GREG NIEMEYER

Waves of Data

Illuminating pathways with San Leandro Lights

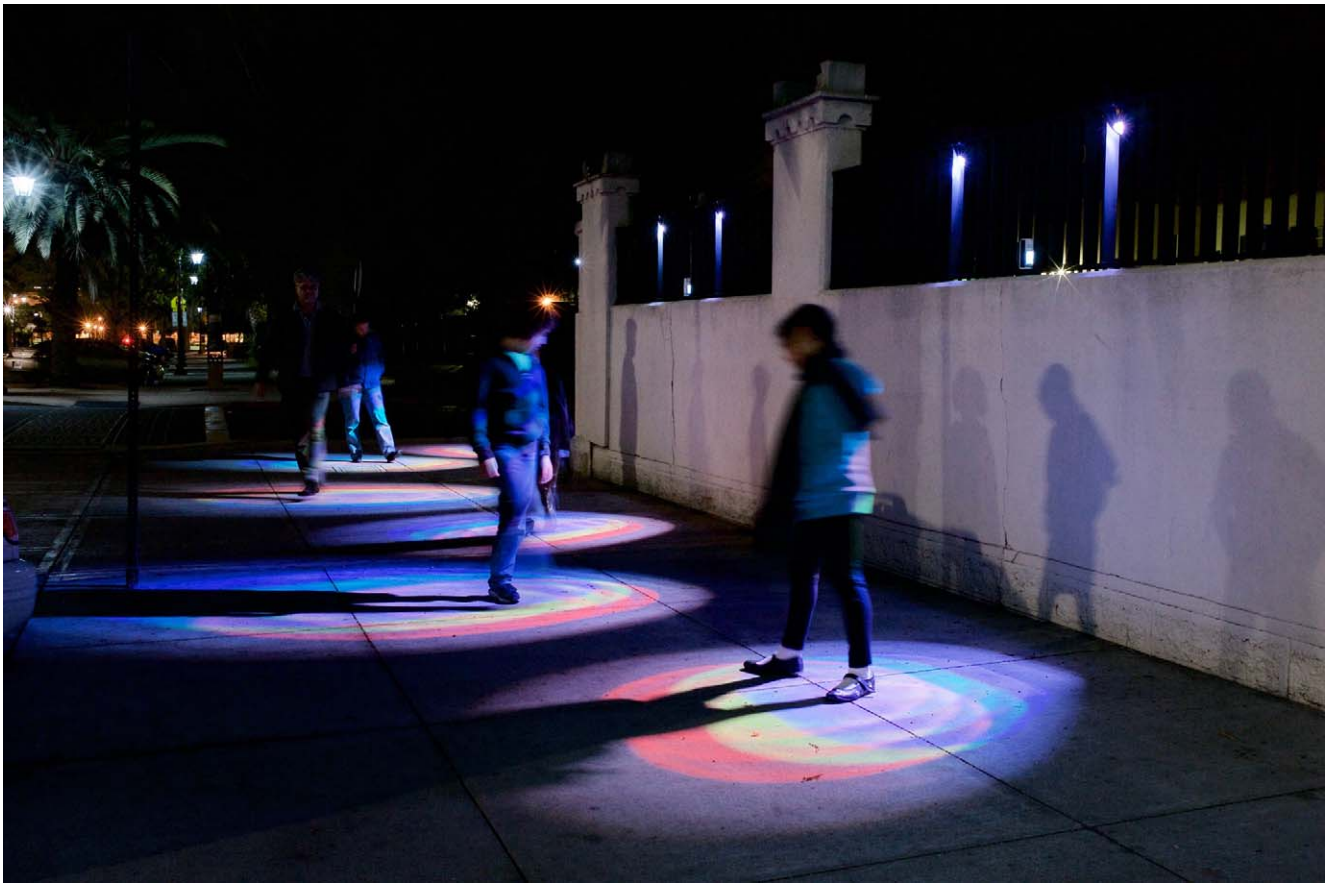
On 20 May 2014, Brittney Silva, a student nearing graduation from San Leandro High School, was walking along the train tracks to her home and talking on the phone. She was using her earbuds and did not hear an Amtrak train approach. She was fatally struck, and her body was retrieved fifty yards from the impact site.

That same week, I met with San Leandro's Chief Innovation Officer, Debbie Acosta, to discuss opportunities for collaboration between the city and University of California, Berkeley. With the tragedy of Brittney Silva's death fresh in everyone's memory, Acosta urged me to do something to make the city safer for pedestrians. When I asked, "How many people walk in San Leandro?" Acosta replied, "We can tell you how much water we use, we can tell you how many cars are waiting at red lights, we can tell you how many streetlights are on, but we have no idea how many people walk where or when."

That conversation inspired a course I developed with my UC Berkeley colleague Ronald Rael that we called Sensing Cityscapes. In that course, which we offered in fall 2015, we aimed to collect data about human activities that are too often ignored. As part of the interdisciplinary UC Berkeley Global Urban Humanities Initiative, we aimed to harness methods not just from city planning, engineering, and architecture (Ron's field), but from the humanistic disciplines, cognitive science, and art (my territory). Our students came from departments ranging from archaeology to public health to performance studies.

We noted that the growing smart cities movement, which aims to use data and tools including urban sensors to improve the provision of urban services, tends to track machines more than people. In our observation, smart city research is full of asymmetries: Cell phone data is used for traffic studies, but not for pedestrians. Health tracker data is held by individuals, but not aggregated at a community level. Streets are lit for cars, but not for pedestrians. We seemed to know more about what shows

BOOM: The Journal of California, Vol. 6, Number 3, pps 80–83, ISSN 2153-8018, electronic ISSN 2153-764X.
 DOI: 10.1525/boom.2016.6.3.80.



Photograph by Greg Niemeyer.

residents watched on Netflix (in San Leandro, *Game of Thrones* is most-watched) than about how they got home every day. Many residents, just like some of us researchers, seem to know more about the politics of the fictional city of Meereen than about their own city.

To address such asymmetries, we taught students in the graduate course to collect their own data, to build basic sensing, logging, and data visualization tools. We demonstrated responsible practices in data collection and explored the manipulative potential and relative power of those who hold the data over those whom the data describes. But most importantly, we taught our students to work in the city with a hypothesis-free approach in which the creative response of the artist is as important as the rational assessment of an established hypothesis. This approach often is described as discovery-based science.

We first asked students to quantify aspects of their own home life so they would understand the impact of data on a community including themselves. Then, we asked our students to consider the city of San Leandro as a larger home, to be treated with the same care as their own homes.

Like impressionist artists in *plein-air* mode, we all visited the city in small teams, without maps and without hypotheses. The walking experiences led to many observations about the city, which converged on pedestrian safety. After a few more need-finding interviews with city staff, we confirmed that the city had a strong interest in pedestrian data, and we studied how best to count people in the urban wild. We learned to train passive infrared sensors on pedestrians to capture their movements but not their identities. We also understood the importance of showing pedestrians that their presence counts by displaying feedback data. Any data about people should be shared with the people the data is about in real time. All projects used lights to communicate statistics to pedestrians about their walking, thereby completing a feedback loop of input, output, and change. We considered hiding or camouflaging the sensors to protect against vandalism, but we ultimately rejected such ideas

because we wanted to make it possible for pedestrians to choose if they were counted or not.

Our students deployed four temporary interactive lighting systems in San Leandro. After several lab prototypes, our students were ready to take on real-world challenges including unreliable power and connectivity that often compromise the magic of the Internet of Things (IoT).

Other challenges included weather and vandalism; but in the end, each team was able to light a critical pedestrian passage in a novel, interactive way and measure the number, direction, and speed of pedestrians in real time without exposing the identities of the pedestrians.

One compelling lesson was that pedestrians interpreted visible machines at head height as "unwelcome government intrusions." At the waist level, pedestrians interpreted the very same machines as "cute." Collected data showed clear rush-hour patterns including a peak between 8:00 AM to 9:00 AM, a peak between 2:00 PM to 3:00 PM (when school gets out), and 5:00 PM to 6:00 PM when commuters return. While this is not surprising, it also seems possible to leverage that data for specific campaigns and urban improvement initiatives. Perhaps the high school marching band could rehearse near commuter hubs between 5:00 PM and 6:00 PM to give the city a musical boost. The lights themselves may also expand pedestrian activity past sunset.

Collectively, the students' fieldwork confirmed that pedestrians were the most vulnerable participants in the urban metabolism, and they were also the least visible. Interviews with pedestrians showed that they felt acknowledged by the interactive lights after dark. Streets were built for cars, but sidewalks were dark and narrow afterthoughts. Walking was an event at the very periphery of an urban culture that focused on speed. Even a small LED light, well-timed, helped pedestrians experience a different city, a place where they could overcome fear and isolation, just like at home.

This field work and a subsequent mini-conference prompted more research. Comparing the various student projects, Pablo Paredes, a teaching assistant in the Sensing Cityscapes course, and I wondered what kind of lighting design might drive pedestrian activity more than generic lighting. We teamed up to study the psychological impacts of various types of responsive lighting. To reduce confounding factors such as external or personal circumstances, we moved the project to a windowless hallway in our research building (the Center for Information Technology Research in the Interest of Society, or CITRIS).

Our setup included up to sixteen colorful LED spotlights illuminating a sixty-foot-long dark hallway path. As test-subject pedestrians walked down this path, sensors picked up their speeds and positions, and a computer controlled the lights and colors as a function of these inputs. With this setup, we could ask how the effect was influenced by the chromatic, temporal, and spatial design of the lights. Which would impact the pedestrians most positively? Having all the lights on? Having selected lights directly before, directly at, or directly behind the pedestrian?

After testing ten lighting regimes with over a hundred participants walking down a dark hallway, we found that a path well-lit ten feet ahead of a pedestrian had a significantly better impact with significantly less energy use than a path that was fully lit or any other regime.

In the resulting research paper, we argued that the positive effect occurred because pedestrians felt acknowledged by the interactive and anticipatory lighting. They felt more in charge of the path and their experience and self-determined their role as an agent with authority who could control the streetlights. Technologically empowered pedestrians, turning lights on ahead and off again through their movement, felt safer, walked with a steadier gait, and had more positive, less lonely walking experiences. We left the system on in a public hallway and learned that several building users made detours just to walk though the lights for a positive experience during the workday. "It's like walking on a carpet of light," said one user.

We now are bringing the installation back to the streets of San Leandro with the support of a National Endowment for the Arts (NEA) Our Town grant for a project called San Leandro Lights. The grant funds the permanent installation of responsive IOT lighting in one or more passages in the city that are not currently lit or are lit only by blinding sodium floodlights. Taking our project back to the street, we can build on the validated lighting design tested in the lab, but we have to consider many additional design factors, including greater range of inputs (consider distinguishing a person in a wheelchair from a person using a motorbike), theft-proofing, and easy maintenance.

We will assess the circulation frequency of pedestrians before and after the deployment of the lights to study if lighting alone can increase pedestrian circulation. At the same time, we hope the circulation data will give residents and city

Photograph by Greg Niemeyer.

officials insights into pedestrian patterns that may help optimize city policies ranging from regulation of store hours to streetlight timing. Other initiatives such as Bike-and-Walk-to-Work day can be validated with the sensor data as well.

Transferring the project from the lab back to the street, we hope that the positive effect for individuals we observed in the lab will remain, and that responsive lighting will create a dynamic culture of attention.

A tragic moment of misplaced attention ended the life of Brittney Silva. Her memory urges us to ask if we are paying attention to the right things. We should ask that question frequently. The answer changes in the course of a second, a week, a season, and a lifetime. It changes for us individually, as our needs change, and it changes collectively, as the conditions within which we live change. From oncoming traffic to climate change, changing situations should cause us and the cities in which we live to refocus attentions continuously, like a camera in autofocus mode. Yet many aspects of our individual and collective lives are regulated by convention, not by curiosity. The art element in our project enables us to reframe our focus continuously, because we approach our environments in fundamentally creative ways.

We see the potential of the San Leandro Lights project both in the practical and in the metaphorical. The lights yield the direct benefit of illumination, energy savings, and pedestrian circulation data. Metaphorically, the Lights tell a story about how every step we take has consequences beyond our intentions. Every step, just like the butterfly wings in chaos theory, impacts our environment, and our environment modulates every step we take in creative response. Just as the colors of the sidewalk change when anyone walks by, so does the meaning of what we do, in the context of an ever-evolving city.

Every study has a beginning and an ending. The San Leandro Lights began with the tragic end of Brittney Silva's life. Unlike most studies, the ending of this study takes us to a modified cityscape in which sidewalks, in creative response, bring people home in a different glow every day. **B**