Introduction

Providing sufficient space for instruction, study, and research is a key requirement for higher education institutions. Knowledge of the existing occupancy use of buildings and facilities is critical for future capital planning as well as optimization of ongoing operations. People counting can lead to lower operating costs by, for example, identifying under-used areas, accurate targeting of janitorial services, reducing energy consumption, and improving classroom scheduling.

Overview

Sensible Building Science (SBS) has developed a novel methodology using existing WiFi RTLS data to determine the building room occupancy at 5 minute intervals. The methodology includes visualization tools for estimating occupancy for rooms and zones for campus environments.
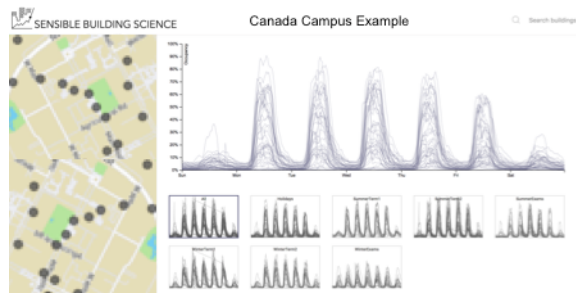

Figure 1: Average Weekly data (all campus buildings superimposed)

SBS conducted a case study for the 4-month period between January through April 2017 for a campus mixed-use classroom/office building. The spatial resolution of the SBS people counting technique allowed for an analysis of occupancy dynamics within a large 400 seat lecture theatre as well as zones across the entire building. This results show that the lecture hall is underutilized with occupancy levels often under 40%. With the lecture hall costing an estimated $41,300 to operate on an area basis, this underuse represents an opportunity cost $25K per year.

Case Study

A building use case study was performed on a four-story mixed-use university building (60,000ft2). The ground floor is occupied by a 400-person lecture theatre (5,000ft2), atrium, and café. The upper three stories consist of a combination of student and staff open office areas.

Whole Building Analysis

Analysis of the occupancy at a building scale can identify time-of-day variations in the building use profile. This data can inform the provision of services such as access, security, or energy. The average 6am-11pm occupancy profiles are shown in Figure 2.
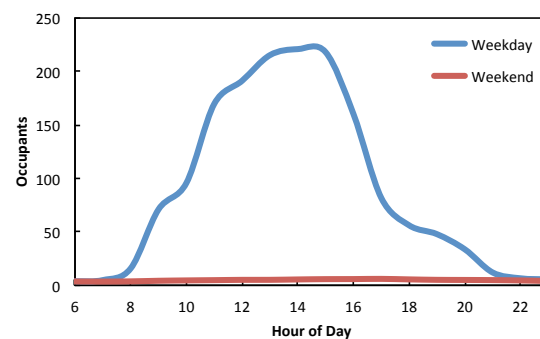

Figure 2: Average Weekday and Weekend Whole-Building Occupancy Profiles

The building occupants begin to arrive at 8am. Peak occupancy is not reached until 2-4pm. At the end of the day occupants leave at approximately 4pm with prolonged evening use until approximately 9pm. Weekend occupancy was found to be very low. These results mean that reduced energy provision and vacant building security strategies should be considered carefully for weekend days.

Lecture Theatre Use

Lecture theatre availability and use is a key concern for many advanced education buildings. These spaces are used for teaching large classes and providing public lectures. Lecture theatres are not flexible-use spaces and are rarely used for ad hoc gatherings. It is critical that lecture

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theatres be optimally used to avoid the construction of additional, unneeded spaces, which can be costly additions to a campus. One of the key parameters of determining if a space is efficiently utilized is the Room Frequency; defined as the number of hours the space is in use divided by the number of hours the space is available. The Room Frequency for the lecture theatre is shown in Figure 3.
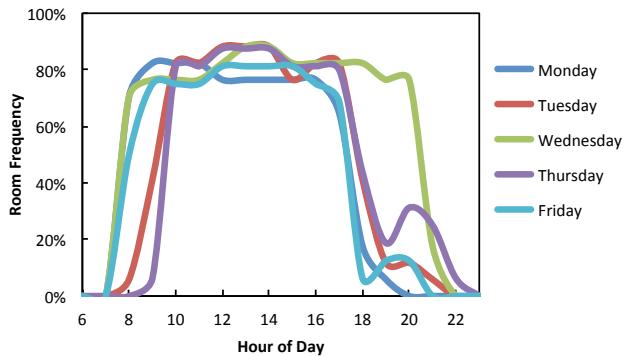

Figure 3: Frequency of lecture hall use throughout each weekday.

The lecture theatre is in use 80% of the time for much of the typical weekday. This means that for most of the time, there is at least a few occupants in the space (defined at 2% threshold of occupancy which is >8 people for a 400 seat lecture hall). The room is used much less frequently after 6pm with the exception of Wednesdays when a late lecture is scheduled that ends at 8pm. The cumulative daytime (8am to 5pm) Room Frequency for the term is 74% which drops to 46% in the evenings (5pm-8pm). This would indicate that the room is being used frequently during the daytime, with at least 8 people in the room.

In addition to the Room Frequency, the Room Occupancy is critical to determine if a room is being properly utilized. The Room Occupancy is defined as sum of all people in the space divided by the capacity and hours used. This indicates how often and how closely the room is being used to capacity. The results are shown in Figure 4. The Room Occupancy of the Lecture Theatre portrays a very different picture from the Room Frequency. The room is rarely used above

40% of capacity throughout the day. The maximum occupancy throughout the study period was 71%.
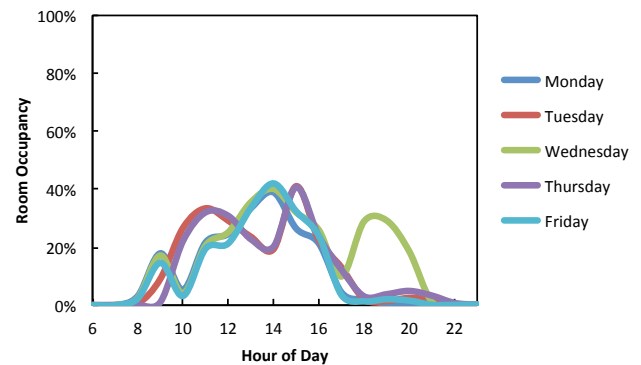

Figure 4: Average lecture theatre occupancy as a fraction of maximum capacity

The results show that the room is often in use *but is being under utilized when considering the capacity of the space.* College Auditoriums typically cost $7.18-9.21/ft^2 per year to operate (BOMA, 2014, Whitestone Research, 2014). If the lecture hall is only running at 40% of capacity then ~$25,000 per year is a lost opportunity.

Conclusion

High-resolution building occupancy data can provide insight into the intricacies of building operation that has not previously been available from standard occupancy survey methods. Occupancy profiles of the lecture theatre has shown that the space us being used approximately 80% of the available hours throughout the term but that it is typically not used to more than 40% of capacity meaning that resources are being wasted on empty seats. Potential exists for optimizing campus space utilization by scheduling larger classrooms in the lecture theatre.

Sensible Building Science Inc.

Sensible Building Science is a sustainable building technology start-up developing innovative technologies to integrate energy, utilization and occupancy dynamics for advanced building performance.

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