

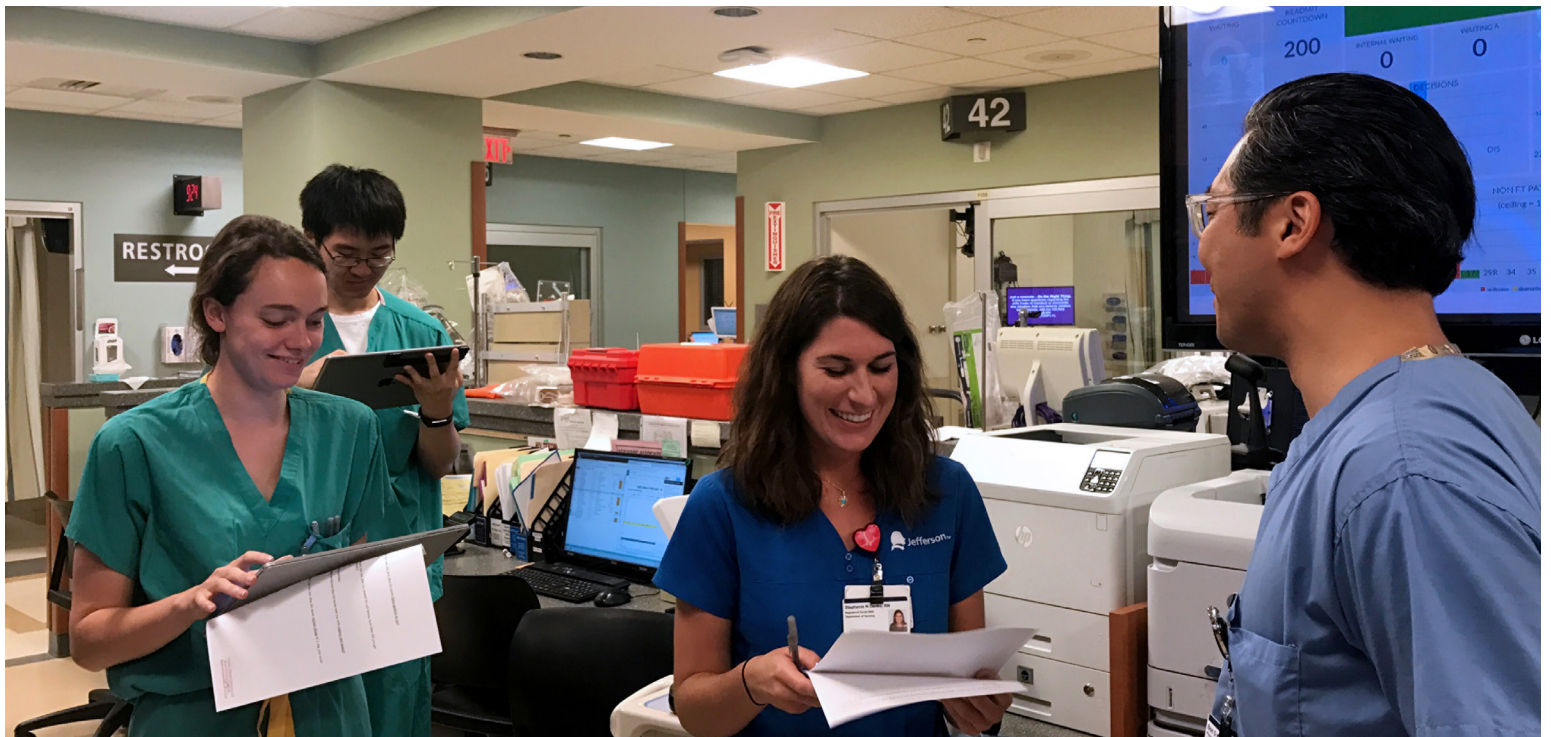


# Occupancy Mapping at Jefferson's Emergency Department

2016-17 REPORT

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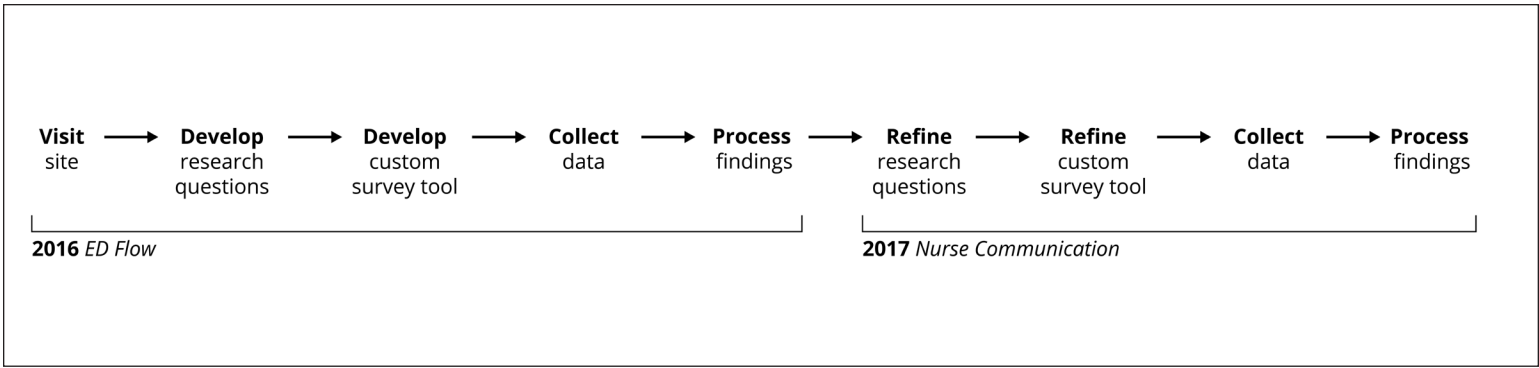
## INTRODUCTION

In an effort to quantify the relationship between quality of care and emergency department (ED) design, Kieran Timberlake collaborated with Thomas Jefferson University Hospital's JeffDESIGN in a two-year post-occupancy evaluation (POE) study. POEs are used to close the gap between building design objectives and actual performance, and have been embraced by researchers as a quantitative way of verifying the efficacy of design techniques, systems, and processes. Here, a holistic approach to POE was pursued, combining techniques such as occupant mapping, environmental monitoring, and satisfaction surveys to better understand the impacts that design strategies have on quality of care in the ED.

## MAPPING HOSPITAL ENVIRONMENTS

Working together with JeffDESIGN, we investigated how the environmental conditions of an urban emergency department impact both healthcare providers and their patients. The team equipped medical interns in a busy emergency department with a tablet-based tool. Custom surveys were created and executed during two eight-week study periods during the summer of 2016 and 2017.

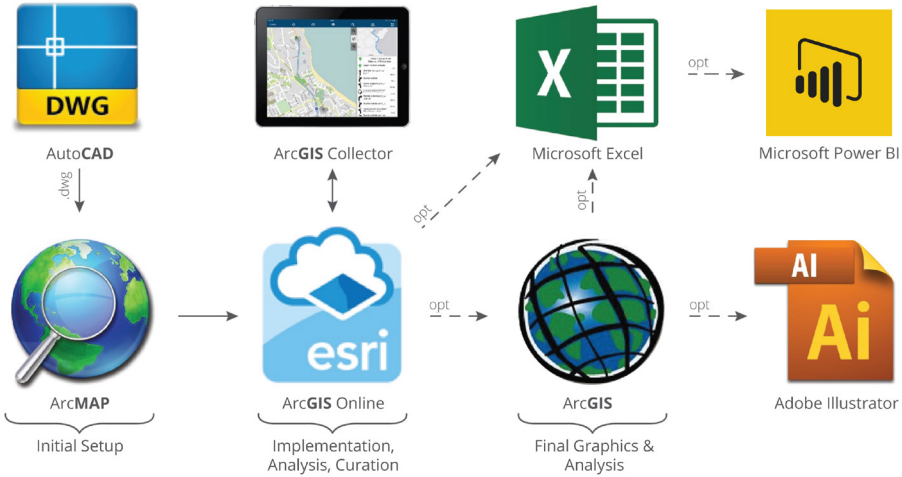
The 2016 study mapped occupant activity across the emergency department broadly and explored the experience of patients and doctors as they moved through the space. The 2017 study focused specifically on the daily experiences of nurses, evaluating the environmental variables that affect interactions between and amongst doctor-nurse teams. Central to both studies was an attempt to provide a workflow to document and describe the relationship between occupant behavior and their environment that would be accessible to occupants themselves. This project presented an opportunity to explore a tablet-based workflow for spatially explicit data collection and processing. In addition to tracking *what* and *when* things are happening in the ED, spatially explicit data focuses on *where* actions take place.



The focus of the two-year study was divided into 'ED Flow' and 'Nurse Communication' studies.

## MAPPING WORKFLOW

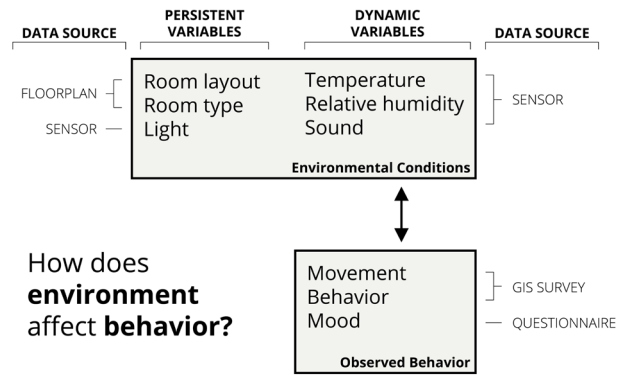
Using tablets equipped with sensors and a custom survey, the team developed a workflow that allowed for the collection of high-resolution, spatially explicit data that could be automatically uploaded to cloud-based storage. Using the ArcGIS suite, the team created a mapping tool with a georeferenced floorplan of the emergency department, allowing surveyors to track occupant movement and behavior, measure environmental conditions, take photographs, and add narrative information.



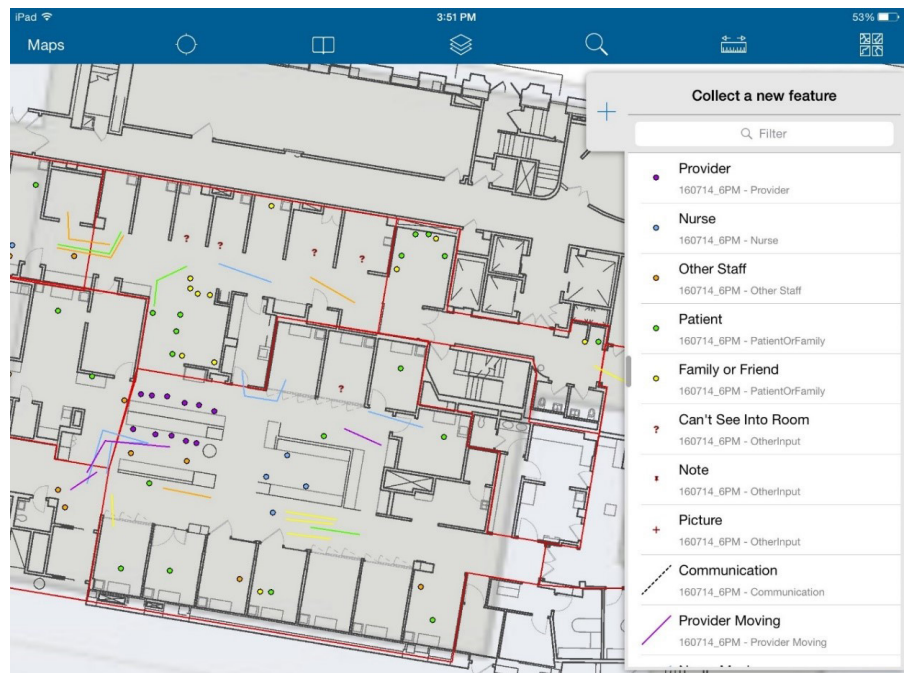
The digital workflow outlined here allowed surveyors to collect high-resolution, spatially explicit data that is automatically hosted on the cloud. The ability to store a variety of multimedia such as text, location, and photos in one platform allows for increased efficiency of data collection and processing.

# VARIABLES

Emergency departments like Jefferson's already collect large amounts of patient data including information like room occupancy levels and wait times, but they rarely capture data about people's movement and behavior in space. A goal in this study was to understand how spatially explicit data could supplement Jefferson's existing metrics.

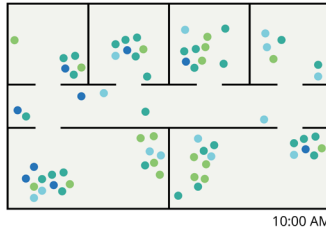


In an emergency department, environmental conditions like light, sound, and temperature are closely tied to the patient experience and were accordingly central to the study.<sup>1</sup> Additionally, to assess the effectiveness of the department's layout and design, we tracked nurses, doctors, and patients, observing their movement through space and tracking behaviors such as conversations, bathroom visits, specific tasks, and phone calls. The variables studied were broken into persistent conditions (i.e. those which do not change significantly over time) and dynamic conditions (i.e. those that fluctuate over time).



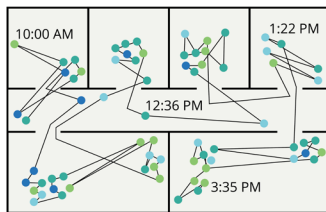
# SURVEY APPROACHES

To accurately capture the many environmental factors at play in a complex environment like an emergency department, we deployed three different survey approaches. Together, the following survey approaches help form a holistic understanding of the space.



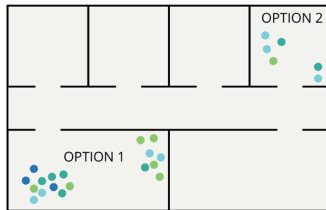
## Snapshot

Surveyor moves across the full emergency department, mapping individual zones as they go. All actors in the space are mapped in terms of location and activity, providing a snapshot of activity and environmental conditions.



## Shadow

Surveyor follows the movement and behavior of one person as they move throughout the space. This approach allows for a rich understanding of the different trajectories and experiences of patients, doctors, and nurses across the space.



## Comparison

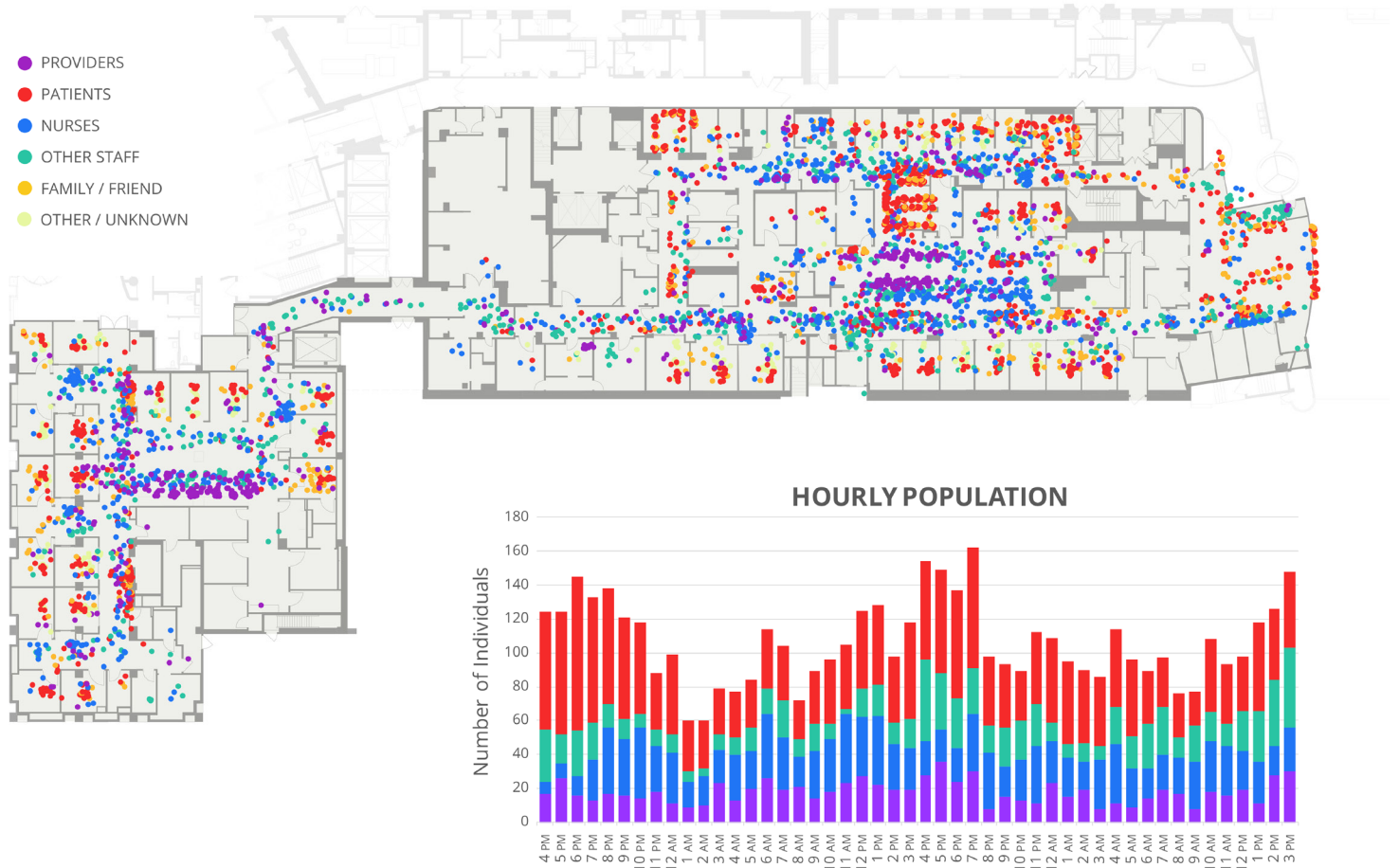
This approach allows one to draw quantitative comparisons between different spatial configurations. These comparisons can be drawn between different spaces or between different configurations of the same space over time (e.g. pre- vs. post-assessment).

# RESEARCH QUESTIONS

One of our main goals was to develop a workflow that empowers occupants such as building owners, students, and staff to conduct research on their own space. The flexibility of the workflow allowed the Jefferson team to ask questions specifically tailored to the challenges posed by their own environment. Below are some of the primary questions that motivated the study.

## QUESTION 1

# How does occupancy in the emergency department change over time?



\*Family, friend, and other not included in hourly population totals

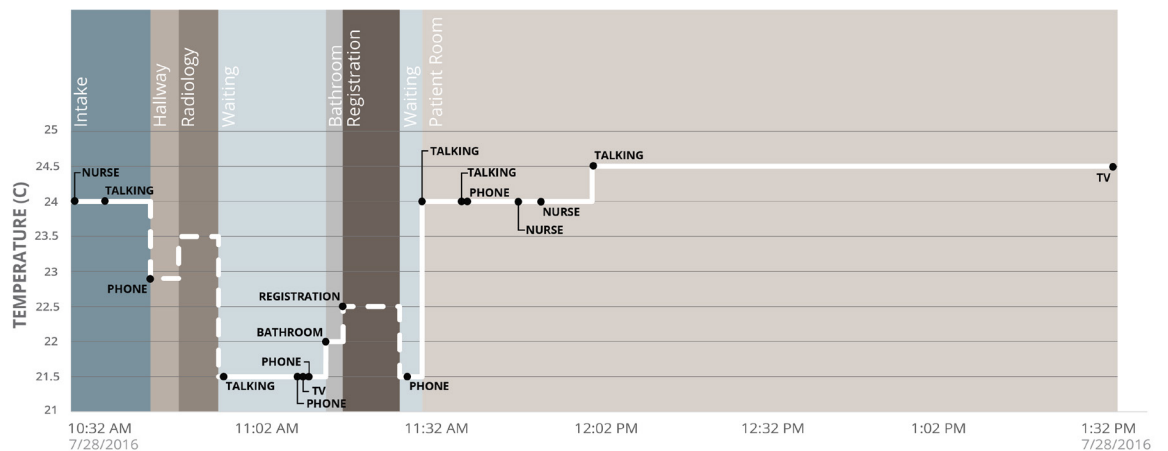
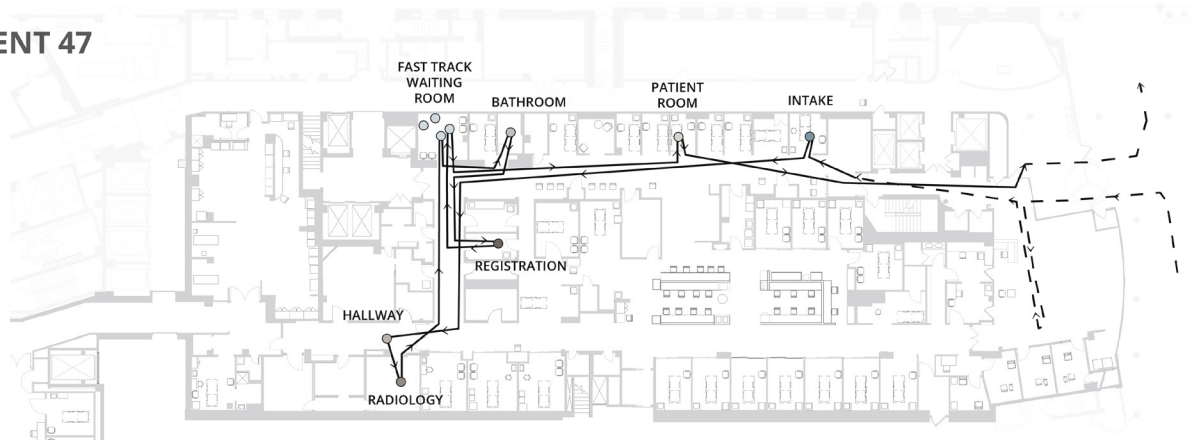
Gaining a global understanding of a space is difficult. Using the snapshot approach, we mapped the cumulative activity of the emergency department over a 48-hour period.

To visualize changes in occupancy over time, the team used the snapshot approach to map the location of occupants in the emergency department over a 48-hour period. This exercise allowed healthcare providers and hospital staff to gain a more holistic understanding of the ED and identify areas of congestion and opportunities for increased efficiency. Specifically, the study led to a rethinking of waiting room placement to reduce congestion and patient wait times.

## QUESTION 2

What can we learn about the relationship between environmental conditions and the quality of patient experience?

### PATIENT 47

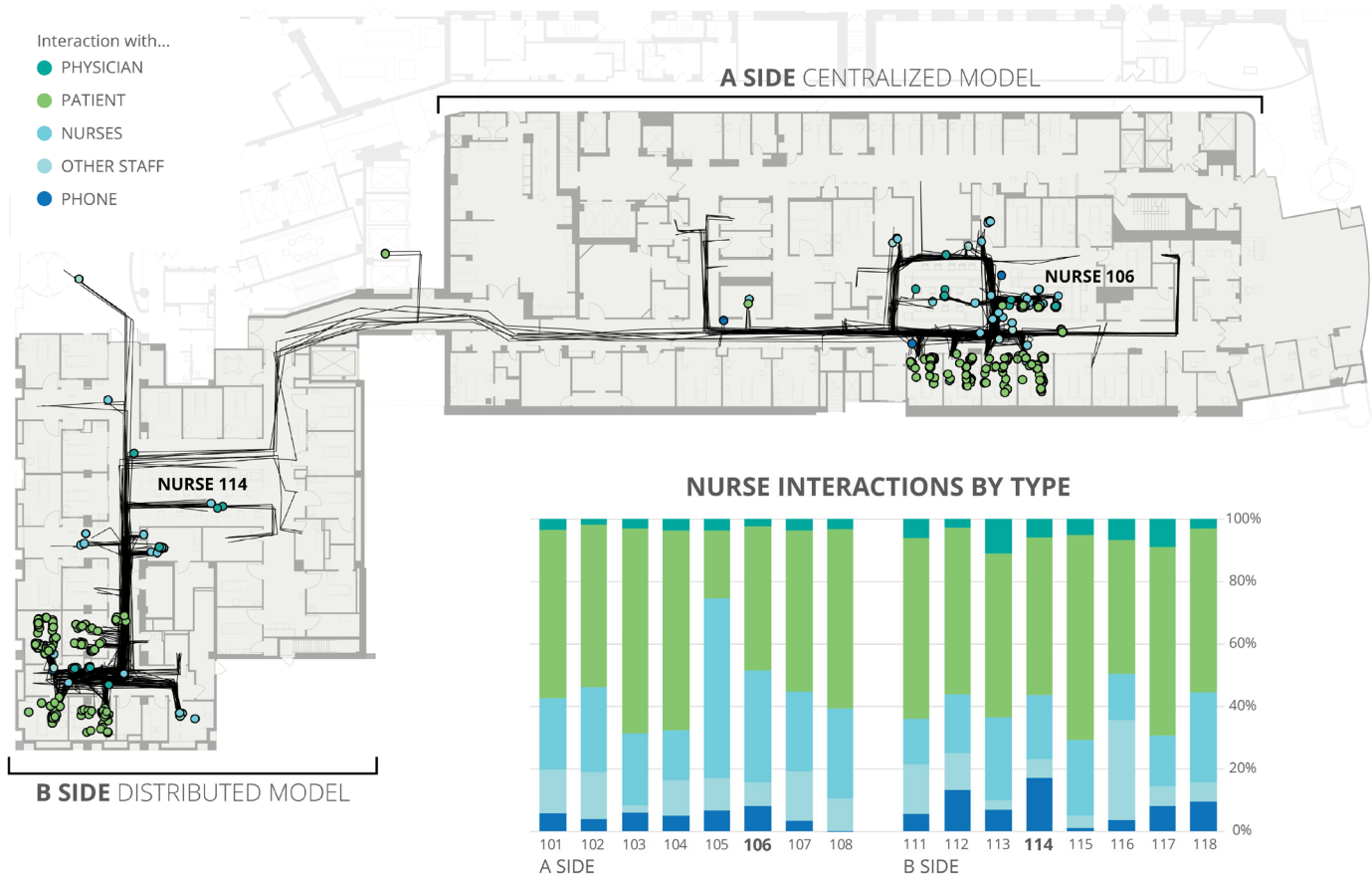


Surveyors also recorded the environmental conditions of a patient's stay by shadowing them as they moved from room to room, comparing variables like sound and light level to provide a more holistic understanding of the patient experience.

Shadowing a patient directly allows for a rich understanding of their experience over time. When coupled with sensor data, this information can reveal high variability in environmental conditions. Since patients often have treatment-specific requirements that demand a carefully tuned environment, variability should not be considered inherently problematic. Providers understand, for example, that trauma patients benefit from quiet environments during healing.<sup>2</sup> This study revealed spaces in the emergency department that are quieter than others, suggesting potential design improvements for better patient placement.

### QUESTION 3

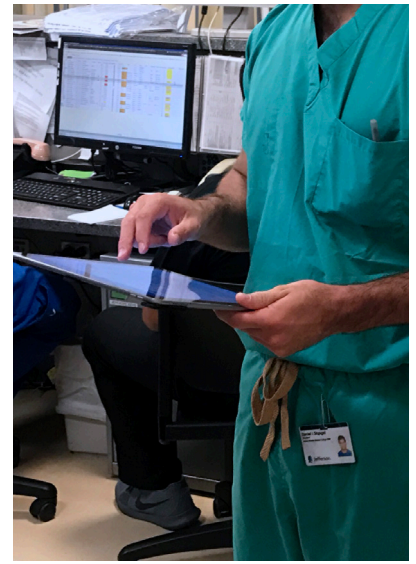
## How do different spatial layouts affect collaboration and communication?



Nurse paths vary greatly between nurses on both sides. Despite concerns that the B-side would result in less communication, observations showed that this model resulted in increased communication with doctors.

With a pair of distinctly organized department wings, Jefferson's Emergency Department provided an ideal backdrop for understanding how different spatial layouts can affect communication. The A-side's centralized layout concentrates a cluster of nurses and doctors in a workstation surrounded by patient rooms, whereas the B-side's decentralized layout and individual nurse stations distances the nurses from other hospital staff in order to situate them closer to patient rooms. Many nurses and doctors voiced strong opinions about which layout they prefer and how it affects their movement and communication with team-members. Perhaps counterintuitively, our study revealed that on average the B-side's decentralized layout led to increased communication and contact time between doctors and nurses despite the greater distance between their workstations. While this comparative study focused on different existing spatial layouts in the emergency department, a similar method could be used to study the effects of design interventions before and after renovations.





## NEXT STEPS

This experiment has led to a deeper and ongoing analysis of other variables that affect movement and experiences in the emergency department, from the composition of a nurse's care team to the condition of the patient being treated. As is often the case, quantitative analysis doesn't tell the full story, but it can help the managers and designers of complex environments like a hospital emergency department unearth patterns and possibilities to foster more comfortable, productive, and empathetic spaces.

While this study focused specifically on a healthcare environment, the workflow could be applied to any type of space. The customizable mapping tool can be adapted to ask and answer site-specific research questions. This project continues to evolve as we explore the means and methods by which we can observe individuals moving through space, collect and catalogue their behavior, and make meaningful conclusions about the patterns that emerge.

1. E.R.C.M. Huisman, E. Morales, J. van Hoof, H.S.M. Kort, "Healing environment: A review of the impact of physical environmental factors on users." *Building and Environment* (58) (2012): 70-80. doi:10.1016/j.buildenv.2012.06.016.
2. Darbyshire JL, Young JD. "An investigation of sound levels on intensive care units with reference to the WHO guidelines." *Critical Care* 17(5) (2013): R187. doi:10.1186/cc12870.