Different from many other infrastructures like the electrical grid or data networks, lighting systems have a noticeable impact on what spaces convey to people on an informational and a visceral level. With the proliferation of LED-based functional illumination, ambient effect lighting and display systems, more and more points of light can be recruited into responsive networks that visibly transform people’s experience of the city. These systems’ inherent programmability enables links between data collected about the city’s metabolism like traffic, weather, or people’s movements to drive different settings for lighting behaviours. The more real-time data is used to initiate changes the tighter the feedback loops between urban data and public spaces becomes. A simple example of negative feedback in a real-time traffic management system might be a sudden red light at an intersection. Other lighting effects might be more subtle and ambient like the weather vanes on the tops of skyscrapers. The less defined and more open-ended the relationship between collected data and corresponding lighting behaviour the more other forces play a role. Economic, socio-political and cultural processes become central to regulating the meaning of a responsive or interactive system. This essay reports some reflections from the field on one attempt — LightBridge — to link people’s movement patterns to a direct-view installation that blurs the boundary between media facade and lighting infrastructure.

The Characteristics of Urban Lighting Infrastructure

Light is an enabler. It allows people to use city environments at night which would otherwise be inaccessible. Without the sun or the moon, citizens are dependent on artificial sources to extend human activity into the night. Geographers like Melbin (1987) aptly characterize this fact in territorial terms as a kind of “colonization”. Insofar as light is regulated according to data collected about the city, public spaces become a function of those data via our lighting infrastructures.

However, the colonisation of night time is neither even nor is the distribution of illumination equal across the entire city (Otter 2008). The regions of better (or worse) lit spaces reflect the forces at work in
a particular city that find their outward expression in particular illumination choices. Interestingly, these night time interventions are also spilling into daytime as an increasing number of systems remain switched on 24-hours a day. (Amengaud 2008)

Whether by day or by night then, the distribution of light impacts a person’s ability to generate a reading of the city at the individual scale and at the global scale. In transforming lighting conditions, the impact of any changes on the “image of the city” (Lynch 1960, 1972) should play a central role. Not only perceptual factors (Lam 1965, Schielke 2005), but also cultural and social ones can influence how any changes are choreographed.

Building a Responsive Infrastructure

When dynamic effects are clearly linked to people’s presence or absence the role of lighting infrastructure also changes. Rather than fading into the background, dynamic lighting continually impacts the perceptual affordances of people’s surroundings. These cycles of change may be linked to real-time data which by itself does not deliver the qualitative settings for triggering particular lighting conditions. The many dimensions of illumination — physiological, emotional, cultural and socio-political — require city builders to be particularly sensitive and strategic in their implementation of new infrastructures.

Technical and popular literature have promulgated the notion of an ever-present infrastructure of sensing and monitoring for controls for decades. For urban spaces, this vision has been translated into a mapping of real-time data flows that reflect the metabolism of the city. In building responsive infrastructures the question arises how these data can be used to control systems to create fine-grained urban design interventions.

If someone’s presence on a city street is detected we can readily imagine a simple control loop that triggers three street-lights ahead of her. As soon as more people are in the street with crisscrossing paths the question of which light to turn on when becomes more complex. The degree and rate of change in the infrastructure needs to be linked to the impact lighting has on the perceptual awareness for the city. Exploring rates of change is essential both to exploiting the potential of programmable systems and to creating comfortable, safe environments for citizens. Interactive systems present even greater challenges because there are so many possibilities for structuring the relationship between users and their environment.

LightBridge

By combining sensors and programmable lighting, LightBridge illustrates the potential for user-driven urban screens and new configurations of low-resolution displays. An urban screen differs fundamentally from its small counterparts on our desktops in that its sheer size, unbounded nature and visual impact transform the city
skyline. Because of its scale, LightBridge is considered a lighting infrastructure in this discussion to break out of the dominant image of urban illumination as light poles.

In celebration of the MIT 150th anniversary, LightBridge animated the railing of the Harvard Bridge. The bridge between the cities of Boston and Cambridge presents a symbolic link between MIT’s first campus in the Back Bay (1861) and the riverfront campus on the Charles (1916). As a result, the railing on the eastern side of the bridge provided the ideal location for a dynamic display that reflects MIT’s historical and contemporary connections between people and places on both sides of the river. LightBridge consisted of a 9,600-pixel display activated by 400 proximity sensors that are triggered by the movement and activities of viewers in the area.

The interactive and responsive goals for LightBridge were two-fold. On the one hand we imagined a simple presence on the bridge. An element in the environment that signals a reflection of the city’s activity with the urbanistic goal of enlivening the Charles River waterfront. On the other hand we wanted to provide pedestrians with an experience on their walks back and forth between Cambridge and Boston. These goals led to our design criteria which included a 360-degree visible display, a focus on pedestrians (as opposed to passing vehicles or other data) and a low-resolution display with texture.

Reflections

Collecting the appropriate data at the right resolution to support interactive installations presents a challenge. LightBridge required an additional network of 400 proximity sensors approximately every four feet to glean the patterns of motion across the bridge. When working at a large scale outdoors the deployment of these additional sensors is no trivial matter. The ever-recurring discussion of city governments around repair and maintenance of public infrastructures is an essential element of any responsive and interactive system. Almost all media facades promise open access and ease of programmability, but those capabilities are rarely exploited or supported over a long period of time. Simple maintenance questions like water ingress and power are challenging enough. Acknowledging these barriers, however, does not detract from the magic of media facades or the aspiration for transformable responsive environments. In fact, confronting the material difficulties involved in creating installations ground the discussions of ubiquitous computing and responsive environments.

LightBridge was centrally controlled in that the aggregated sensor data were used to derive lighting effects for the entire bridge. We could have also subdivided the bridge into segments and only enabled localized interactions or some combination of the two approaches. Changes in lighting patterns were driven by aesthetic and interaction design principles (as well as some concerns for roadway safety keeping the transitions on the bridge relatively gentle). Different factors can be used as criteria for change in an
infrastructure, but these criteria — like the infrastructures — may not be readily available (Amengaud 2008).

How much and whether these rules are exposed is a fundamental question the operators of infrastructures must consider. In an artistic intervention the rules are linked to an artist’s vision. Not all lighting installations are linked to individual interaction they need to be more generally controlled based on the season, time of day and of course real-time data. Predictive models based upon these collected data will play an ever increasing role in controlling more complex assemblages of infrastructure.

With most outdoor lighting infrastructures, safety considerations and energy management goals dominate the conversation. The more fine-grained the potential for control and responsiveness becomes, however, the more context and use play a role. Safety can no longer be equated with the mere presence or absence of light. Rather questions like rate of change as described above become central. The more LED lighting coupled with computer-based, real-time controls enable fine-grained transformations of the visual environment the more these relationships must be designed and choreographed.

People are always in a dialogue with their surroundings only nowadays their influence extends to the dynamic and otherwise hidden aspects of the environment. LightBridge illustrates just how messy and piece-meal the trend towards responsiveness can be in the real world. We are far from a holistically responsive lighting environment outdoors at night. This article seeks to recall the challenges in creating dynamic environments that contribute to cityscapes. Simple problems such as usable and reliable sensor data or fresh content to maintain relevance and interest. Through the messiness and the grittiness involved in building infrastructures in real places these issues must be solved creating a wealth of knowledge form the field to be shared and exchanged across places and among different communities. All stakeholders involved in city-building thus become engaged in a debate around appropriate dynamic lighting that should allow for new and unexpected public spaces to emerge.

References


THEATRUM MUNDI


Acknowledgments

Susanne Seitinger created LightBridge with Pol Pla (MIT Media Lab) for the MIT 150th Anniversary Festival of Art Science and Technology (FAST). The software was developed by Andrew Chen, Russell Cohen, Dave Lawrence, Daniel Taub, Eugene Sun and David Xiao. Countless volunteers assisted in mounting the installation. Philips Color Kinetics was the primary sponsor of the project donating time, funding and hardware to the project. CISCO, SparkFun Electronics, Panasonic and the MIT Council for the Arts contributed significant donations to the project. The project would never have been possible without the unwavering support of the MIT 150th Anniversary Committee and FAST Festival Organizers.