Dynamic Physical Architecture:
An Informative Socially Responsive Environment

Winslow Burleson
MIT Media Lab
Cambridge, MA 02142
win@media.mit.edu

Beatrice Witzgall
Schwanthalerstrasse 12
60594 Frankfurt, Germany
beatrice@in3Design.com

Abstract

This investigation explores the potential of "informative responsive environments", spaces that reconfigure themselves responding to their occupant's activity. Strategies illustrate how information can augment interfaces that alter physical space. Emerging sensor and modelling technologies can: map people's activity and movement, interpret behaviours, create contextual meanings, and transform the findings into site specific informational interventions with temporal sensitivities and social relevance. We define these as "social technologies." Physical interfaces act as ambient information displays of site-specific social models presented at the boundaries of human perception. The intervention reconfigures architectural space according to appropriate socio-spatial scenarios. Two examples of such systems are presented and their scenarios discussed. The system fosters social interactions and re-conceptualisation of information, time, space, and community.

Keywords: informative responsive environment, context aware, social technologies, ambient display, dynamic architecture, interface design

Introduction: *Architecture, Information Technology, and the Fabric of Society*

As work, the Internet, and gaming industries now compel more and more people to sit in front of computers, personal and physical - "real" - relationships are being lost in favour of virtual ones. People and their relationships, however, are the fundamental fabric of social structure. In this context, what is the role of a physical public space and its personal encounters in a world which is now dominated by the virtuality of information technology? Can information technology help to bring people together in a physical environment?

Obviously, Information Technologies have gained a more important role in our daily lifes. It has permeated our lives ranging from PDAs, cell phones, ubiquitous computing platforms, to home automation, environmental and ambient displays (i)(Ishii, 1997). Physical spaces have only started to integrate information with architecture (Time Square NASDAQ building, the "virtual" NYSE 3DTFV by Asymptote Architecture), but it is still considered as two different entities, one layer on top of another. This paper proposes to merge the entities of physical architecture and the advantages of information technology to create a new approach towards architecture, a physical architecture that is responsive and interactive to people's activity.

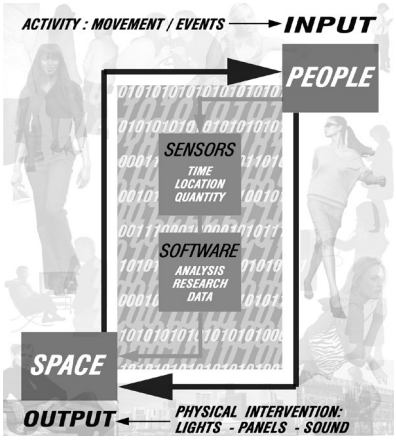
As people influence and create the space and its social quality, the space influences the way people interact and communicate with each other, assisting them in the realization of their goals. In this way the space is a Captological interface (ii)(Little, 1987) that stimulates individual and group "flow states" of optimal experiences (iii)(Csikszentmihalyi, 1990): getting people

somewhere on time, providing opportunities for meaningful social interactions, and creating large-scale community spaces.

Shared moments of “bar waiting”, “train waiting”,“trapped in an elevator” contribute to social dynamics. Moments of “extra time”: getting a coffee, reading a book, buying a gift become the reality of a place that create the opportunity for social interaction through time allocation.

Informative Responsive Environments and Social Technologies:

“Informative responsive environments” use strategies of context aware computing (sensors and models of activity with appropriate feedback) to provide useful information as well as a physical intervention in an architectural scale. Interventions transform information into ambient and physical displays which impact the environment and its occupants. This means that information generated by inhabitants directly influences the spatial configuration. Changes in spatial configuration influence how people move, use and inhabit the space, and - even more importantly - the way they interact with each other. The aim is to create an environment where people develop activity awareness: becoming more aware of each other, the environment and the activities it contains, as well as providing site-specific useful information.



There are four parts to the “Informative responsive environment” system: input, sensors, “social technologies“, and output.

Input: is the social and infrastructure (i.e. movement) activity of people that is occurring in the space or passing through the space.

Sensor Systems: are the devices that are deployed to transform the inputs into signals that the social technologies use. These are software and hardware that analyse and translate information to develop raw environmental data. Existing examples of social technologies include: traffic monitor systems (v) (Siemens) and Sommer’s Crowd dynamics models.

Social Technologies: are the computational systems that along with the designer’s understanding of the space take sensor data and transform them into context utilizing site-specific parameters to develop an understanding of possible social activity (e.g. dancing, chatting) and event dynamics (e.g. party, performances). In programming social technologies, methods like AI pattern analysis and decision making algorithms come into play.

Output (Ambient and Physical): are the ambient displays and physical devices that present site-specific,socially relevant information to beneficially impact the occupants of a space. Sometimes the “intervention“ is noticable and explicitly informative; at other times it is presented at the boundaries of human perception as subtle captological (computers as persuasive technologies) suggestions (vi) (Fogg, 1998). Interventions might include modulations to light, sound, vibration, heat, humidity, or changes to physical (wall location, prominence, and volume) or spatial structures (large open group spaces versus small, personalized spaces).

Emerging sensor and modelling technologies map social activity into contextual meanings. The output effects the occupants,who in turn reconsider their activity (the input) creating a dynamic feedback loop. Through appropriate reconfiguration of socio-spatial scenarios the system fosters a re-conceptualisation of information, time, space, and community.

Queens Plaza, NY: Transforming a Traffic Hub into a Public Plaza?

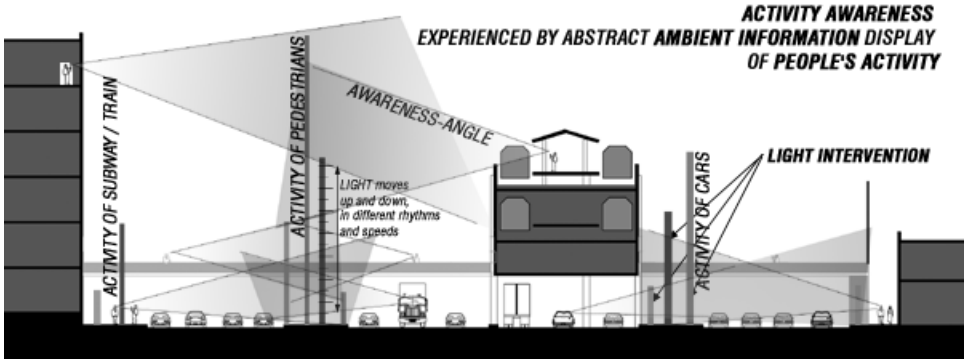


Illustration 2: Queens Plaza Section, relationships of commuters and light inter-vention.

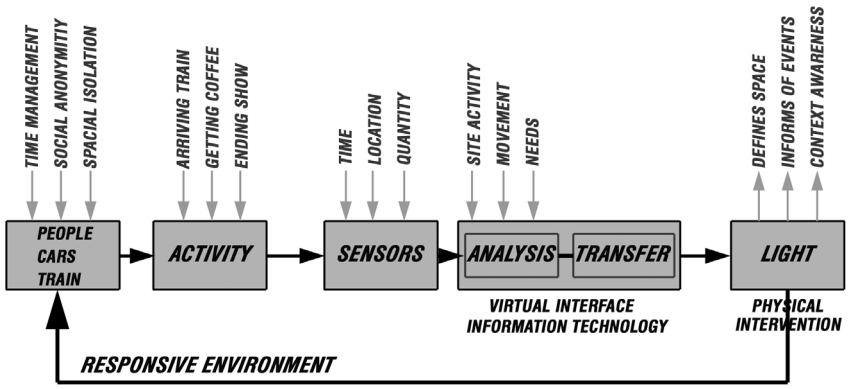
Queens Plaza is a example of a space that is undefined (lack of points of orientation and identification) and unpersonal. It is a major public site, but without communication and social interaction. Traditional types of personal interaction, such a buying a train ticket at a counter, are more and more replaced by vending machines.

The inhabitants in this traffic hub are in constant flux. They are passers-by: commuters in cars, subways, trains, and pedestrians. By providing a better understanding of the environment and providing site-specific information in an ambient and abstract way we offer a platform for social interaction as well alterantives for time allocation.

Commuters are constantly confronted with questions ("When is my train coming?", "How jammed is the bridge today?") and subsequent, often fast-to-make decisions ("I have time for a coffee and a chat.", "I have to reschedule my appointment."). The necessary information to facilitate an appropriate decision making can be conveyed through conventional data displays we know from airports and train stations. Ambient and physical displays powered by social technologies can convey this information more effective, and also foster social interaction.

To transform Queens Plaza into an "informative responsive environment" we propose deployment of a sensor system, social technologies, and physical output in the form of lighting interventions. Sensors throughout the site located at major entry points (subway station and traffic intersections), points of transitions (public places such as parking lots, cafes, theatre entrances, etc.), and those sites also beyond the Plaza yet related (in buses and trains), provide the social technologies systems with raw social data. The models of social structure are applied and the potential interventions and their impacts are analyzed and selected. An intervention may be an display of "light play" in response to a soothing environment fostering social interactions or it could modulate lighting of a secondary path to the subway alleviating rush hour crowds. As the interventions are applied, the sensors system continues to acquire data for this interative infrastructure-inhabitant exchange.

The lighting interventions react, as components of a coordinated system, to various inputs to create a visual composition. The always-changing light orchestrates a meaningful pattern of motion that communicates information – a light symphony. This composition represents the activity of the people in the space and therefore creates the current identity of the site. It defines the space perceptually. Sharing a common sensation of this informative responsive environment creates a sense of awareness that connects isolated occupants. Information generates the atmosphere and creates a character to the site but it also serves as a reflexive feedback loop to

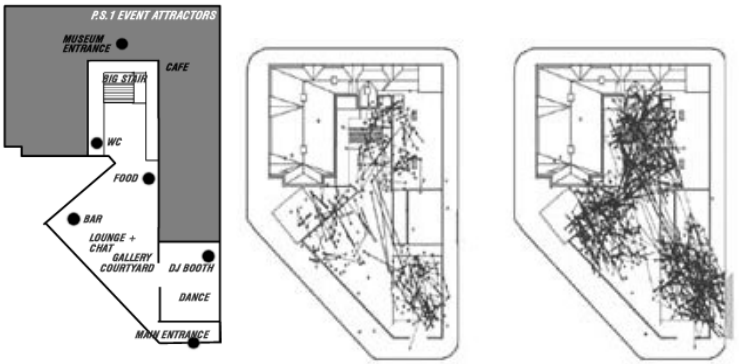


transform itself. The information is reflecting the presence and activity of the people and they reflect the impact of the information: the virtual informs the physical and the physical the virtual.

Illustration 3: map of social technology presenting its components and relationships.

P.S.1. Contemporary Museum of Art, NY: A Multi-Functional Event Space

P.S.1. in Queens, NY, is a multifunctional space, housing diverse events, which vary over time. As such, it presents a rich opportunity for "informative responsive environment" techniques. This investigation explores the relationships of people, activity, time allocation and space-usage. We see several opportunities to have "social technologies" reconfigure space, creating opportunities for meaningful social interactions, greater enjoyment of events, and more personalized space.

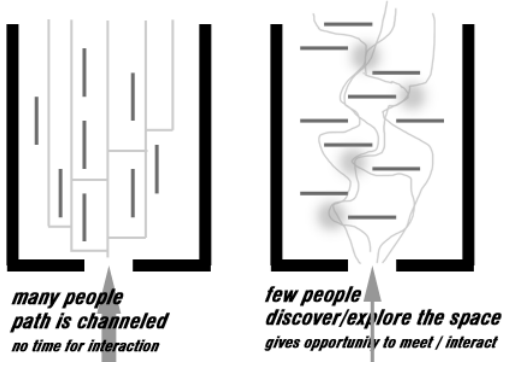


Every summer since 1998 P.S.1 has transformed its outdoor courtyard and gallery space into a summer hang-out and DJ showcase. Besides the wide range of exhibitions the museum has to offer, the "WARM-UP" series includes music performances, art installations, film festivals and dance coupled with an innovative architectural installation.

Illustration 4: P.S.1 site conditions and event attractors
Illustration 5: People's movement and temporal shift between activities

This study takes the lighting intervention of the Queens Plaza example further and introduces *physical spatial dividers* that slide, rotate, and scroll vertically. This enables physical spaces to architecturally re-purpose themselves from small intimate spaces such as café tables and alcoves into vast public areas such as a dance floors or performance areas. The informative responsive environment has the familiar components of inputs, sensors, social strategies and outputs. Site-specific sensor locations now provide social data on narrow passageways, bar area, food court, DJ booth, rest room lines, and museum exhibits. The social activities classifications include: people entering the site, progress of ongoing events, small group conversation, dining formality, start and stop of DJ's playing, museums exhibits crowd dissipating, and performances starting. The

interventions are *physical spatial dividers*: panels consisting of aluminium framed translucent material (Macrolux, tinted glass, or even smart glass allowing translucency modulation), supported by cables, with motors enabling rotation and sliding of the panels along the cables. The possibility of using translucent modulations within one panel could also be used to portray information such as "if you don't see the bar, you don't necessarily desire to go there right away".



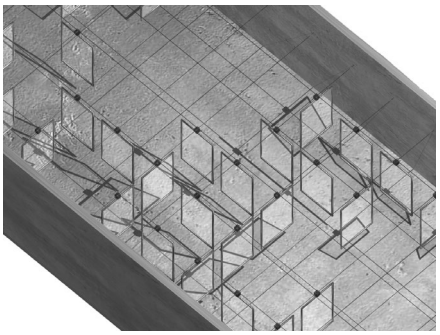


Illustration 6,7: Schematic panel configuration in relationship to the flow of people
Illustration 8: Schematic 3D diagram of space usage

Again, individuals visiting the site desire, partly subconsciously, to get value-added information to enhance the quality of their stay at the location: "How long is the wait at the bar?", "When is the DJ starting to perform?", "Its too crowded here to sit or chat?" In addition, the event hosts typically would like to influence the crowds towards specific activities (exhibition, dancing trinking) at specific times of the event.

The panels go further than the light interventions in the sense that they are not only acting as an information display, but also that the architectural space is physically transformed, potentially accommodating new events. A dynamic change of space size occurs as it transforms from an intimate chat or hang out space into a vast dance area. By subtle and unconscious redirection and adjustment of the panels the flow of people can be influenced and the people can be influenced to move in another direction. The panels adjust to the crowds. They redirect and channel them to provide an easier and shorter way from one point to another one.

Walls not only influence the way space is occupied but also most of the time determine its physical boundaries. Not unlike the natural flow of liquid, occupants of a space are subject to its physical constraints. With the ability to change the shape of architectural space, the pattern and position of panels, the intervention can react to occupant activity and modulate social opportunity. Human activity and interaction has always been limited by well-defined spatial boundaries. This work demonstrates an alternative. No longer must we be subservient to the walls. Now we can influence the walls through our presence to accommodate to our needs and activities. The walls become responsive servants, guides, and social facilitators.

Future Work:

Once the relationships of a site are understood (the flow of people, activities, time-frame, and site-specific information) an appropriate intervention can be found to create a dynamic responsive physical environment. Different sites and scenarios require different interventions, but the basic principles apply. The two scenarios developed here are only examples of a spectrum of possible applications. At conference and exhibition fairs the desired information,"How crowded and occupied is a specific booth," could be answered using heat mapping and ceiling displays.

The spatial responsive intervention could offer time-management for visiting an exhibition and faster navigation across the exhibition.

Further out, compelling interventions may include amorphous walls in multiple dimensions, voxel spaces which use the free space (air or the ether) as an intervention media, and cloud rivers of wispy transitory flows of mist with projected information controlled by fans. These modalities demonstrate the potential for contextual information and spatial integration to create quasi-tactile and multi-sensual impacts on their occupant participants.

Conclusion:

Providing these interfaces enables opportunities for occupants to better perceive and allocate personal time through a heightened state of awareness and understanding of their physical surroundings (an interface can turn waiting time into usable time). The physical environment transforms through information input. The input is generated by the people and reflects the ongoing activity. Therefore the people become active members of the environment. People can identify themselves with the place. Their activity and presence generate the information responsive environment and its interventions. People become more aware of other people, their activity and context, and can therefore act accordingly. This intervention provides the opportunity of bringing anonymous people into social encounters and turns undefined spaces into personalized spaces. The signifigance of this strategy is that it incorporates information technology for the creation of dynamic space and it transforms information into an ambient and physical presence, which is responsive to and interactive with human social activity.

Architecture explores the relationship between people and space. Today, “IT” has to be considered and integrated into architectural definitions. This opens up the possibility to redefine the perceptions of space and therefore architecture. Architectures can now become actively responsive, transformational, and beneficial toward the current needs of their inhabitants. In this way architecture becomes democratic, because its generated by the people, and not by the absolut hand of an architect. This research explores technologies applied into different context and creates novel applications that can fundamentally change the way we perceive space, information, and social structure. Space has gained a new dimension, an integrated layer of information and a physical responsiveness to people. Space is no longer static, but becomes an intelligent, aware, social actor!

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