286.
- Earthman, G. I. (2004). *Prioritization of 31 criteria for school building adequacy*. Baltimore, MD: American Civil Liberties Union Foundation of Maryland.
- Felix, E., & Brown, M. (2011). The case for a learning space performance rating system. *Journal of Learning Spaces*, 1(1)



- Flutter, J. (2006). 'This place could help you learn': Student participation in creating better school environments. *Educational Review*, 58(2), 183-193.  
doi:10.1080/00131910600584116
- Fulton, R. D. (1991). A conceptual model for understanding the physical attributes of learning environments. *New Directions for Adult and Continuing Education*, 1991(50), 13-22.
- Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2), 95-105.
- Gow, G. (1999). Shifts in the campus planning and development paradigm. Wellington, NZ.
- Green, D., & Turrell, P. (2005). School building investment and impact on pupil performance. *Facilities*, 23(5/6), 253-261.
- Gregory, R., & Thorley, L. (2013). In Thorley L., Gregory R. (Eds.), *Using group-based learning in higher education* Routledge.
- Grummon, P. (2008). Summary report of a survey of learning space design in higher education. *Society of College and University Planning*,
- Harvey, L., Moon, S., Geall, V., & Bower, R. (1997). *Graduates' work: Organisational change and students' attributes* Centre for Research into Quality Birmingham.
- Hill, M. C., & Epps, K. K. (2009). Does physical classroom environment affect student performance, student satisfaction, and student evaluation of teaching in the college environment? *Academy of Educational Leadership*, , 14(1) 15.

- Howe, N., & Strauss, W. (2000). *Millennials rising: The next great generation*. New York: Vantage.
- Hua, Y. (2010). A model of workplace environment satisfaction, collaboration experience, and perceived collaboration effectiveness: A survey instrument. *International Journal of Facility Management, 1*(2)
- Hua, Y., Loftness, V., Heerwagen, J. H., & Powell, K. M. (2011). Relationship between workplace spatial settings and occupant-perceived support for collaboration. *Environment and Behavior, 43*(6), 807-826.
- Jamieson, P., Dane, J., & Lippman, P. (2005). Moving beyond the classroom: Accommodating the changing pedagogy of higher education. *Refereed Forum Proceedings of the Australian Association for Institutional Research, 17-23*.
- Jamieson, P., Fisher, K., Gilding, T., Taylor, P. G., & Trevitt, A. (2000). Place and space in the design of new learning environments. *Higher Education Research and Development, 19*(2), 221-236.
- Jamieson, P. (2009). The serious matter of informal learning. *Planning for Higher Education, 37*(2), 18-25.
- Jensen, E. (2005). *Teaching with the brain in mind*. Alexandria, VA: Association for Supervision and Curriculum Development.

- Kowske, B., Rasch, R., & Wiley, J. (2010). Millennials' (lack of) attitude problem: An empirical examination of generational effects on work attitudes. *Journal of Business & Psychology*, 25(2), 265-279. doi:10.1007/s10869-010-9171-8
- Kumar, R., O'Malley, P. M., & Johnston, L. D. (2008). Association between physical environment of secondary schools and student problem behavior A national study, 2000-2003. *Environment and Behavior*, 40(4), 455-486.
- Kurkland, N. B., & Bailey, D. E. (1999). The advantages and challenges of working here, there anywhere, and anytime. *Organizational Dynamics*, 28(2), 53-68.  
doi:[http://dx.doi.org/10.1016/S0090-2616\(00\)80016-9](http://dx.doi.org/10.1016/S0090-2616(00)80016-9)
- Lee, N., & Tan, S. (2013). Traversing the design-language divide in the design and evaluation of physical learning environments: A trial of visual methods in focus groups. *Journal of Learning Spaces*, 2(2)
- Lippman, P. (2002). Practice theory, pedagogy, and the design of learning environments. *CAE Net Quarterly Newsletter*,
- Lippman, P. (2003). Advancing concepts about activity settings within learning environments. *CAE Net Quarterly Newsletter*,
- Maxwell, L. E. (2000). A safe and welcoming school: What students, teachers, and parents think. *Journal of Architectural and Planning Research*,
- Maxwell, L. E., & Schechtman, S. L. (2012). The role of objective and perceived school building quality in student academic outcomes and self-perception. *Children, Youth and*

- Environments*, 22(1, Reconceptualizing School Design: Learning Environments for Children and Youth), 23-51.
- McGlynn, A. (2005). Teaching millenials, our newest cultural cohort. *The Education Digest*, 71(4), 12-16.
- McLaughlin, P., & Faulkner, J. (2012). Flexible spaces... what students expect from university facilities. *Journal of Facilities Management*, 10(2), 140-149.
- McLaughlin, P., & Mills, A. (2008). Where shall the future student learn? student expectations of university facilities for teaching and learning. *Proceedings of the 17th Annual Teaching and Learning Forum*, 1-9.
- Monahan, T. (2000). Built pedagogies & technology practices: Designing for participatory learning. *Participatory Design Conference, Palo Alto, CA*,
- Oblinger, D. G. (2006). Space as a change agent. *Learning Spaces*, , 1.1-1.4.
- Pasalar, C. (2003). *The effects of spatial layouts on students' interactions in middle schools: Multiple case analysis*. (Unpublished North Carolina State University, Raleigh, NC.
- Price, I., Matzdorf, F., Smith, L., & Agahi, H. (2003). The impact of facilities on student choice of university. *Facilities*, 21(10), 212-222.
- Pullman, M. E., & Robson, S. K. A. (2007). Visual methods: Using photographs to capture customers' experience with design. *Cornell Hotel and Restaurant Administration Quarterly*, 48(2), 121-144. doi:10.1177/0010880407300410

Schneider, M. (2002). *Do school facilities affect academic outcomes?*. Washington, DC:

National Clearinghouse for Educational Facilities.

Scott-Webber, L., Strickland, A., & Ring Kapitula, L. (2013). Built environments impact behaviors: Results of an active learning post-occupancy evaluation. *Planning for Higher Education Journal*, 42(1)

Smola, K. W., & Sutton, C. D. (2002). Generational differences: Revisiting generational work values for the new millennium. *Journal of Organizational Behavior*, 23(4, Special Issue: Brave New Workplace: Organizational Behavior in the Electronic Age), 363-382.

Starkey, K., & Tempest, S. (2009). The winter of our discontent: The design challenge for business schools. *Academy of Management Learning & Education*, 8(4), 576-586.

Svinicki, M. D. (2010). Student learning: From teacher-directed to self-regulation. *New Directions for Teaching & Learning*, 2010(123), 73-83. doi:10.1002/tl.411

Temple, P. (2008). Learning spaces in higher education: An under-researched topic. *London Review of Education*, 6(3), 229-241. doi:10.1080/14748460802489363

Thorley, L., & Gregory, R. D. (1994). *Using group-based learning in higher education*. Psychology Press.

Uline, C., & Tschannen-Moran, M. (2008). The walls speak: The interplay of quality facilities, school climate, and student achievement. *Journal of Educational Administration*, 46(1), 55-73.

Vavoula, G. (2005). A study of mobile learning practices: Internal report of MoBIlearn project.

Waxman, L. (2006). The coffee shop: Social and physical factors influencing place attachment.

*Journal of Interior Design*, 31(3), 35-53.

Woolner, P., Clark, J., Hall, E., Tiplady, L., Thomas, U., & Wall, K. (2010). Pictures are

necessary but not sufficient: Using a range of visual methods to engage users about school design. *Learning Environments Research*, 13(1), 1-22.

Woolner, P., Hall, E., Higgins, S., McCaughey, C., & Wall, K. (2007). A sound foundation?

what we know about the impact of environments on learning and the implications for building schools for the future. *Oxford Review of Education*, 33(1), 47-70.

doi:10.1080/03054980601094693

Yang, Z., Becerik-Gerber, B., & Mino, L. (2013). A study on student perceptions of higher

education classrooms: Impact of classroom attributes on student satisfaction and performance. *Building and Environment*, 70(0), 171-188.

doi:<http://dx.doi.org/10.1016/j.buildenv.2013.08.030>

Young, E., Green, H., Roehrich-Patrick, L., Joseph, L., & Gibson, T. (2003). Do K-12 school

facilities affect education outcomes. *The Tennessee Advisory Commission on Intergovernmental Relations*,