Metapolis and Urban Life

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Where: ***UbiComp 2005*, Tokyo, Japan**
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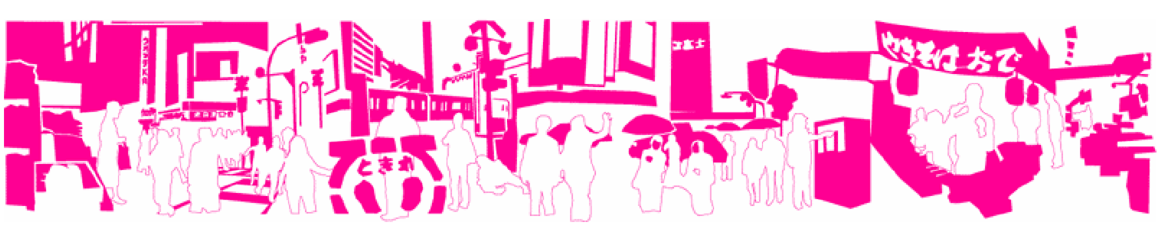

48 hours, 100 ideas, walk, watch, sketch, collect, discover, uncover, map, spy, follow, trace, shadow, deception, intrigue, mystery, karaoke, don't miss out...last chance to participate in forming our future urban life...

The Metapolis and Urban Life workshop at UbiComp seeks to include a range of practitioners exploring urban projects for which the urban is not merely a palimpsest of our desires but an active participant in their formation. From dynamic architectural skins to composite sky portraits to walking in someone else's shoes to geocaches of urban lore to hybrid games with a global audience, position papers for the Metapolis and Urban Life workshop should transform the "new" technologies of mobile and pervasive computing, ubiquitous networks, smart materials and locative media into experiences that matter.

Scope and Aims

The city has always been a site of cultural, social and physical transformation, on scales from the most personal to the most collective. However, with the rise of the "metapolis" and the issues it brings with it, 24/7 rush hours, the conversion of public space to commercial space, the rise of surveillance, transnational neighborhoods, polyvocal politics and architecture etc. the contemporary city is weighted down. We can no longer technologically or socially be constrained by something planned and canned, like another confectionary spectacle. We dream of something more, something that can respond to our dreams. Something that will transform with us, not just perform change on us, like an operation. The Metapolis requires individual, social and technological interaction.

As the field of wireless and locative technologies matures, this workshop is interested in exploring a more enduring relationship between the physical and cultural multicity and its digital topographies. This workshop asks the question what might an authentic or native digital/physical relationship be? Authentic to whom? How can these be considered within the hybrid space emerging from the interaction between digital and physical practices? This workshop seek to understand alternative trajectories for digital and wireless technologies while building definitions of place and practice in both physical and digital terms, as well investigating their interaction, influence, disruption, expansion and integration with the social and material practices of our public urban spaces.

We desire to explore the meaningful experience of urban life and landscape through a spectrum of sub-themes, and challenge urban practioners to bring ideas to the workshop that engage with this issue through a variety of positions. The workshop is not intended to determine a definitive "position" rather to open new territories and contexts, and set about understanding and developing tools we may need to operate within them.

Workshop attendees will be asked to speculate on the role of wireless and mobile computing technologies and the city in these terms through a brief position statement (10 minutes) at the beginning of the workshop. Over the course of the two day event, we will determine a range of methods and strategies for engagement of the metapolis in these terms by engaging with Tokyo itself.

The following sub-themes are not exhaustive but suggestive of views of the metapolis that may trajectories for further discussion.

Shadow City

What types of lived and practiced neighborhoods exist within the urban landscape? How can they be realized, exposed, and experienced?

Collaborative Challenge

Cities - a crowd of individuals? How can the crowd inspire the individual through collaboration, competition, confrontation? How can this massive audience become active co-conspirators in a collaborative challenge? What change, effect, or experience could only be achieved by a mass movement, a mob, a cooperative crowd? What spaces could be accessed, created or re-imagined by a massively-scaled intervention? How can we stage a series of “new happenings” that may be very brief or extend and develop for years?

Hybrid Histories

Uncovering the past and looking toward future histories. Where has your urban environment been? Where might it go? These histories need not be accurate; we encourage participants to imagine alternate histories based on existing conditions.

Inbetween and nondisciplined spaces Urban environments are largely composed of the “spaces between”. Let us celebrate them. How can we engage with the overlooked, abandoned or disreputable urban spaces: alleys, underpasses, and empty lots? What nondisciplined spaces are specific to Tokyo or your own city? What role do daily rhythms play in the tensions between places, undisciplined spaces and “inbetween places”? How can we stage a series of "new happenings" in the city that may be very brief or extend and develop for years.

Alternate Playgrounds

Rules, play, games, and toys. Let's create new sandboxes in the metapolis. What about games that span a single event or activity within the urban environment? How can we promote playful encounters in our metapolis? Can metapolis come out and play?

Urban Archeology

What can we uncover within the layers of strata of the urbanscape? How will we “dig” within our newly emerging technological metapolis and how will we exhibit its “discoveries”?

Open Traversal

Ebb and flow. Waxing and waning. What's all this hustle bustle about anyway? Where are all these people, goods, and information going and why? What are the rhythms of this metapolis?

Exposed Urban Environments

What are we not seeing, feeling, smelling? What do we not understand about our Urban Environment? More importantly, how does this reconfigure our future?

Operational Metapolis

How is our metapolis at work? At play? How does it function? Is it healthy? Sickly? Tired? Happy? How can we measure its production, health, and mood?

Hacked Metapolis

What are you rebelling against? ... What've you got? Learn the rules of the metapolis then let's break them together and create something deliciously new.

Parasitic Metapolis

Parasite - an organism that grows, feeds, and is sheltered on or in a different organism while contributing nothing to the survival of its host. Is the urban environment our parasite or our host?

Open Source

Open source or open-source software (OSS) is any computer software distributed under a license which allows users to change and/or share the software freely. How can this be transposed onto the infrastructure of the urban environment? What are the source codes of the metapolis and how can they be re-coded?

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An economic system is a mechanism which deals with the production, distribution and consumption of goods and services in a particular society. The economic system is composed of people, institutions and their relationships as well as the allocation and scarcity of resources. Why not impose a new system of exchange across the urban scape? Complete with new forms of trade, transfers, currency, concepts, modes, utopias, co-ops, gifts, barters, punishments, and rewards.

Town Hall

Take your issue to the people. Isn't it time we held a real town hall meeting? Then call the meeting to order. One of the roles of a town hall is to create a common meeting space for citizens. What is the vision for the new peoples' "town hall"? How can all citizens be full participants in the new metapolis? What are the barriers to full participation? How can they be overcome? How can all citizens be invited into the town hall?

Community Mapping

An aid which highlights relations between objects, people, situations within that space. How can urban inhabitants map their environment? What will they look like? How will they be shared? What will they provide? Ignore? Remove? Celebrate?

Parallel Metapolis

What are the new sister metapoli? Where are they connected? disconnected? How to they share time and space with each other? Where do they disconnect?

Let's Get Dirty

The workshop is planned to run over two days, with a significant amount of time involving actively engaging the urban environment through "deep exploration" and urban actions. Attendees will give a brief 10 minute presentation on the morning of the first day, stating their interest and trajectory within this topic area, followed by a discussion and strategy session on the issue of digital urbanism as a practice and place in the context of the Metopolis. On the afternoon of the first day and morning of the second day, we will adventure into Tokyo to collect, discover, uncover, map, spy, follow, trace, shadow, etc in an effort to construct a discourse through doing. Participants will get dirty and hands on with the urban environment. On the afternoon of the second day participants will discuss their findings through a series of "visual speculations" assembled from the work in Tokyo, closing with a discussion of projections and speculations.

Goals

Taking the above perspectives as a spring board for discussion and action, this workshop has the following aims:

- To bring together a multi-disciplinary group of practitioners to discus how our future fabric of digital and wireless computing will influence, disrupt, expand, and be integrated into the social patterns existent within our public urban landscapes.
- To elaborate new methods and models in design practice that can accommodate designing technology for urban environments and lifestyles.
- To extend the discourse of locative media and technologies and their relationship to urban space and practices as a maturing dialogue, raising issues that are reflective of this.
- To develop an agenda for future collaborations, research and design in the area of urban computing and identify critical opportunities in this space.

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Metapolis and Urban Life

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"Never confuse the map with the Territory"

- *Empire of the Sun*, J.G. Ballard [1]

"Only in Marco Polo's accounts was Kublai Kahn able to discern, through the walls and towers destined to crumble, the tracery of a pattern so subtle it could escape the termites' gnawing." [2]

ABSTRACT

The city has always been a site of cultural, social and physical transformation, on scales from the most personal to the most collective. However, with the rise of the "metapolis" [3, 4] and the issues it brings with it, 24/7 rush hours, the conversion of public space to commercial space, the rise of surveillance, transnational neighborhoods, polyvocal politics and architecture etc. the contemporary city is weighted down. We can no longer technologically or socially be constrained by something planned and canned, like another confectionary spectacle. We dream of something more, something that can respond to our dreams. Something that will transform with us, not just perform change on us, like an operation. The metapolis requires individual, social and technological interaction.

As the field of wireless and locative technologies matures, this workshop is interested in exploring a more enduring relationship between the physical and cultural multicity and its digital topographies. This workshop asks the question what might an authentic or *native* digital/physical relationship be? Authentic to whom? How can these be considered within the hybrid space emerging from the interaction between digital and physical practices? This workshop seek to understand alternative trajectories for digital and wireless technologies while building definitions of place and practice in both physical and digital terms, as well investigating their interaction, influence, disruption, expansion and integration with the social and material practices of our public urban spaces.

Author Keywords

Urban computing, Situationist, *dérive, détournement,* mobility, urbanism, locative, urban media,

INTRODUCTION

The *Metapolis and Urban Life* workshop at UbiComp seeks to include a range of practitioners exploring urban projects for which the urban is not merely a palimpsest of our desires but an active participant in their formation. From dynamic architectural skins to composite sky portraits to walking in someone else's shoes to geocaches of urban lore to hybrid games with a global audience, position papers for the *Metapolis and Urban Life* workshop should transform the "new" technologies of mobile and pervasive computing, ubiquitous networks, smart materials and locative media into experiences that matter.

BEYOND PRODUCTIVITY

"Beyond the metropolis of the industrial era emerges the Metapolis of the digital era. The city is now a place of places, where numerous urban models coexist, each with its own qualities that make it different from the rest." [3]

The city has been described through many metaphorical lenses, mechanical, monstrous, biological, utopic etc. We are interested in uncovering further how we may characterize and importantly operationalize (act upon) the new metapolis when understood in terms that are not mappings of external metaphors onto the city, so much as uncovering existent conditions within the urban landscape. To this end we offer prompts for illuminating different types of cities within cities.

Beyond any single technology (such as GIS) there lie a range of strategies and practices for uncovering, understanding and exploring alternates that build on the interaction between technology and the urban landscape as a practiced place. The physical fabric in this instance is as constitutive of the project as the technology itself.

"Let us embrace the full scope of urban life with all of its emotions and experiences."

Developing themes from the UbiComp 2004 workshop *Ubicomp in the Urban Frontier*, this workshop seeks to both speculate and act upon the possibility of meaningful spatial and technological practices within the urban context.

THEMES

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CONCLUSION

Urban environments continue to transform under pressures from wireless digital tools and mobile devices, and the reconnection of information to place. Within this dialogue a new set of spaces and practices are constantly being evolved, not just remappings of technologies to the hardscape, but hybrid practices and methods that are more intensively oriented and built on the hybridity of the urban landscape. We are looking to be able to nuance both our understanding of our urban digital practices as well as the multiple layers of context that go with the modern "metapolis". The need to develop a continuing investigation of the implications of emerging technologies on our urban landscape is unabated, and we recognize that we are moving into a more mature phase of understanding, searching for and exploring deeper connections to place, technology, material and practice. The Ubicomp *Metapolis and Urban Life* workshop aims to provide a trajectory and hands on exploration of what digital practice and urban computing might mean in the metapolis, and how we may begin to empower urban dwellers in the construction of a meaningful and continuously emergent digital landscape.

Let us experience your vision of the Metapolis!

PARTICIPATION

Selection of Workshop participants and presentations will be based on refereed submissions. Authors are invited to submit a two page position statement in the ACM SIGCHI conference publications format. Position statements are encouraged to be provocative and will be used during the workshop to guide and disrupt our views of urban computing. They may include personal experiences, performances, studies, or individual urban projects. Position statements should have only one author, and should include a brief biography. Selected participants will be invited to present a short position statement, and should come prepared for a physically active two day workshop in, around, under and through Tokyo.

REFERENCES

[1] J. G. Ballard, *Empire of the Sun: a novel*. New York: Simon and Schuster, 1984.

[2] I. Calvino, *Invisible cities*, 1st Harvest/HBJ ed. New York: Harcourt Brace Jovanovich, 1978.

[3] M. Gausa and Instituto Metâapolis de Arquitectura Avanzado., *Diccionario Metâapolis arquitectura avanzada*. Barcelona: Actar, 2001.

[4] G. Simmel, "The Metropolis and Mental Life," *On Individuality and Social Forms*, 1971.

distributed displays, infrastructure, and empowerment

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Submitted to Ubicomp W11: Metapolis and Urban Life

1. introduction: situated and distributed displays

In our current research creating tangible ambient displays of office activity, we have focused on the importance of site-specific displays. [1]. If we consider naturally occurring sources of ambient information, we see that they are in a sense ideally suited for their situations. Both the sound of rain and shadows from the sun are inherently wed to their location; hearing rainfall means that it is raining *right here*. Additionally, these displays are integrated into their surroundings, or rather, they constitute the surroundings.

In the course of designing our system, we have noticed a corollary to situated displays. In many environments – the office being one, the city being another – "situations" may tend to repeat themselves. Thus we see many offices in an office building, each with similar layouts and serving similar purposes. And similarly, in a city we will find many coffee shops, many intersections, many parking garages, bus stops, highway on-ramps, trash bins, drains and manholes. In such environments, situated displays may also become distributed displays.

Our system, Nimio, was designed to support a group of ten administrators at a technology institute. During our site study, interviewees made a point of telling us how closely they worked together, and it is notable that they like to present themselves as a close-knit group. At our first visit on site, most group members had jasmine blossoms in their offices. We were told later that they were all from the same bush.

Figure 1: a distributed display in the office

While one of these jasmine branches may constitute a mere pretty office decoration, the set of them, distributed throughout many coworkers' offices, conveys information about the working relationships of this group.

Based on the practices of the work group we are collaborating with, our design is itself a distributed display. Nimio takes the form of desktop toys in four shapes and three colors. These two properties create two "family groups," a shape group and a color group. Using embedded microphones and accelerometers as input and LEDs as output, they reflect activity level around the other Nimios. Objects of the same shape resonate with each other, as do objects of the same color. Each Nimio is uniquely identifiable by shape and color. If, for example, the green cube is shaken, the owners of other cubes will be able to identify the shaker while the owners of other green shapes will have a more nebulous awareness of the action. While each toy may allow awareness of the presence of several coworkers, the system as a whole conveys on one level who is active, and on another level, who is aware of whom.

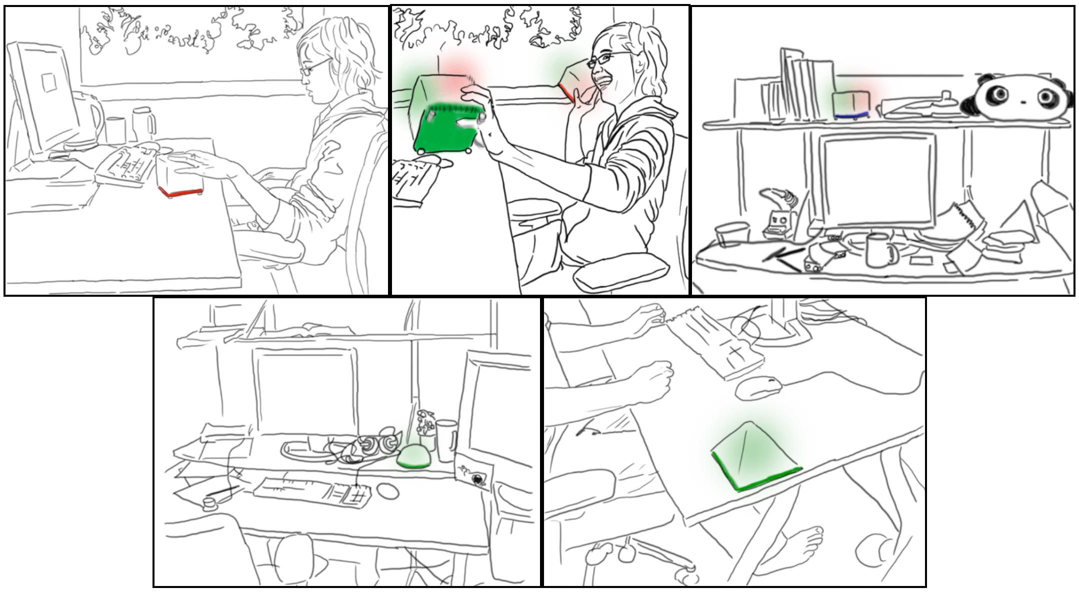


Figure 2: ambient awareness + distributed display

We first became attuned to distributed display in an office suite. However, we feel that cities – with their density of infrastructure, population, technology and built structures – are particularly rich sites for study of distributed display, and that being aware of distributed displays can be a powerful way to read a city and empower its inhabitants.

2. existing urban distributed displays

When studying distributed displays "in the wild", we should consider that much of their value as informative objects is imparted by those who read them as such. Some questions: What is the intent behind the object? Behind the set of objects? How do inhabitants render these objects legible? How do inhabitants' readings confirm or confound the intent behind these signs?

One common, indeed nearly inescapable[1] distributed display in our everyday lives is the repetition of brand logos. Brand logos serve as a marker of corporate identity, assuring potential customers of a certain quality of product and increasingly connoting image and lifestyle and personal identity [2]. Effective brands must be widely visible and readily recognizable, a sort of pervasive, repetitive distributed display.

Brand logos, however, do not exist in a vacuum. Situated in time, in locations, in complex and dynamic environments, what might we read into them that the manufacturers never intended? A favorite example is Popeye's Famous Fried Chicken & Biscuits, a fast food chain which – at least in California – seems to exist almost exclusively in dodgy neighborhoods. (In San Francisco they are located in the Mission and the Lower Haight.) An isolated Popeye's logo may indicate delicious fried chicken, but based on our experiences of situated Popeye's logos over many places and many instances, we may also take it as a sign that we

[1] The rightmost photograph of Starbucks was taken inside the Forbidden City.

shouldn't stick around alone after dark, a reading that surely could not have been intended by Popeye's marketing department.

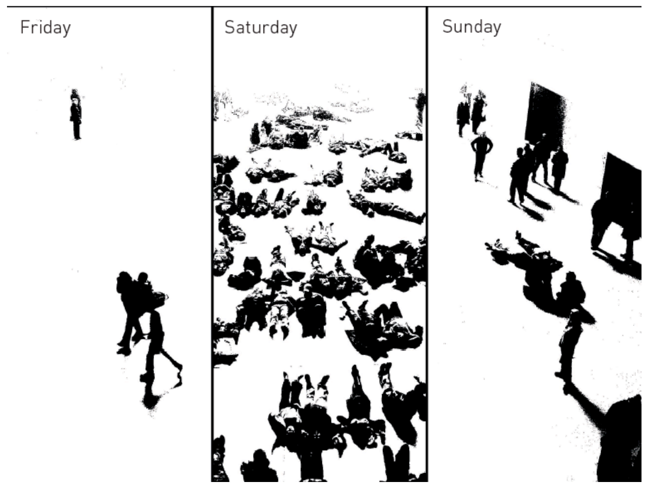
An accessible sort of personal branding, graffiti tags are ubiquitous in many urban areas. (Note the octopus stickers on the signs in each of the above photos.) While each individual sticker conveys personal identity, their distribution may mark off territory – indeed, this is the supposed purpose of gang-related graffiti. In the case of sticker graffiti in the Capitol Hill area of Seattle, taggers do not seem exclusively possessive of territory; often several stickers and marker-drawn tags shared space on a single sign without encroaching on each other. A walk through the neighborhood and an attentive eye reveal not just the territorial claims of a single octopus artist, but an overlapping network of turfs claimed by several local sticker-artists.

We find that infrastructural access points can easily be read as distributed displays, a trait hinted at by the fact that Capitol Hill taggers chose to tag parking signs, access points to a legal infrastructure regulating parking in the city. Manhole covers typically fade into the background, a generally unnoticeable part of the urban landscape (unless the covers are removed and the hole revealed). However, a closer look reveals care in labeling: covers providing access to the water system are distinguishable from those leading to drainage, which are different from those leading to electric. Still others are mysterious. The distribution of manhole covers can be used to discern the routing of these infrastructures, an activity occasionally undertaken by students motivated to explore the "steam tunnels" beneath Stanford University.

3. three proposed urban distributed displays

a. distributed shift

During the CHI 2005 Engaging the City Workshop, a number of participants proposed an installation, *Shift*, designed to "invite authorship, performance and interaction amongst inhabitants of a public space across time in order to sensitize us to natural rhythms in urban space."[2] Though potentially an informative (and fun) single interactive display, *Shift*, with some alterations, could prove to be an engaging distributed display as well. In its original form, images of a certain place would be continuously captured, while display of those images in the same public space would be time-shifted. Cameras and displays, rather than being hidden, would be obvious enough to invite interaction. The ebb and flow of activity within the space is thus highlighted, though perhaps also mitigated by the presence of a population remote in time but not place.



Shift could be turned into a distributed display simply by being installed in many different sites in a city, sensitizing residents to the ebb and flow of activities in different areas, perhaps allowing them to gain a sense of how activities in different parts of the city might influence each other. Another distributed version of *Shift* might instead serve as portholes from one site to another, revealing the quiet of a residential neighborhood to revelers on a street full of bars and clubs, or showing a bustling shopping district to a nearly deserted university campus.

b. distributed display of demographic data

The Dorchester and Roxbury neighborhoods in Boston suffer asthma rates that are 178% higher than the state average [3], a trend that is often blamed upon the diesel buses that frequently run through those areas. Income in those neighborhoods also tends to be lower than the citywide median income [4]. Fairfax County's median income is almost double that of the United States as a whole [5] and its SAT scores are 79 points above the national average of 1026 [6]. Malcom McCollough writes in *Digital Ground*, "More than any other single indicator, ZIP correlates with how you vote, what kind of money you earn, which kinds of actors you prefer to see in television commercials, and what kinds of places you frequent. [7]" Maps displaying statistics such as income, disease rates, high school graduation rates, or crime rates can be extremely enlightening, but such information must be sought (and hence is easy to avoid, or never encounter). What if such information were to be made visible, in situ, something to be encountered in everyday life?

Situated displays of pollution can be potent and empowering tools for activism, as demonstrated by Natalie Jeremijenko's "feral aibos" project, in which a pack of aibos are modified and equipped with toxic gas sensors and set loose at a Southern California middle school (formerly a Superfund site). Such a demonstration, however, is a one-time thing, not a constant reminder. A situated pollution display that would stay in place might employ wireless sensor networks and some inexpensive form of display, such as colored LEDs reflecting localized pollution levels. There is no reason to limit display to pollution; demographic data is readily available and can be tied to location.

Distributed displays of demographic data would not only be pervasive situated displays, but also, by highlighting local *differences* in things like asthma rates and SAT scores, could help quantify disparities within a metropolis in an everyday, situated way.

c. distributed display of wireless infrastructure

One infrastructure we, especially those of us reading this paper, have come to rely on is, of course, wireless internet access. Many of us have become so concerned with access that we map out our daily routines based on WiFi hotspots. Services like JiWire boast a database listing of 67,432 WiFi hotspot locations in 101 countries [8]. Like many modern infrastructures, you cannot see, hear, or smell WiFi. However, we all manage to find it somehow; the easiest way is to scope out a coffeeshop and see if anyone has their laptop open. If someone does, chances are there is WiFi access, and so you open up your laptop too.

[2] From the workshop poster.

This behaviour creates a distributed display of sorts, but it is, unfortunately, pretty limited. It only allows you to spot a potential access point once you've actually taken the time to enter it. Furthermore, seeing people with open laptops does not guarantee there is access, and more importantly, it does not say anything about the nature of that access. How many times have you opened your laptop only to realize that the WiFi is restricted either by requiring money or a by means of a WEP key. Frustrated by a lack of access, pressed for time, or too tired to walk to the next potential access point many people will give in and pay a one time fee.

Currently, Hotspot Bloom displays the existence of coverage as an illuminated flower [9], and the Digital Hotspotter, which is a personal handheld device with an LCD display, provides more information about coverage such as SSID, encryption and channel data [10]. Wifisense, a handbag with an array of embedded LEDs, provides both coverage strength and in some cases the existence of WEP encryption [11]. We propose a device that provides an outward display of both the positive and negative aspects of WiFi coverage, specifically is the access open or restricted (to those willing to pay or having a password). The device would be a small display easily attachable, for instance, to laptop bag. This device would consist of a small microcontroller and corresponding display, either LEDs or a small patch of augmented fabric. It would resemble a small bar with two circles on either end (like a double ended thermometer, or the two "i"s in WiFi). One circle would be always red, and the other always green. In the absence of any coverage the bar would remain black. When coverage is present the color on the bar would be a mixture of red and green, the ratio of color indicating the ratio of open to restricted (either requiring payment or a key) access. Furthermore, one could imagine these devices having an additional display component that receives information about WiFi coverage in more distant places. As I move through the city my device can transfer information about wireless coverage from one location to another, adding a "getting warmer" component to the displays. The key idea behind this proposal is the fact that it is distributed display whose small form facilitates widespread adoption. This simple device, if adopted by enough people would provide an indicator of what kind of coverage is available, and hopefully, would cause people to change their patterns of WiFi usage. People would gravitate toward areas with more "green" coverage, and thus establishments which supported restricted infrastructures would suffer and lose business. A small technology like this, with enough dissemination, can then act as an impetus for broader social change.

4. conclusions and further questions

Often we (okay at least the authors) can be heard to gripe about how the true natures of many infrastructures are hidden. Plenty of them lie in the hands of government organizations or massive corporations, so what can we really do to change things? Much of our research relies on these infrastructures (e.g., the internet, urban landscapes), and so we get caught in a kind of Catch-22: fight for technological freedoms or continue with our work? We think that it might be worthwhile to try to do both. What if we design technologies to expose these infrastructures for what they are and try to create pushpoints which allow the end users to promote change? Clearly we cannot expect that those who control the infrastructures to help us in this task, and so distributed displays become an attractive option. If enough people are willing to participate, if enough people care about the state of an infrastructure, then a critical mass can be achieved for the proliferation of a distributed display. Our task is then to see what about an infrastructure we would like to expose, and how we could actually go about doing that without the support of the organization whose curtain we would like to pull aside.

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author bios

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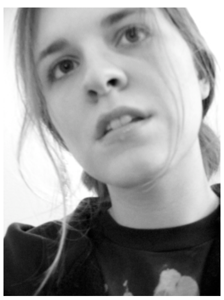

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TRACE: MAPPING THE EMERGING URBAN LANDSCAPE

Alison Sant

Abstract:
Digital networks and wireless technologies are radically reforming the contemporary notions of urban place. As network technologies move away from their hardwired roots, they are activating an urban dynamic that is no longer based on referencing static landmarks, but on a notion of the city in which spatial references become events. These developments imply a changing pattern of urban reference in which invisible boundaries of connectivity alternately thicken or marginalize the urban territories they overlay. *TRACE* is a collaborative project, by artist Alison Sant and programmer Ryan Shaw, that examines the layering of physical space with the on and off zones of the wireless network. The project seeks to blend the corporeal experience of the city with the invisible qualities of the network, creating a narrative mapping of the hybrid space between them. This mapping is one that challenges purely static notions of public space to promote a temporal logic of the city that reflects the fluctuating character of the wireless network.

Introduction:
Wireless networks and mobile devices are radically reforming our contemporary notions of urban place. As the traditional architectural definitions of public and private are blurred by the infiltration of portable electronics and the invisible edges of wireless connectivity, the dynamics of the urban environment grow progressively more complex. Though these were once easily delineated through the shades of the Nolli Map,[1] they are now blurred by the technologies of text messages and cell phone calls that can reach us anywhere, the phenomena of camera phone peeping, and the interception of wireless transmissions.

In addition, as portable electronics become integrated into the ways in which we navigate cities, our relationship to place becomes one that is increasingly mediated. Network technologies are moving away from their hardwired roots, to a mobile computing model in which both the network transmitters and the technologies that access them are portable.[2] These advances activate a new urban dynamic that is no longer based on references to static landmarks, but on a notion of the city in which the events themselves become spatial references.[3]

Although they are not physically obvious, the boundaries of wireless technology have profound implications for our notion of the space of the city. They suggest a changing model of urban reference that is modified not only by patterns of communication but also by zones of connection and disconnection. Mobile phone connectivity, WiFi (Wireless Fidelity) access, and ad-hoc networks[4] generate a series of boundaries that continually reconfigure urban space. Such networks may create density in public spaces by overlaying free access or marginalize urban areas, as they become known as “dead zones” in the connective tissue of mobile communication.

TRACE [5] is a project that examines the layering of physical space with the on and off zones of the wireless network. The project seeks to blend the corporeal experience of the city with the invisible qualities of the network, creating a narrative mapping of the hybrid space between them. This mapping is one that challenges a purely static notion of public space to promote a temporal logic of the city that reflects the fluctuating character of the wireless network.

TRACE borrows from the conventions of cartography to produce a series of maps that visualize the Hertzian landscape. Each map responds to a different state of the wireless network, examining the binary qualities of being on and off the network, in locked or unlocked zones, and in areas of unique or default node names. State changes are triggered by participants’ routes through the city, which enact the relationship between the physical experience of the urban landscape and the network. As surveyors of this evolving landscape, they contribute to a collaborative mapping of this hybrid terrain. By making this topography visible, *TRACE* seeks to reveal the intersection of the physical and immaterial infrastructures of the city.

Section 1: Node Dynamics

<u>Hertzian Footprints</u>
Since the invention of radio transmission, more than sixty years ago, the technologies of wireless electronics have increasingly crowded the airwaves of the city. The relay of satellite television, radio broadcasts, cell phone transmissions, and WiFi hotspots fill the electromagnetic spectrum, creating an invisible Hertzian space that overlaps with the physical infrastructure of the city. Although unseen, this landscape has its own physical contours created by transmission ranges, signal strengths, and frequencies. In addition, as Hertzian space interacts with the physical landscape of the city it creates a hybrid space of shadows and hotspots that conform to the topography, architecture, and weather patterns of the space it overlays.[6]

Hertzian space has a significant effect on the way we occupy the physical space of the city. Avoiding dropped calls in tunnels, finding locations with strong signal to use a cell phone, or a WiFi hotspot to check e-mail are familiar examples. As our notions of physical space become increasingly informed by the fluctuations of wireless technology, our traditional points of urban reference also shift.[7]

Current projects in spatial annotation--the process of inscribing space with an electronic tag--offer examples of this changing orientation.[8] These projects utilize location-sensing technologies, including GPS (Global Positioning Systems) and wireless networks, to augment physical space with its digital double of media annotations. An annotation might be a collaborative map, documenting one’s memories or associations with a site.[9] Alternatively, advertisers may use this space to broadcast a nearby restaurant or an item on sale in a neighborhood store. In addition, data on current traffic patterns, weather conditions, or crime rates may also be used to mediate one’s journey through the city.

Generically, these examples can be qualified as temporal data. Spatial annotation includes media that may be revised by the day, hour or minute. In turn, our understanding of the city may become increasingly informed by temporary references. When compared with the time scale of architecture, a building constructed as a landmark to last decades or centuries, this raises questions about the structure of urban space. Do these changing references begin to undermine a more permanent architectural framework, including the iconic landmarks of the clock tower, or church steeple? As electromagnetic fields increasingly become the carriers of data that inform our notions of space, will they become new reference points to the urban landscape, creating the Hertzian equivalent of the landmark?

Thousands of WiFI hubs are installed in residential and commercial spaces every week, each of which further erodes the traditional architectural boundaries between public and private space. A typical WiFi hub may have a signal radius of 150 feet. Some of these hubs extend intentionally and unintentionally into public space, creating an invisible front porch to the houses, apartments and businesses where they are installed. This spatial phenomenon has produced new urban practices in which neighbors or passers-by access unlocked private networks to borrow bandwidth. As private space is extended into the public realm, the built infrastructure becomes increasingly marginalized by the use patterns that penetrate it. Current debates over whether these WiFi signals are part of the public commons or are the wireless equivalent of stealing private property are especially illustrative of the confusion between public and private space.

As the traditional structures of reference are undermined by the dynamics of an unseen landscape, how are new frames of reference created? In his essay entitled "Thinking About Cities as Spatial Events," Urban Planner, Michael Batty proposes that **" It is possible to conceive of cities as being clusters of 'spatial events'…"**[10] He argues for a temporal understanding of the life of the city as a means for appreciating the profound effects of events that take place in cities over short periods of time. Batty examines examples as benign as pedestrian patterns at a carnival to the significant chaos in Manhattan on September 11, 2001, and proposes that, as a discipline, urban planning focus on these temporal events.

In addition, as both the corporeal and Hertzian experiences of the city are examined as temporal events, they reconfigure our notions of space from the static to the temporary. This hybrid landscape, and the urban patterns it creates, are a further example of what Batty would refer to as "spatial events." His model of the event as a reference for urban activity offers a context for understanding the dynamics of the emerging wireless landscape and its impact on city life. By focusing on the city as an ever-changing experience, we may begin to register the ephemeral dynamics of the city as significant mechanisms in the creation of urban space.

<u>"Space as a Practiced Place"</u>

If, as Batty suggests, the city is considered as a system of spatial events, then space can be reexamined as a construction of the actions of its inhabitants. In his book *The Practice of Everyday Life*, Michel de Certeau defines urban space according to the patterns of those who use it. He suggests that **"…space is composed of intersections of mobile elements. It is in a sense actuated by the ensemble of movements deployed within it . . . In short, space is a practiced place."**[11] As described, walkers inscribe a logic to the city through their daily movements and intersections. In turn, space is delineated by their itineraries.

De Certeau's notion of the city can also be extended to the dynamics of Hertzian space. For example, as wireless networks are overlaid onto the urban itinerary, one's everyday movements enact a series of ad-hoc networks as Bluetooth devices collide,[12] registering the proximity of strangers.[13] In addition, as the WiFI infrastructure grows organically out of the use patterns of their administrators and users, they similarly inscribe a logic to the city.

The decision to leave a WiFI node locked or unlocked or to rename a base station communicates a bias to those that "see" these nodes through wireless devices. In addition, WiFI node names and encryption states become vehicles to express disparate attitudes about public access. An inflammatory declaration of privacy like "Go Away!," may be opposed by an open invitation to logon in the form of a web site address "go http://192.168.168.4/airport."[14] In addition, companies like ZRNet[15] and "Surf and Sip,"[16] which offer paid public access to the Internet in cafes differ from free community networks like Manhattan's New York City Wireless[17], San Francisco's SFLAN[18], and the UK's consume.net[19] and free2air.org.[20] Cumulatively, these independent dispositions create a special hegemony, which informs patterns of collective activity.

Our understanding of physical space becomes complicated by traces of electronic signals, the way they are formatted, and the information they project to us. The wireless network suggests a new subtext to urban space. In turn, these transmissions change our fundamental understanding of location. Instead of responding purely to the physical space around us, we also become engaged with the fleeting qualities of wireless signal. These "states" of the network begin to inform and direct our interactions with the urban landscape as significantly as the material landmarks on city maps.

Section 2: Mapping the City as a Space of Events

<u>*TRACE*: project description</u>

TRACE is a is a collaborative project, by artist Alison Sant and programmer Ryan Shaw, that examines the interplay of wireless networks with the corporeal experience of the city. The project challenges purely static notions of the city to promote an alternative perception that recognizes both the fluctuating character of the wireless network as well as the ephemeral aspects of the urban landscape. In turn, the project seeks to understand the events of the city through the spaces and experiences they construct.

TRACE borrows from the conventions of cartography to produce a series of maps that visualize the wireless landscape. These maps are generated by a software program that runs on a WiFi enabled PDA. Each map responds to a different state of the wireless network, examining the binary qualities of being on and off the network, in locked or unlocked zones, and in areas of unique or default node names. State changes are triggered by participants' routes through the city, which enact the relationship between the physical experience of the urban landscape and the network. In turn, the project represents both a temporal and subjective view of the city.

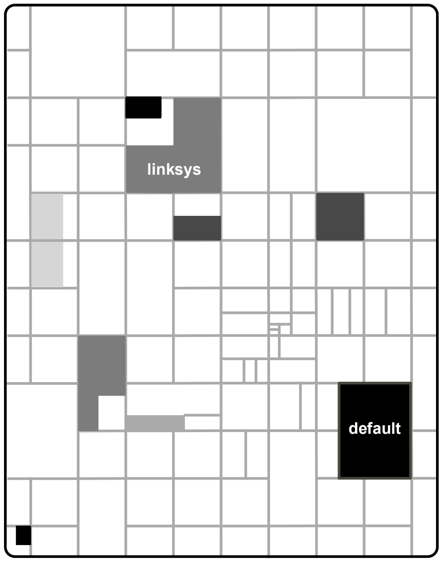
These states are explored as urban events in each map. Furthermore, the temporal qualities of the city are framed as the physical counterpart to its state, and are evoked though a series of questions. As surveyors of this evolving landscape, participants contribute to a collaborative mapping of this hybrid terrain. By making this topography visible, *TRACE* seeks to reveal the intersection of the physical and immaterial infrastructures of the city.

<u>States</u>

TRACE proposes an approach to mapping that examines the "state" of the wireless network over the geographic point as a means for understanding the evolving urban landscape. Inspired by the notion in ancient Greek maps of space as a system of relations, rather than an inventory of locations,[21] the project examines states as the focus of the map.

A_on

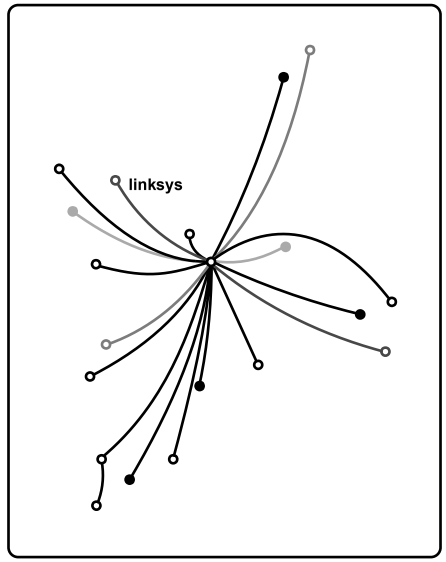
wifi nodes: mostly locked with mostly default node names



(*figure 1*)

B_on

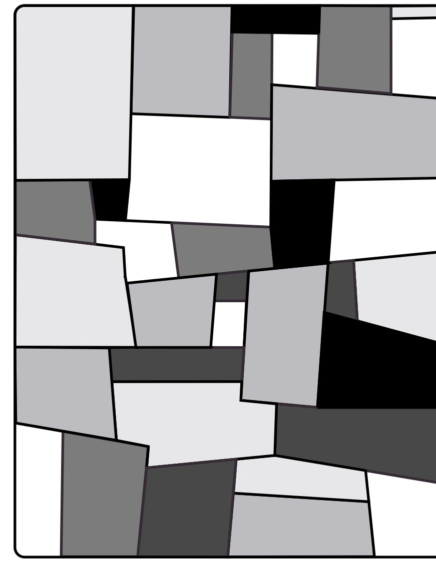
wifi nodes: mostly unlocked with mostly default node names



(*figure 2*)

C_on

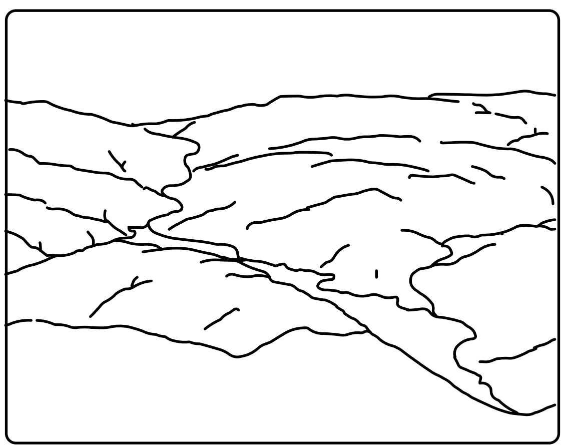
wifi nodes: mostly locked with mostly unique node names



(*figure 3*)

D_off

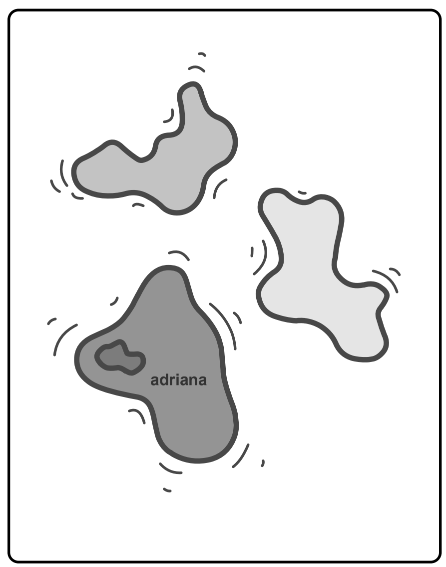
wifi nodes: no nodes detected



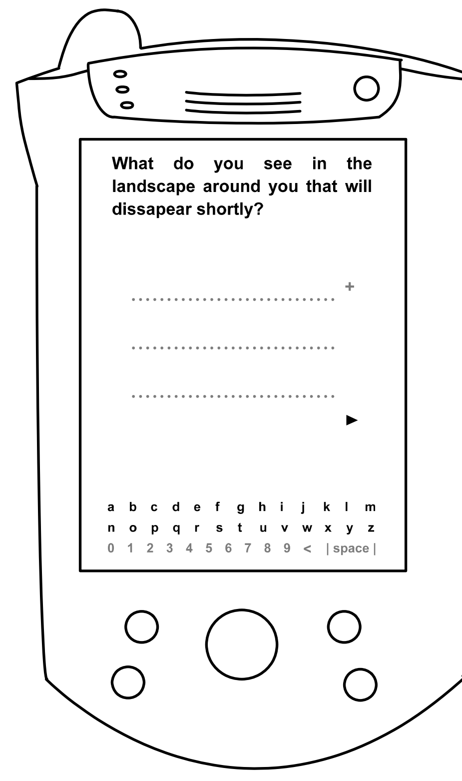
(*figure 4*)

E_on

wifi nodes: mostly unlocked with mostly unique node names



(*figure 5*)



(*figure 6*)

TRACE similarly examines WiFi nodes as elements with a system of relations. This concept of mapping is particularly applicable to the idiosyncrasies of wireless networks in which there is the often an accidental occurrence of common network names which are understood by stumbler utilites, as being the same network. As accumulated, these nodes contribute to a collective state, derived from a matrix of possible conditions generated from the logs of stumbler programs. These conditions, most generally include being in or out of range of a WiFi network. If a network is encountered, the piece generates a map based on node names (unique or default) and encryption status (locked and unlocked). This matrix produces five states that correspond to five unique maps **(see figures 1-5)**.

Although each node is independently recognized within the project's software, these points are mapped according to the conditions of the majority of nodes. TRACE examines these nodes as related events that contribute to a landscape, rather than as discreet incidences. In turn, the project becomes a register of the collective wireless landscape as it is impacted by the discreet events of individual decisions.

<u>Temporal Maps</u>

By investigating the urban landscape through the concept of the state, *TRACE* interprets the city as a dynamic space that is perceived through one's subjective route. The project employs the graphic conventions of cartography to illustrate each state, and extends these mappings over time, as an evolving animation characterizing fluctuations in the wireless landscape as well as the duration of the route. The project borrows from the cartographic traditions used throughout the history of mapmaking. Broadly, these include the devices of projection, orientation, a key or legend, naming, and field conditions illustrations. In addition, specific maps draw from the graphic conventions used in boundary, topographic, aerial, and panoramic maps.

Most generally, projection in *TRACE* is used to describe the binary state of being on or off the network. While the vertical plan is used for maps within range of WiFi zones, the panoramic or perspective map is used for being out of range, or in dead zones. The plan view is an official and precise means of orientation. It is an "objective" view, created through exact measurements. As a survey of space, it is common to the official depiction of geographic location. As a result, it is a visual convention that is used to describe features including sanctioned boundaries, lot sizes, property lines and streets. *TRACE* adopts this projection as a means for representing the data detected about each node including signal strength, node name, and encryption status. In addition, by choosing a generic view, the project removes geographic orientation while remaining familiar to common forms of representation. This evokes the idea of Hertzian space as a landscape, and the participant as a surveyor of it. In comparison, the panoramic or perspective map conveys a looser interpretation of space. Generally an interpretive illustration, not drawn to scale, it suggests a subjective view of the landscape characteristic of late 18th century maps.[22]

<u>Survey</u>

Inspired by the poetic questionnaires created by Yoko Ono, and other Fluxus artists in the 1960's, *TRACE* employs the device of the survey as a tool for understanding the hybrid space created between the Hertzian state and the physical landscape. As one uses *TRACE*, encountering new states in the wireless landscape, their journey is punctuated by a series of questions about the city around them. These questions create parallels between the fluctuations of the wireless network and the ephemeral qualities of the city. They are formulated to gather responses to urban events that are both unmapped and temporary **(see figure 6)**.

Conclusion

Hertzian space is radically reforming our relationship to the physical landscape. Wireless technologies undermine the traditional boundaries of architectural space and create new margins of public and private, on and off, lost and located. The implications of this erosion have profound effects on the ways in which we orient ourselves to the city as well as the ways in which we conceive of the construction of space. As we relinquish our bearings on a purely corporeal interpretation of the urban landscape, we have the opportunity to reconsider the city as a temporal system, rather than as a series of static landmarks.

As the wireless landscape increasingly becomes a subtext to our experience of the city, it undermines an exclusively geographic interpretation of space. Mapping this terrain provides a means for understanding its emergent dynamics. In addition, maps are important agents in provoking new ways of seeing the territory they describe. Although many recent projects have attempted to map this hybrid landscape, they have not rejected the idea of static space associated with the basemap.

TRACE is a project that reveals the dynamics shaping the urban landscape. It proposes new methods for understanding the life of the city as an ever-changing system that can be visualized independently of the built infrastructure of the city as well as the Cartesian grid. By making the intersection of the physical and immaterial landscapes visible, *TRACE* aims to provoke new ways of understanding the contemporary life of the city.

References

Notes:

[1] See Giambattista Nolli's 1748 figure-ground map of Rome entitled "New Map of Rome" in which he delineated public space as white and and private space as black. Published online at <http://www.lib.berkeley.edu/EART/maps/nolli.html> (accessed August 2005).

[2] See William Mitchell's discussion of wireless transmitters in William Mitchell, *Me++* (Cambridge: MIT Press, 2003), p. 49-52.

[3] See Michael Batty's discussion of the city as clusters of spatial events in Michael Batty, *"Thinking About Cities as Spatial Events," Environment and Planning B: Planning and Design* l29, no. 1 (January 2002) p. 1-2. See also Anthony Townsend, "Wired/Unwired: The Urban Geography of Digital Networks," <http://urban.blogs.com/research/dissertation/index.html> (accessed August 2005), p. 119-133. See also Mitchell (2003), p. 120-127.

[4] Ad-hoc networks are formed when two wireless devices, equipped with a transmitter and receiver, come within range of one another. As opposed to fixed networks, they do not require a base station, the network is established between peers.

[5] See project web site <http://www.tracemap.net>.

[6] See Anthony Dunne and Fiona Raby. "Tunable Cities," *Architectural Design* 68, no. 11/12 (November-December 1998) p. 78-79. Dunne and Raby describe Hertzian space by observing that,". . . [H]ertzian space is actual and physical even though our senses detect only a tiny part of the electromagnetic spectrum. Images of footprints of satellite TV transmissions in relation to the surface of the earth, and computer models showing cellular phone propagation in relation to urban environments, reveal that hertzian space is not isotropic but has an 'electroclimate' defined by wavelength, frequency and field strength. Interaction with the natural and artificial landscape creates a hybrid landscape of shadows, reflections, and hot points."

[7] William Mitchell, *Me++* (Cambridge: MIT Press, 2003), p. 120. William Mitchell points out in his book *Me ++* that "The most profound effect of electronic tracking, inscription, and interrogation techniques is, in combination and on a large scale, to change the fundamental mechanics of reference – the ways in which we establish meaning, construct knowledge, and make sense of our surroundings by associating items of information with one another and with physical objects."

[8] See current projects and open source code created by the Locative Media Lab <http://locative.net> (accessed August 2005).

[9] Many of the first forays into collaborative mapping projects, including Urban Tapestries <http://www.proboscis.org.uk/urbantapestries/>, Annotate Space <http://www.panix.com/%7Eandrea/annotate/>, and PDPal <http://www.pdpal.com> draw from digital data sets to present basemaps that illustrate the geographic features of the city; including road systems, public transport routes, and district names, as a datum upon which to annotate information. Although many collaborative mapping projects undermine their own basemaps by layering them with communally defined concepts of space--including participants' emotions, itineraries and memories--these annotations are inextricably linked to the predefined foundations of the map the overlay. Common digital datasets, like the U.S. Census Bureau's TIGER databases, are an expression of a singular notion of urban space – one that favors the street over the route, the static over the temporal, and the formal over the subjective. The basemap promotes an understanding of the city founded on a purely geographic categorization of urban space, defined by the Cartesian coordinate, the road system, and the block plan. As contemporary projects are created that build upon the datum of common basemaps, they are structuring a collaborative notion of space within this predefined conception of the city. For a further discussion of the basemap see Sant, Alison "Redefining the Basemap" in *Acoustic Space: Trans Cultural Mapping* (Riga: The Center for New Media Culture RICX, 2004) p. 153-156.

[10] Batty (2002), p. 1.

[11] Michel de Certeau, *The Practice of Everyday Life* (Berkeley: University of California Press, 1984), p.117.

[12] Bluetooth is a specification for the use of low-power radio communications to wirelessly link phones, computers and other network devices.

[13] See Eric Paulos and Elizabeth Goodman, *Familiar Stranger Project: Anxiety, Comfort, and Play in Public Places* in which "familiar strangers" are detected on mobile devices via Bluetooth networks and visualized as an ambient landscape. <http://berkeley.intel-research.net/paulos/research/familiarstranger/> (accessed August 2005).

[14] From author's stumbler logs in San Francisco, June 2004.

[15] ZRNetService, <http://www.zrnetservice.com> (accessed August 2005).

[16] Surf and Sip Network, <http://www.surfandsip.com> (accessed August 2005).

[17] Anthony Townsend is an urban planner and founder of NYC wireless. His thesis outlines a project for Manhattan's Bryant Park, one of the first outdoor public places to provide for 802.11 wireless access. He continues to work toward providing free public wireless Internet service to mobile users in public spaces throughout the New York City metropolitan area. See New York City Wireless, <http://www.nycwireless.net> (accessed August 2005).

[18] SFLAN, <http://www.sflan.com> (accessed August 2005).

[19] Consume.net, <http://www.consume.net/> (accessed August 2005).

[20] free2air.org, <http://www.free2air.org/> (accessed August 2005).

[21] Christian Jacob, "Mapping the Mind" in ed. Denis Cosgrove, *Mappings* (London: Reaktion Books, 1999), p. 40-41. In Christian Jacob's essay, he describes Erosthenes' third century BCE world map as an example of a map as networked space: "If Ptolemy's regional maps were a catalog of positions, Eratosthenes' world map was perhaps more like a relational database: a device wherein a given place was meaningful and relevant only as an element within a system of relations. . . Erosthenes was interested in the structure rather than the inventory. His map relied on a set of notable points, each defining its unique meridian and parallel. These lines were not organized into a systematic grid, and the aim of the map was not to locate points, but to organize a space of *summetria* (commesurability). . . It established a set of mathematical correspondences between places that were not interrelated. . . . Thus it allowed new kinds of journeys – analogical and syllogistical ones…It was thus possible to travel through the inhabited world in an abstract and geometrical way, thanks to this network of lines creating non-empirical relationships between remote places."

[22] For a broader discussion of planar and perspective maps see Christine Boyer, "Topographical Travelogues and City Views" in *The City of Collective Memory: Its Historical Imagery and Architectural Entertainments* (Cambridge: MIT Press, 1998), p. 203-291.

Illustration Credits:

figure 1 Alison Sant, *TRACE: Map A* (Flash Animation 180 x 240 pixels, 2004-05)
The organizing grid used in map A draws from the rural grid divisions of the American Land Ordinance Act of 1785 in which land was systematically surveyed into six-mile square townships, which were then subdivided into thirty-six sections equaling one square mile each. Map A evokes this constrained grid to describe the state in which most nodes are locked and have mostly default node names. The lines of the grid are at ninety-degree angles, and all set as a scale of the primary dimension, 20 x 20 pixels. As a node appears, it is rendered according to these dimensions, and grows in proportion if new nodes with the same name are added. The mapping evokes the constraints of the grid and a lack of customization, as the majority of node names are factory-assigned.

figure 2 Alison Sant, *TRACE: Map B* (Flash Animation 180 x 240 pixels, 2004-05)
Map B, predominately unlocked nodes with default node names visualizes the idiosyncrasies of stumbler programs in which identical WiFi node names are recognized as a common network. Map B borrows from aerial maps in which an itinerary is illustrated as a set of connecting destinations. As new nodes with the same default node name are added, they contribute to a growing array of interconnected points. The pattern that is formed is unique to each participant's journey and is unconstrained, to suggest their unlocked status.

figure 3 Alison Sant, *TRACE: Map C* (Flash Animation 180 x 240 pixels, 2004-05)
Map C, extends the metaphors used in Map A, but distorts them as it applies to mostly locked nodes with mostly unique names. Although the grid is still present, the shapes are uniquely suited to each node and are at varying angles. The map suggest customization, but within the constraints of a fixed system. Map C also borrows from US county maps in which boundary lines are modified around cultural, political, and geographic features as well as Sanborn maps in which property lines are set, but unique to the specific footprint of a building and lot size it occupies.

figure 4 Alison Sant, *TRACE: Map D* (Flash Animation 180 x 240 pixels, 2004-05)
Map D, is a map describing the "dead zone." It is uniquely horizontal, requiring the user to turn the PDA on its side to view it, and is the only map drawn in perspective. The use of perspective in Map D suggests a subjective and unmeasured view appropriate to the dead zone as it is a state in which WiFi detection is unavailable. The mapping is derived from cartographic conventions, typical of the methods of panoramic maps. Generally not drawn to scale, they show the landscape as a pictorial representation, emphasizing the subjective view of the map-reader.

figure 5 Alison Sant, *TRACE: Map E* (Flash Animation 180 x 240 pixels, 2004-05)
Map E, mostly unlocked nodes with mostly unique node names, draws from the conventions of topographic contour drawings in which a boundary line articulates uniform heights in a geographic area. Each shape is highly unique, conforming to the specific landscape it is derived from. The contours in Map E reinterpret this graphic form to suggest unconstrained access and unique node names. Each node illustration is derived from the number of characters in its name, producing a variety of shapes. As additional nodes, with the same node name are added to the map, they build upon the original node, creating more complex shapes. The field is unconstrained by the grid, evoking open access.

figure 6 Alison Sant, *TRACE: Question* (Flash Animation 180 x 240 pixels, 2004-05)
TRACE employs the device of the survey as a tool for understanding the hybrid space created between the Hertzian state and the physical landscape. As one uses *TRACE*, encountering new states in the wireless landscape, their journey is punctuated by a series of questions about the city around them. These questions create parallels between the fluctuations of the wireless network and the ephemeral qualities of the city. They are formulated to gather responses to urban events that are both unmapped and temporal.

Glossary

city as a space of events
A concept proposed by Urban Planner Michael Batty in his essay "Thinking about Cities as Spatial Events" (2002) in which he argues for a temporal understanding of the life of the city as a means for appreciating the profound effects of events that take place in cities over short periods of time.

Hertzian space
A term derived from the name of German Physicist Heinrich Rudolf Hertz (1857-1894) who was the first to produce electromagnetic waves artificially. The concept of Hertzian space was popularized by Anthony Dunne in his book *Hertzian Tales: Electronic Products, Aesthetic Experience and Critical Design* (Royal College of Art, 1994) and later expanded on in the 1998 essay "Tunable Cities" co-authored with Fiona Raby in *Architectural Design* (November-December 1998), as well as in their book *Design Noir: The Secret Life of Electronic Objects* (Birkhauser, 2001).

temporal maps
Used by the author to describe a cartographic technique in which spatial relationships are illustrated over time.

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Sant teaches classes in new media at the San Francisco Art Institute, Mills College, and the California College of the Arts. She has been awarded artist residencies at the Djerassi Resident Artists Program in 2001, Headlands Center for the Arts in 2000, and the Tryon Center for Visual Art in 1999. Sant is also a recipient of a 2003 Creative Work Fund Grant and is currently an artist in residence at UCSF Mount Zion. She received her BFA from New York University in 1993 in the Departments of Photography and Interactive Telecommunications and received her Masters in Design at the College of Environmental Design, University of California Berkeley in 2004. Sant is currently an Artist in Residence at the San Francisco Exploratorium.

Telecommunications and Sustainability

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ABSTRACT

Although telecommunications networks are central to modern urban life, the relationship of sustainability to telecommunications has been largely ignored by scholars and policymakers. Telecommunications can affect sustainability as a result of the complex, indirect effects that changes in telecommunications systems have on mobility, land use, locational decisions and energy consumption. During the past quarter-century, the construction of new telecommunications networks for communications across national borders, within metropolitan neighborhoods, and inside buildings, has transformed the way in which we use information. This article explores ways in which telecommunications has allowed for great strides towards a more sustainable urban ecology by making buildings more efficient, shifting reliance from roads to fibers and transforming government, economic development, transportation and disaster preparedness.

Keywords

Telecommunications, environmental sustainability, government, economic development, transportation, disaster preparedness

1. INTRODUCTION

In the most current discussions of the legacy being left for future generations, environmental sustainability is an inordinately popular theme. Sustainability, or the concept of minimizing environmental impact to maintain a usable environment for millennia to come, typically is discussed in concert with mining natural resources, developing infrastructure, farming, sprawling, population control, and the like. What are typically under-discussed, however, are the various points of intersection between sustainability and telecommunications; in fact, the latter was excluded from a recent United Nations comprehensive report on the former. Telecommunications' impact on sustainability may be excluded from the debate because of the fast and furious rush for everyone to gain mobile phone access in their areas, "get online" at work and at home, and expand service to those without. Particularly in cities, both the pervasion of infrastructure buildouts and long-term environmental effects are muted, if not unnoticed. But the confluence of these two elements should undoubtedly evoke greater focus, as it is significant and multifaceted, as will be discussed here.

Environmental sustainability consists of two main components, the first involving the adaptation and re-employment of infrastructure from previous uses, such that unused building materials, train tracks and the like will be reused for new purposes, such as recycled steel or bicycle paths. This method curtails the amount of heavy waste and unnecessary development of new infrastructure. The second type of sustainable development idealizes minimal impact on the environment while remaining a productive society. This is defined by the U.N. as "development that meets the need of the present without compromising the ability of future generations to meet their own needs." Such development would call for a reduction of development in previously undeveloped areas, or construction of "green buildings," which lessen the quantity of natural resources needed for day-to-day operations.

2. A KEY TO SUSTAINABILITY

2.1 Buildings

Efficiency is one major measure of urban sustainability, whereas a piece of infrastructure produces more than its input. Clearly, the advent of telecommunications has substantially increased the efficiency of urban buildings: their amplified input and output, plus communications within, significantly increase efficiency and therefore heighten the value of every building from its former usage levels. In a sense of adapting infrastructure to new uses, buildings stand as beacons for sustainable development, now more valuable than they were before telecommunications became the lifeblood of urban communications.

Specific growth in building efficiency is the result of greater deployment of high-speed connections and higher usage of existing ones. The following table shows the growth of available information rates over time, enhancing building efficiencies consistently.

Table 1. Data Speeds over Time [1]

1978	100 to 300 baud
1988	1200 to 2400 baud
1993	14,400 baud
1997	33,000 baud
1998	56,000 baud
1999	1.5Gbps DSL and cable mode connections
2003	10Gbps

2.2 Applications within Cities

As the internet has gained in popularity, several observers have predicted an end to the need for cities: business operations would move to cheaper locales closer to workers' suburban residences; people would work from any location, dispersing the workforce;

and communications would take place only through phones or computers, eliminating the need for face-to-face contact. Since telecommunications does allow workers and businesses to disperse across the globe, many believe it will lead to more use of polluting automobiles and trucks. However, cities remain vital as nodes for both telecommunications infrastructure and human interaction; what has changed is the need for balance between virtual and face-to-face contact. Although simple discussions may take place via phone or internet, the increase in information inputs has, in turn, added to the number of complex factors that need to be considered at a given time, therefore requiring face-to-face interaction for those non-routine questions requiring negotiation, bargaining and use of subtle body language in communication. It is this combination that keeps a handful of mega-cities relevant and thriving in this age of high-speed telecommunications.

2.3 Blurred Boundaries

Structures increasing in usefulness are not only businesses-related; homes and transportation modes are experiencing major upsurges in information available to them and the amount of communications that happen within. Home life has become more productive overall, allowing people to perform functions for which they formerly had to travel, like banking, food shopping and registering health measurements from home-based equipment. Like office buildings, homes have significantly grown in their efficiency and sustainability. For similar reasons, people can journey further from their home bases and still be easily in touch; both commutes and long-distance travel have increased in mileage due to ability to maintain contact and productivity. This use of transportation vehicles as satellite offices and contact points considerably adds to the sustainability of related infrastructure, like roads, trains and buses.

In fact, due to the emergence of ubiquitous computing, the home, car and office have become nearly indistinguishable in function: people can work from home, manage home-related tasks (like banking) online at work, and can make personal or work-related calls from the car, train or bus. The boundaries between home, office and travel have been obliterated by the growth of mobile phones, which now exceed the number of land lines in the U.S. last year; 6% of mobile phone users are no longer using land lines, demonstrating that people need to be in contact regardless of their location or setting. [2] Furthermore, according a recent Pew Internet study, "23% of adult U.S. internet users have gone online from a place other than home or work," including schools, friends' homes, libraries, hotels, cyber cafes, community centers and houses of worship. [3] Apart from each locale's own efficiency measures, a cumulative benefit arises from their relative interchangeability.

2.4 An enabler of economic development

Efficiencies brought about by telecommunications have also fostered local and regional economic development. While office workers claim to have been made more productive by email, businesses co-locate in high-rise buildings or office parks to share telecommunications fiber, parking lots and mass transit resources, adding further efficiency to each piece of infrastructure. These businesses' ability to gain lowest-cost locations at the greatest opportunities shows marks of efficiency in the real estate market and in communications, as their travel needs are heavily reduced. In fact, an estimated $2 billion was spent on communications equipment and services in 2004 (versus $371 million in 2000), according to one study. [4]

Efficiencies rising from telecommunications have also significantly benefited the development of small businesses. Because city life combined with telecommunications provides more and more opportunities for interaction – in person, on the phone, and by email – business people can make plans rather quickly, can arrange for meetings just moments in the future, and can adjust plans instantly. The ability to continuously adapt schedules tremendously simplifies business operations and eliminates many superfluous exchanges.

In general, telecommunications has begun a trend towards the sharing of previously individualized resources that can contribute to overall economic productivity and sustainability, particularly through the implementation of ubiquitous tools. For example, public wireless internet facilities allow users to connect without the road upheaval and wire placement necessary for smaller-use connections. Public places are now more purposeful places of work, education and entertainment alongside mere relaxation. Likewise, car-sharing services managed online allow for a more efficient use of soft infrastructure, as do Voice over IP communications, which essentially share hardware for their operations. Most of these uses are only practical in urban settings, indicating a trend towards reduction of superfluous infrastructure and thus a positive step towards more technologically and economically progressive and environmentally sustainable cities.

3. ENHANCED ACCOUNTABILITY OF GOVERNMENT

Several additional ingredients of cities combined with telecommunications contribute to urban sustainability, including citizen interaction, public safety and transportation. City governments, which comprise much of the employment and transactions in major urban areas, produce far less paperwork waste with the advent of e-government websites, intranets and information phone numbers. The websites allow city residents to pay parking tickets online, find lost property information, and instantly complete other processes that formerly took months. In fact, according to the Pew Internet Project, 97 million Internet users have used government Web sites. City intranets allow for simplified transactions between different agencies, while the 3-1-1 information line available in many cities has truly enhanced residents' concerns and knowledge about services. New York City's 3-1-1 number has received nearly 45,000 calls every week, mostly to express concern about negligent landlords, parking information and transit inquiries. With a tool like 3-1-1, residents and visitors respond effectively when making decisions about their behavior and activities, improving cities' overall functionality. Likewise, city governments learn a great deal of new information from callers, like pothole locations, noise violators, and missed trash pickups. The mutually beneficial system of 3-1-1 fosters more productive citizens and government, significantly reduces the use of materials, and on the whole improves the efficiency of city functions.

3.1 Transportation

Transportation, and intelligent transportation systems (ITS) in particular, is perhaps the best example of the harmony between sustainability, telecommunications and ubiquitous computing. ITS unclogs highways by directing drivers to the least congested route, which decreases use of natural resources for fuel and reduces pollution emitted by idling cars. [5] Similarly, several mass transit ITS tools streamline the systems' uses and improve management of transit activity, including passenger information displays, which allow passengers to make the most efficient decisions about their transit routes; bus and subway tracking, which makes deployment and en-route management more effective; and commuter pattern monitoring through digitized transit passes, which allows for enhanced knowledge about travel activities, like multi-stop trips. All of these technologies provide important improvements to city transportation agencies' abilities to manage effectively their systems, therefore ensuring infrastructure that will serve its best possible purpose, last longer, and minimize necessary construction. With efficiency heightened and pollution reduced, telecommunications directly steers transportation towards a more sustainable future.

4. CONCLUSION

This article is an initial exploration of the relationship between telecommunications and urban sustainability. Although we have considered telecommunication's sustainability in terms of efficiency, effectiveness, and minimizing long-term impact, the topic warrants further study in order to find sustainable approaches to infrastructure development, such as using reusable materials for communications lines, to encourage building communications-efficient buildings that are readily upgradable to future needs, and to encourage technological developments for enhanced cyber-meetings and office work. Even without taking these steps, telecommunications will likely continue to ever-increasingly improve the sustainability of our cities. It is, however, important to consider the consequences of current developments in order to allow future generations to best meet their needs, physically and virtually.

5. AUTHOR BIOS

Mitchell L. Moss is the Henry Hart Rice Professor of Urban Policy and Planning at the Robert F. Wagner Graduate School of Public Service at New York University. He conducts research and writes about urban government and politics, telecommunications and economic development, and the future of urban regions. Mitchell Moss has been on the faculty of New York University since 1973 where he teaches "Public Policy and Planning in New York." His essays have appeared in The New York Times, New York Daily News, Newsday, The New York Observer, and The New York Post. From 1987 to 2004, Professor Moss was Director of the Taub Urban Research Center at NYU where he directed several studies of information technology and urban development. Mitchell Moss received his B.A. from Northwestern University, M.A. from the University of Washington, and Ph.D. from the University of Southern California.

Sarah Myland Kaufman recently completed her graduate studies in Urban Planning at the Robert F. Wagner Graduate School of Public Service at New York University. She specializes in telecommunications in urban settings, particularly as related to intelligent transportation systems, economic development and emergency communications, and received Wagner's writing award for her Masters thesis, "Hour Power: A physical, political and economic design for New York's bus arrival time indicator system." During her time in graduate school, Sarah worked for two New York City government agencies, the Economic Development Corporation in the Infrastructure division, and the Department of Information Technology and Telecommunications. She is now conducting research on telecommunications in cities at NYU. Sarah Kaufman received her A.B. from Washington University in St. Louis in Science Writing with a concentration on Computer Science.

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Swarm Intelligence for Urban Computing

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ABSTRACT

Artificially designed cities from the 60s often suffer from their simplified architecture, resulting in a reduced quality of life for the inhabitants. In this position paper, we propose to apply results from the field of swarm intelligence to the design of an urban computing environment to appropriately reflect the complex structure of modern society. We outline a multi-agent system for a basic implementation of the envisioned infrastructure.

Keywords

Urban Computing, Swarm Intelligence, Multi-Agent System, Urban Design

1. INTRODUCTION

In "A City is not a Tree," Alexander [1] argues that natural cities differ from artificial cities in that they are often unsuccessful in acquiring the "patina of life." His point is that artificial cities are designed as tree structures and thus create mutually exclusive places. But modern society contains a lot of overlap, e.g. there are several overlapping circles of friends one belongs to. Alexander writes, that a much more complex structure is needed to reflect the social reality.

Minett [5] took up this argument and wrote that the problem can be found in the design process itself. Since the shortcomings of urban design cannot be easily undone, the designer is in a responsible and powerful position. Minett further argues that the needed complexity cannot be designed intentionally. In his opinion, the overall design should instead result from the interaction of independent actors. A complex structure would emerge from multiple interactions.

Recent designs of *Digital Cities*, e.g. parts of Digital City Kyoto [3], exhibit a similar simple tree-like structure. On the one hand, we worry about the repetition of the same mistakes observed by Alexander when it comes to the design of an infrastructure and of applications in ubiquitous computing for the urban environment. On the other hand, we think that an adequate infrastructure could have a strong positive influence on the further development of a real city.

The discipline of artificial intelligence gives an interesting perspective to the design of complex systems which is related to the idea of Minett: Multi-agent systems and swarm intelligence [2].

Swarm intelligence is inspired by the behavior of social insects. Although individual insects are strongly limited in their personal capabilities, the swarm can solve complex problems, e.g. finding food, building or extending a nest, efficiently dividing labor among individuals, responding to external challenges, and spreading alarm. In these systems, decisions are based on local knowledge and not on global knowledge and control.

Although the complexity and the capabilities of a human being cannot be compared to an insect, humans also need sophisticated tools and mechanisms for the coordination of complex urban projects. We believe that the success of social insects can serve as a starting point for new metaphors in urban computing. Such a ubiquitous information infrastructure for the city could be used to amplify and accelerate the growing of Alexander's "patina of life."

2. FROM SWARMS TO CITIES

Several swarm intelligent systems rely on two basic concepts: Self-organization and stigmergy [2].

Self-organizing systems can be characterized by four properties. *Positive feedback* amplifies a certain behavior, e.g. bees may recruit other bees to follow them to good food sources. *Negative feedback* on the other hand limits a behavior, e.g. if a food source is too crowded. The *amplification of fluctuations* enables discovery of a new collective behavior resulting from random walks or errors of individuals. Finally, *multiple interactions* between individuals are necessary for a new behavior to be adopted by the swarm.

Self-organizing principles are apparently the underlying reasons for several phenomena in a city, e.g. word-of-mouth recommendations of new restaurants or good doctors. Word-of-mouth can be accelerated and amplified by information technology, as demonstrated in the down-throw of the Filipino president Estrada in 2001: The forwarding of a message to a dozen of friends can be done easily in a few minutes with mobile phones. As a result, a large crowd of people was able to form and coordinate their actions [6].

By further taking advantage of such patterns of communication, many situations in urban life could be solved more efficiently. An appropriate information infrastructure could also contribute to the emergence of complex structures in the city through multiple interactions of independent actors, as Minett put it. A critical mass could be achieved through the infrastructure which would not exist otherwise.

Besides direct communication between two individuals of the swarm, e.g. by means of visual contact, a swarm can communicate indirectly by changing the environment, the so-called stigmergy. The environment becomes the medium for communication in this case.

Through stigmergy, an ant colony is e.g. able to solve the problem of finding the shortest path to a food source. The ants do not communicate directly the distance of a path which would be far beyond their capacity. Rather they find the shortest path with a very simple behavior by laying and following a track of pheromones.[1] The concentration of this chemical on short paths is higher and gets reinforced by followers. This mechanism observed in the nature was quite successfully applied to the travelling salesman problem [2]. Wasps use stigmergy to build complex hives including different kinds of chambers and ventilation facilities.

When looking for stigmergy in urban life, one can find many simple applications. Blackboards on the university campus serve for finding a student's job or a student's apartment. Graffiti on walls transport political attitudes of inhabitants of a quarter. Commercial billboards promote a nearby restaurant. A Post-it note on a door saying "back at 10:00" is a useful hint for a potential visitor.

Various location based services for mobile phones aim to digitize such applications. Nevertheless, stigmergy as used by social insects goes far beyond these trivial applications. Could this paradigm not be used for cooperation on a large scale? Could it not be used to even build and extend a human city? Since swarm intelligence is based on local knowledge and local decisions, the inhabitants of a city would have the possibility but also the obligation to actively participate in the process.

An appropriate information infrastructure for these purposes should support the aforesaid communication patterns. It should also provide a mechanism to extend the virtual environment itself so additional environmental properties and simulations could be deployed easily.

3. AGENT PLATFORM FOR THE CITY

Multi-agent systems address both communication paradigms: direct communication and stigmergy. They can change their environment with actuators and perceive the actual state, and thus changes by other agents, with their sensors. They can also directly communicate with other agents. An architecture could roughly be designed from four elements.

A *public agent platform* for urban purposes (private components could also connect) is at the heart of the system. This platform provides a generic environment for direct communication and stigmergy. The platform could be protected against misuse, e.g. by registering every citizen. Compatible platforms are installed on the *mobile devices* of urban dwellers. People can communicate with the public platform through user agents and send their own agents by migration. This gives the mobile user several well-known advantages, e.g: to reduce network load and cope with unreliable connectivity [4]. *Objects in the city are represented by agents*, e.g. trams, shops, public offices. These representative agents may offer services related to the objects, e.g. schedule a reservation in a restaurant. The *simulation of the environment* could also be implemented by agents. Separate environmental functions, e.g. a pheromone track, could be added successively to the public platform as they are needed. Compared to a WWW-based infrastructure, the agent platform is much more flexible. It can act as a true universal environment for urban self-organization and stigmergy.

[1] A pheromone is a chemical used for communication by animals.

4. CONCLUSIONS AND FUTURE WORK

In this position paper, we have argued for a systematic research into self-organizing and stigmergic systems for urban computing, inspired by results from the field of swarm intelligence. The basic aspects are self-organization by direct communication as well as indirect communication through the environment (stigmergy). The goal of this examination is twofold: (a) rules for the design of an urban information infrastructure reflecting the complexity of social reality may be derived, and (b) the feedback to the atmosphere of the physical city may be studied. Multi-agent technology was identified to be well suited for the implementation of the infrastructure.

For further progress, results from the social sciences may prove to be useful. The aspect of competitive behavior, additional to cooperative behavior which is usually assumed in swarm intelligence, needs to be addressed. Theories from sociology may contribute to foster trust and reputation among the users.

There are also open challenges in the field of multi-agent systems. Especially mechanisms for migration between heterogeneous platforms and for security, both for the agent and for the platform, are not mature, yet.

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Urban Playware
- Intelligent technology for children's play

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Introduction
The last decades have seen considerable changes in children's and youth's play with entirely new kinds of play equipments such as computer games and intelligent toys. At the same time we have seen a decrease in outdoor play, street play and the like, which in childhood research is often conceived as an outcome of the marketing of electronic and digital products that are more attractive and compelling to children than traditional play opportunities. A long list of researchers have warned that the penetration of electronic and digital media will harm children's play and even destroy their ability to engage in social and fantasy play [1, 2]. In recent years a growing problem concerning childhood obesity has alerted the industrialized societies and intensified the criticism of children's media and computer usage from health care and medical science. While the lack of physical activity in play is not the only cause behind the rapid growth of obesity among children and youth it is certainly one of the reasons to the problem. Children are spending an increasing amount of their leisure time sitting in front of a screen, and it seems obvious to lay blame on the seductive forces [3, 4] that apparently are embodied in the media and intelligent products. However, in the following we take the liberty to view the matter in a different perspective and to argue that digital, intelligent technology should be seen as a part of the solution rather than only as a problem. On the one hand, the recent developments in mobile and ambient technologies hold promise for play environments that can stimulate children and youth to engage in social and physical play and thus become an important factor in, for instance, the community's fight against an increasing child obesity problem. On the other hand, it can be argued that the belief of a simple cause and effect relation between the increase in new kinds of play equipments and the changing play behaviour of children is neglecting the many significant social, cultural, and physical transformations taking place in modern societies.
The transformations mentioned above have decisive influence on the decrease in traditional play activities among children and youth, mainly because they have deprived them of many opportunities and places that formerly constituted play spaces, not least spaces for physical play. Therefore, the idea that we can turn the wheel back and recreate children's play behaviour from the past, which is the underlying assumption in most childhood research, is a well-intentioned but probably unachievable goal.

Figure 1. Children playing physical games on the performance tiles at an open square in the city of Odense, Denmark. Performance tiles are both on the ground and on a wall.

"Playware" – a definition
It is not without reason that products that can inspire and create play and playful experiences among children and youth have grown into an important and prospering new industry over the last decades. Computer games are outstanding examples and to day by far the most successful. But the possibilities of using intelligent technology to create play are enormous, and until now only briefly explored and developed. Below we will describe a prototype that can serve as an example of what we consider a new brand of leisure products based on digital and intelligent technology. We suggest the term "playware" as this use of technology to create the kind of leisure activities we normally label play, i.e. intelligent hard- and software that aims at producing play and playful experiences among users and of which e.g. computer games are a sub-genre. Further, we suggest the

term “ambient playware” for playware with ambient intelligence characteristics. Ambient intelligence has been defined as the integration of technology into our environment, so that people can freely and interactively utilize it. In concrete terms, ambient intelligence is provided by a large number of small, intelligent devices, ´in-built´ into our surroundings. These devices have three important characteristics: they can be personalized, they are adaptive and they are anticipatory.

It is our belief that such playware and ambient playware hold great potential for the development of a prospering future industry. But maybe even more important than the economic and scientific impact is the potential impact on fighting the above mentioned increasing obesity threat to our population, as the playware can be directly focused on creating new spaces and possibilities for physical activating play, and thereby promote physical health and thus contribute to the reduction of health problems such as obesity and other lifestyle-related diseases, which are of increasing concern in all industrialized societies. In contrast to the vast majority of research into childhood, health and media, we believe that at least part of these problems in the industrialized societies should be dealt with not by fighting electronic and digital media and play equipment but by releasing their potentials. Playware that can initiate physical play should off course not be seen as the only or the ultimate solution, but we regard the concept as hugely important for the society to prevent the growing obesity threat to the society.

Playware technology

In order to support playware and play environment, it is vital to design and develop units that can be distributed in the environment that the users inhabit (e.g. playgrounds, school yards, city squares, skateboard ramps, sports centres). The units to be developed can be considered *building blocks* with processing and communication capabilities. These units are placed in the real, physical environment and utilise the characteristics of the real world to emerge as a collective, intelligent ‘robotic’ system.

We developed a set of tangible tiles for physically activating children in their play. The tangible tiles are initially utilised in 2D on the ground, but are also extended with wireless handheld units in order to develop activities where children can interact with virtual and/or physical elements in 3D. The new wireless technologies have great potential for the development of new products within the genre of play and games, but exploitation of that potential requires the development of an easily accessible technical platform that joins together the technologies and makes the products widely usable for both producers and users.

The tangible tiles are new play elements, which functions as building blocks by containing processing power, sensors, actuators, and communication capabilities. The tangible tiles have a soft surface, and each measures 40cm*40cm in the first implementation (and 25cm*25cm in the second version). Inside each tile, there is a force sensitive resistor that can register when someone jumps on the tile. The actuation consists of 9 red LEDs and 9 blue LEDs distributed equally on the tile in a 3 times 3 matrix. Furthermore, on the back of the tile, there is made room for a microcontroller (ATmega128) that can register activity from the sensor and control all the 18 LEDS individually. With this simple tile, it is possible e.g. to switch from blue to red or from red to blue every time someone jumps the tile.

To be able to do more complex games than just switching colors on a single tile, there is communication between the tiles. Hence, the micro controller in each tile can be used to communicate with the four neighboring tiles, and it can control the games. So there is distributed processing and it gives the possibility of using different physical configurations (e.g. different number of tiles and different placements) without having to change any program. Each tile can check if it has a neighbor in each of its four sides.

The tiles can be viewed as the technological platform that provides us with opportunities for creating new kinds of play and games. It is possible to have more than one game in the microcontroller so the users can play different types of games. Hence the tangible tiles are an example of playware, and if implementations make them adaptive, personalised, and anticipatory, we would view them as an example of ambient playware.

We implemented different games on the tangible tiles and analysed children’s physical play on the tiles in continuous use for 2 months at a school in Denmark (Tingager Skolen, Denmark), see Fig. 2. In one of the games, colour race, children compete against each other (more children can play in groups) by first choosing a colour (either blue or red) and then in a hurry jump on the tiles so they turn into their colour. Another example is a tangible version of the computer game Pong where a red arrow moves around randomly and when it gets to one side of the tiles configuration, a child has to step on the tile quickly, to return the arrow to the opponent. The arrow can move to one of the connected neighbours. The wicked witch game is an extension, which uses PDAs and WiFi localization to provide story lines and guidance for the children’s play.

The characteristics of having building blocks with sensing, processing, actuation and communication capabilities allow us to develop the physical play in interaction with units that can *adapt* and *learn*. Therefore, ambient playware development aims at creating an ambient intelligence environment for physical play by investigating different issues from modern artificial intelligence such as adaptability and learning and applies them to the physical interaction in the interaction space. For instance, adaptation and learning may be utilized for the system to reconfigure processing (e.g. games) based on the physical rearrangement of building blocks performed by the user in the interaction space. On longer term, the ambient intelligence solutions should be developed at different scales, from objects to environments, able to sustain various human activities. These solutions are based on intelligent building blocks that allow non-expert users to develop intelligent interactive artefacts and environments.

Urban Playware

The utilisation of the robotic building block concept for creating playware allows the user to set up a play space in an easy manner anywhere. In the current form, the implementation can be viewed as an intelligent surface, which can be used in several ways in an urban context. (For earlier interactive surface technology, see [5]). One can imagine such an intelligent surface as a sidewalk, or as the surface of the subway station or bus stop. Indeed, the robotic building block concept allows us to go beyond a static surface, since the surface can be easily reconfigured by any user. As shown in Fig. 1 Left, the tiles can be mounted both on the ground and on a wall. For such surfaces in the city space, one could deploy the tiles as ambient playware to become guiding surfaces, information points, and play spaces, depending on the individual user's need. This would demand personalisation as envisioned in ambient intelligence in order to allow the surface to react in the appropriate manner as, for example, guiding surface, information point or play space. Indeed, part of the playware research investigates how to recognition human behaviours on the tiles, or in the play space in general. This can be done by trying to recognize individuals by their footprint profile recorded on the tiles [6, 7], or by recognising patterns of physical behaviour [8]. In the latter case, we are able to show that different age of children and play patterns can be recognised with an accuracy of up to 90% in such a play space consisting of a floor of tangible tiles. Such classification of human behaviour can be used to create intelligent urban spaces that adapt to persons entering into these spaces, e.g. by transforming from a play space to an information space when an adult enters into the space, as opposed to transforming into a play space when a child enters.

On longer term, by making playware technology based upon the robotic building block concept, we provide freedom to explore the creative potential of designers and architects as well as end-users of urban spaces. The system can be put into different physical configurations and different input/output configurations in a very easy manner by putting building blocks together. The behaviour of the system may then depend on the physical arrangement (the morphology), the uploaded program (the control), and the interaction by the users (the environment).

Indeed, in order to support playware and play environment, it is vital to design and develop units that can be distributed in the environment that the users inhabit, e.g. playgrounds, school yards, city squares, skateboard ramps, sports arenas. Hence, in future we believe it to be important to provide building blocks with wireless communication, easy attachment, and low energy use in order to allow end-users to distribute such building blocks anywhere in their daily environment where they would like to create a play space, even to be able to create and unmount ad-hoc play spaces within seconds or minutes.

Acknowledgement

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Figure 2. Two different types of playware tiles in an indoor environment (school) and outdoor environment (urban square).

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Biographies

Henrik Hautop Lund, full professor, the Maersk Mc-Kinney Moller Institute for Production Technology, University of Southern Denmark. His research group, the AdapTronics group (www.adaptronics.dk), focuses on research in modern artificial intelligence. He is member of the Danish National Research Council, has published more than 90 peer-reviewed papers, and has initiated and coordinated numerous, big research projects such as HYDRA on self-assembling robots (www.hydra-robot.com), Body Games, Intelligent Artefacts, Flexible robots for SMEs, VIKI Humanoid (RoboCup Humanoids Freestyle World Champions 2002), Playing with Ambient Intelligence, etc. He is co-inventor and co-founder of RoboCup Junior. He has collaborated with numerous companies such as LEGO, Bandai, Siemens, ABB, Microsoft. His robot work has been presented to e.g. prime ministers, HM Queen of Denmark, and HM Emperor of Japan.

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Thomas Klitbo, chief of development at Entertainment Robotics. Entertainment Robotics is a company that develops robot and robot technology for toy, playgrounds, advertisement, therapy, etc.

Initiating an Urban Co-Evolution: Injecting Ubiquitous Computation into the Rejuvenating Tel-Aviv Seaport Complex

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The inspiration

It was the biologist and cybernetician Steward Brand who posed this great question: "What color is a chameleon placed on a mirror?" [1]. Two prominent solutions were offered. The first suggests that the chameleon eventually sets into a middle-ground set of colors, a state of *equilibrium.* The second argues for *disequilibrium,* where the chameleon keeps changing color schemes as long as it is standing on the mirror [2]. This magnificent predicament, which relates to the very essence of consciousness and the nature of co-evolution, directs us to one of the most exciting tenets facing the emerging relationship between ubiquitous technology and urban space: Can urban physicality, digitality and biology co-evolve into a new form of urban life? If so, which of the two forms of existence will it take, that of a calm equilibrium or dynamic disequilibrium?

This paper introduces the concept and method of the "Urban Interaction Platform", a Metapolitan project to be executed at the Tel-Aviv seaport area, rapidly-developing public zone supporting a plethora of population, activities, physical elements and natural resources.
Along the project's timeline we will try to explore and test different angles of Brand's quandary with a coherent set of urban interventions.

The Co-evolution of a Metapolis: a Re-composition of values

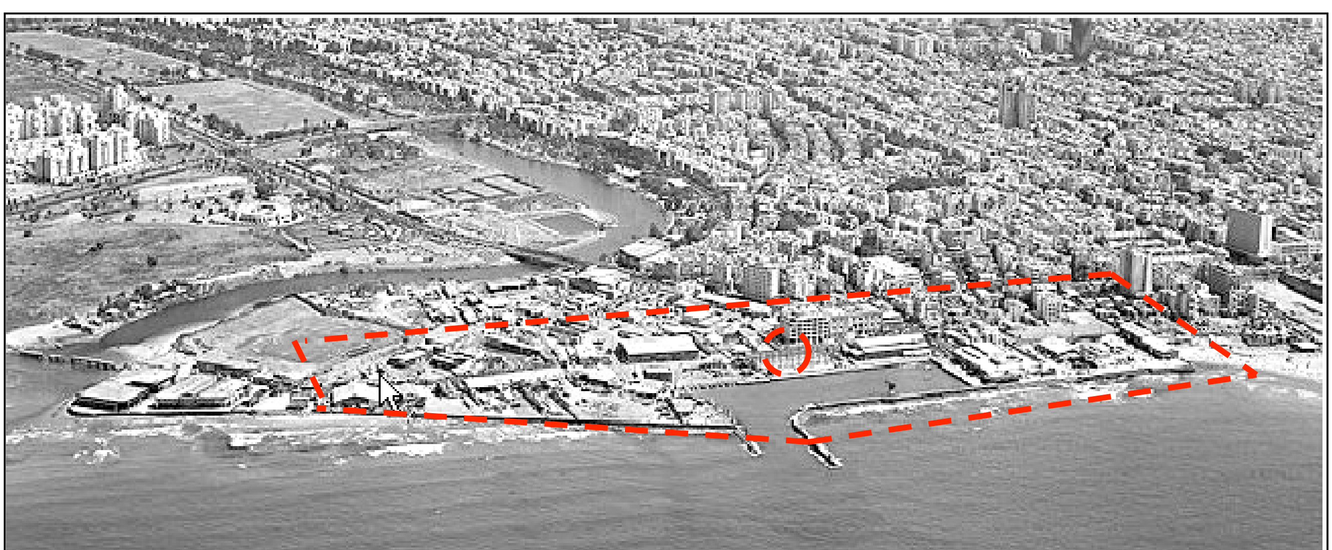
When you sit casually on a bench with legs crossed in the middle of a busy street, you are projecting a certain sense of "inner-ness" to the outside of your body; an inner space that reflects mood, position in life, an attitude towards time and space, towards life. You create a reflection of you. Yet, simultaneously, you are being projected; you absorb the glances of passers by, the coldness of the metal bench, the smell of a nearby bush, the intangible beat of the city. And in turn, this projection would influence your behavior, your reflection. If too many people look at you funny, you might get up and leave your precious bench, regardless of how much your feet hurt. Like the chameleon standing on a mirror, these dynamics generate cause-and-effect processes that formulize into situations, events. These events alter our behavior as well as state of mind. By virtue of contemporary computation we are allowed to enhance such chameleonic dynamics mainly by changing *subject-action-object-action-subject* chain. We do that, for the most part, by empowering objects to respond to subjects, and by shortening distance between time and action. Suddenly, your action on the bench yields a consequence. Suddenly, the digital urbanoid gives the physical urbanoid a voice, an opinion. Now the biological urbanoid is not alone in interpreting his environment. Now he needs to reevaluate his behavior, revisit his values.

Case in point: sensorial networks, wireless communication as well as video/audio surveillance systems allow for the manifestation of omnipresence. While sitting on the bench you are present elsewhere, sniffing and being sniffed by something or someone else. The bench is now an active agent. It reacts to your actions. It likes you. It dislikes you. Your actions (you yawn, your scream, you get up), once linear in nature, are now multidimensional, potentially responsible for not one chain of events, but a few coinciding ones, “disturbing” a long history of physical, psychological and cultural balance.

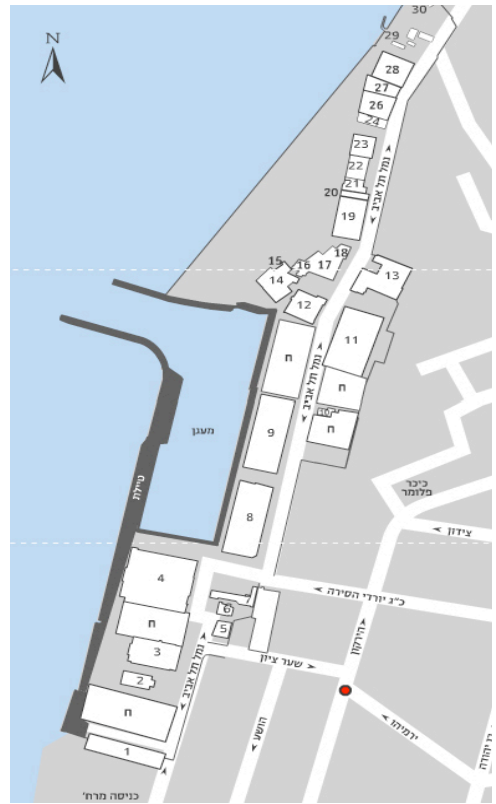
New urban narrativity

These “amebic” interactions evolve into perceptions and behaviors of all three major agents involved in urban co-evolution. They set the ground for new semiotic paradigms and meaningful narrativity: relationship develop as the object becomes a subject, human subjects become information objects, identities alter with location, business models and transactions transform, personal safety involves bits and not just atoms, and playgrounds need not have sandbox or slides. Stories and storylines will not come to existence solely because now “the building can talk” the “light pole can recognize me” or the “public bathroom can cast emotions”. They will evolve because, with its simple building blocks and sassy competition-cooperation tactics, the equilibrium-disequilibrium game is bound to rule this urban space.

The testing ground: Tel-Aviv Seaport



Opened for operation in 1937 as a symbol of prosperity and "redemption" of the Jewish people in then Palestine, the Tel-Aviv seaport has been inactive as such since 1965. However, it is now an emerging area with substantial investments (public and private) made towards increasing its financial and cultural value and branding it as a 21st century model for public activity. The seaport management is committed to its constant development and to the process of transforming the seaport into an important business, culture and entertainment region.



Schematic view of Tel-Aviv seaport area

As a testing field for co-evolutionary Metapolitan process, the TA seaport is highly appropriated. It resides in a defined location, self-managed, and branded as a 24/7 activity zone. It contains a variety of business and leisure establishments and entertains a diverse crowd over the course of a day as well as the yearly seasons. It is embedded in the city (within a few minutes walking distance), and it is an invaluable source of natural energy sources.

The *Urban Interactions Platform (UIP)*

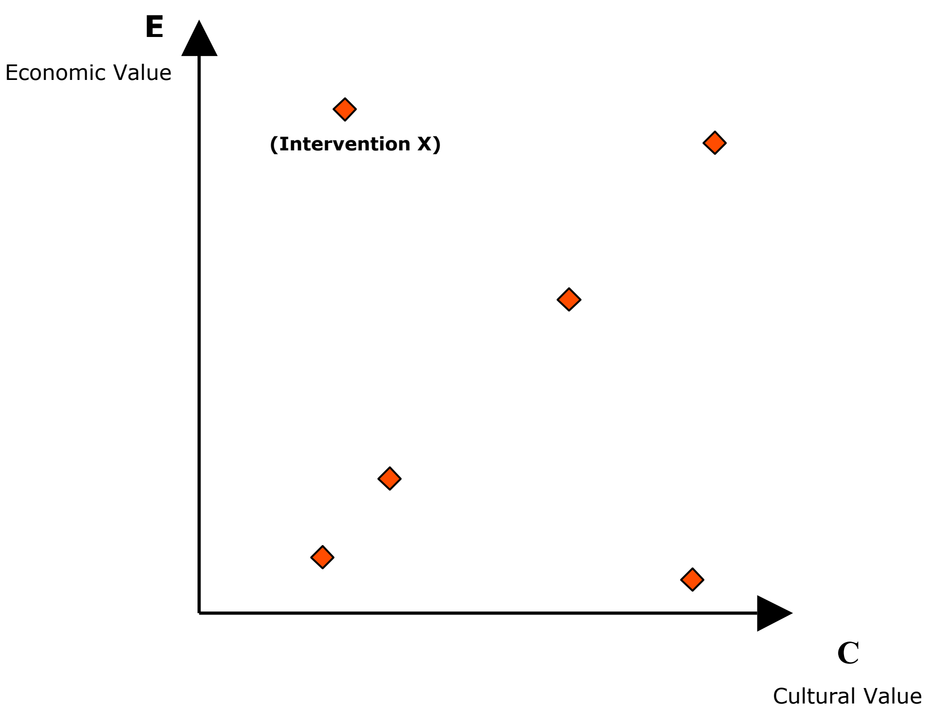
Motivations and goals

Truth to be told, this project was driven, in its present state and time, by opportunity. The Marine authority was looking to add values of both wonder and commercial leverage to its developing real estate; we were looking for a "real world " lab to implement ideas. In that sense, one might argue that the UIP concept is also co-evolving, adjusting to the changing needs of the two-headed monster. Therefore, at this point in time, it would be an academic deception to argue that the goals of this project are set. We will try and we will error, and it will not come as a complete shock to us if, eventually, the "answer" to what really the goals of this project are will come from an elderly lady who will turn to her friend after experiencing one of our interventions and say: "Oh, but this reminds me of…".

This necessary ambiguity in the construction of a new urban myth also corresponds with the natural classification of the UIP: is it a set of tools? A medium? Is it a space-changing construct or human behavior-changing construct? Will it carry the main features of an emergent behavior (robust and resilient, quick to adjust to changes, no single-point of failure, distributed intelligence)? What's to happen, as one of our reviewers has wisely suggested, if a space went bad and reject its biological counterparts? - To make a general assertion, we don't know. We will the goals and potentials for each intervention as well as the conceptual framework for a set of interventions.

We did, however, set up a number of practical goals for the project:
A - to merge and reflect through the system the past, the present and the possible future of this unique urban locale as part of an on-going system.
B - to embrace a multi-scale mode of operation where simple and clear interventions reflect and are reflected onto space.
C – to be able to position our interventions on cultural and financial bars in order to depict and project value to external agents.

UIP Value Graph



Method

The UIP encloses four layers of activities varying in scale and effect, each layer encompassing a series of formulized interventions. The specific nature of each intervention is to be formulized.

Platforms of Interactions:

The embedding and operation of sensing networks that provide sensory/sensual hotspots for information-based interactive applications facilitate new cultural and playful activities. The goal is to use the sensual networks to create information databases from which a new form of community will be initiated.

Events of Interactions

The creation of a series of open interactive events in various locations within the autonomous area that stimulate individuals for play and exploration within the physical surroundings, utilizing unfamiliar design elements.

Installations of Interactions

Forming various closed and open environments in different scales which introduce a combination of the natural and the artificially designed together with the technological environment. The ambition is to tell a personalized story to a random visitor within the urban environment. An important part of these activities is the use of environmental energy and output resources, such as changing weather conditions, sunlight and solar energy, heat and humidity, movement, wind force, water streams etc.

Objects of Interactions

The generation of a series of static and carried objects probes and products that are connected to the spread networks in the location, aimed at creating novel interrelations between the individual guest to the object, within groups of anonymous guests to themselves, and between guests and the physical environment. The goal of these probes is not only to serve as a physical interface between the biological inhabitant and the physical place, but to vehicle a meaningful added value due to design and positioning as a branded, fashionable item.

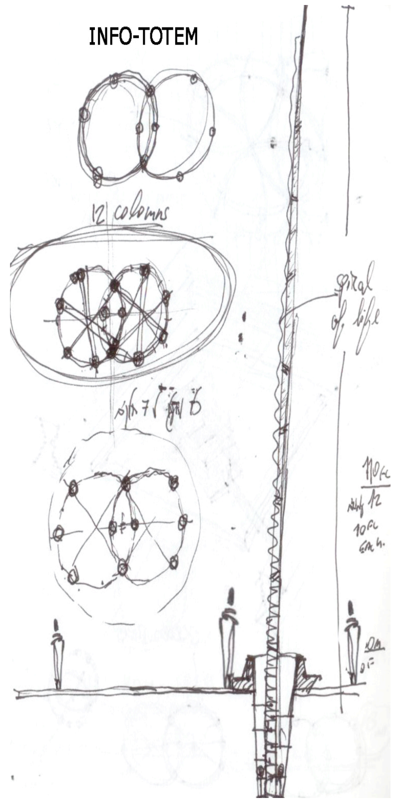
Early implementation: Desensitization

We begin our activity at the Tel-Aviv seaport with three different interventions.

An important objective in choosing these particular interventions is to “desensitize” both marine authorities and future users to our activities. In other words, qualities of functionality, familiarity and communality should be features in these activities so that the UIP approach can penetrate the common consciousness and then be expanded, and to correspond with our intent, co-evolve into a comprehensive Metapolitan process.

The InfoTotem

A public information system that supplies textual, visual and auditory information about the seaport, its history and current attractions. The system is designed as a conspicuous architectural construct (a totem) and will engage visitors to approach. Visitors will navigate and explore information by moving their bodies/hands. Although the InfoTotem will introduce concrete information and simple and clear interaction method, it is aimed to entice indeterminate behavior with unintentional results, wherein visitors play with the system not only to get the direction they need but also to explore the nature of the artifact in front of them. At a later stage, visitors might also be able to add their own "information" to the system by that changing its nature and functionality.



Revisiting the (outdoors) public toilets

Why do people visit the public toilets? What are they actually doing there? Can they do something else? Who will gladly go? Who will risk public humiliation and avoid the public toilets at all cost? What part do public toilets take in urban space? Can we change it? Should we change it? - We will rethink, not only redesign, the public toilets facility at seaport. We view this intervention as an opportunity not only to upgrade an important public service, but also to ask questions about users' beliefs, attitudes and consequential behaviors in this environment. For example: the public toilets are an extremely democratic system. Whether a paid service or not, conditions for all users in a particular facility are equal. Should they be? Should we think of a way to discriminate between toilet users so that the ones "more worthy" receive a better service? Who are they worthy ones? How can the system identify them? According to what criteria? – These are some of the Metapolitan questions we encounter and define, and that will inspire our design.

Participatory installation

We aim, in tandem with the seaport authorities, to set up a series of hands-on workshops to take place inside the seaport area. These workshops will enable participants of various backgrounds and character to be introduces to the Interaction Design paradigm and to the effect its approach might have on their urban surroundings and consequentially urban way of life. These activities will involve field research, introduction of new technologies, analysis of potential social and individual implications and the exploration of new “solutions”. The workshops will result in an event (installations, exhibition, publication) and along a defined timeline, will add not only to our understanding of the Metapolitan field and the nature of the co-evolutionary approach, but will hopefully reduce misunderstandings and misapprehensions as to the integration of new thinking and new tools into intimately familiar and emotionally crucial environments.

A participatory installation, the IDII, Regio, Italy, May 2003

The dock at the Tel-Aviv seaport area, potential location

Be that an RFID-based collaborative game played at 02:00, a motion-sensitive “InfoTotem”, a public toilet cabin that will only open for the “agonizing person” or a self-archiving fishermen’s pier – We are excited about entering the era where, to quote Kevin Kelly, “…openness wins, central control is lost, and stability is a state of perceptual almost-falling ensured by constant error” [p. 89]. Thus a fresh urban mythology is slowly built.

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Eyal is a social scientist and Interaction Designer. With background in social psychology and mass communication, Eyal has done web design work in New York, research at the PLAY research studio of the Interactive Institute in Gothenburg, and conceptual design work for Max Interactive in Tel-Aviv, Israel. Between 2002-04 he has been part of the postgraduate program at the Interaction Design Institute Ivrea (IDII) in Italy, where he performed design and technology-related research and has been exhibited and published internationally. In 2005 he co-founded the B-Lab, an interdisciplinary design research laboratory.

Gal Gaon

Gal is an architect and designer co-founder of the B-Lab operating now from Israel. With an academic background in architecture and design mixed with communication technologies, Gal has conducted worldwide research of design and technology development for Proventus Inc., Sweden. In the last two years gal is focusing on the implementation of new technologies in physical spaces, conducting a studio titled "Virtual to Physical" at the Technological Institute Holon. Gal headed the architecture and design department at the Ascola School in Tel-Aviv and exhibited in several international group exhibitions (Passage de Rets, Paris, the Venice Biennale)

The B-Lab

The Urban Interactions Platform was conceived at the B-Lab, the first interdisciplinary Interaction Design research lab in Israel. Established at 2005, the B-Lab is focusing on research and implementation of concepts integrating contemporary technologies with design and architecture approaches with the intent of authoring a new paradigm for social and individual experiences. The B-Lab is currently collaborating with local and international institutions such as the IDII, Italy, the Technological Institute Holon, and the Technion Haptics Lab, both in Israel.

Parasites?

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ABSTRACT
In this paper, I explore the link between people and the architectural environment today. The way we link informs how to build.

General Terms
Design, Theory.

Keywords
Neo-nomads, mobilities, technologies, urban, architecture.

1. PARASITISM
He studied parasites… When at the Massachusetts Institute of Technology, I came across the work of Michael Rakowitz[1] who had graduated the year before from the Visual Art department. For the purpose of his thesis, Rakowitz, at that time a student of Krzysztof Wodiczko,[2] had put in display the homeless population of Boston areas. His art statement was showing the strong relationship homeless have with the society who engenders them. Rakowitz provided the particular nomadic culture with shelters made of plastic. Not only the strange worm looking shelters drew attention, but their envelopes were also an interface which stressed communication. "By adding pockets to the 'paraSITE' shelters, Rakowitz allows 'the user to display messages to the public,' like a tattoo on one's flesh."[3] More fundamentally, the shelters made of plastic could stand because they were connected to exhausts vents—where usually homeless gather because it is warm. Without the air coming out of buildings, and the link which channels it, the shelters could not take form.

Obviously the relationship is symbiotic because at least one element benefits from the other. On one hand, the "paraSITE" takes shape and the homeless gains a certain identity because of the exhaust vent, while on the other hand, the building—the host—does not profit from the "paraSITE". The relationship however is not totally parasitic as the shelter feeds from wastes of the building. So, if indeed the SITE is "para~", which means "alongside", it does not harm the edifice (unless it is considered as "bad publicity"). As the host remains unaffected, the symbiotic relationship is called commensalism, meaning "at table together" rather than parasitism.[4]

The biological metaphor is by no means innocent. Rakowitz' brilliant art statement which raises awareness of a social dysfunction of our cities has inspired an investigation of close contacts between mobile populations and buildings. Today, other nomadic tribes, those with cell phones, wearable, and other connecting devices develop a deep skin relationship with the architectural environment, starting with the building envelop.

2. LINKS
All New technologies, ubiquitous computing and automats feed today's nomad, the neo-nomad, with information and goods. By calling a number affixed to a wall at a specific location, a "PoemPoint", an itinerant in the city of Leeds in England could receive back on his mobile device poetic text messages.[5] By swiping my cellular phone against a device on a bus, I validate my e-ticket.[6] By inserting my credit card in a vending machine I can buy a wide range of items. In exchange, retailers retrieve information about my tastes and approximate my needs after analysis of my purchase patterns. Hence the symbiotic relationship is mutual, as each depends on the other for survival. A neo-nomad would not survive without his credit card and his cellular phone (as cellular phones increasingly enable transactions). A misplaced vending machine would have no use in a public space, unless one owns a location awareness device.

Similarly to the appendage of Rakowitz' shelters however, the card or the mobile device, the automat even, are tools enabling the link, the exchange between the skin of the building—even if just an interface—and the individual.

Appendages could belong likewise to the individual and/or the building. Like hypertexts, they are at the intersection. When François Asher writes that "It is the 'individuals-words' who constitute themselves the prime links between these 'texts-social fields'", he means that with new technologies individuals navigate in various cultural and social realms. "Et les individus font du code switching…" he says.[7] The link I believe occurs each time an association is created, each time a symbiosis happens.

Architects and urban designers must also consider digitalized cities and their increasingly mobile populations also as fields of hypertexts.

"I link therefore I am" writes William Mitchell in Me++, commenting on our Google visibility.[8] So being part of a network—this extends to any network—signifies gaining an identity! A link enables neo-nomads to make themselves "at home" anytime they plug or connect to automats or, rented spaces like hotels rooms for example. For the sociologist George Amar, biology has taught us that individuals and their movement evolve in "mediums" rather than "space".[9] This observation led him to develop the concept of "adherence" or "grip". People "adhere" with a different degree to environments they pass through. Time and familiarity surely are important for people to "adhere". The experience of a month stay in a hotel room is certainly different than a three days stay. So is the experience of renting the same room in the same hotel, and regularly five times during a year. Some habitués even ask hotels to store away familiar objects that, the next time the client comes, will carefully be put in place exactly where he/she wants them.[10] Alternatively in the virtual arena, the frequency with which I connect, "blog" and appear in chat rooms assure me a digital existence, hence maybe a physical one that one might be interested to know.[11] **Linking is a mental and a physical process.**

3. PARADOXES

Neo-nomads do not roam anywhere and everywhere. The symbiotic relationship between individuals and buildings, how one feeds from the other via linkages (these linkages may be identified through patterns of practice), raises many paradoxes. Being a neo-nomad, both a physical and mental traveler, means that I can roam anywhere… anywhere where the infrastructure exists. For instance, who possesses a credit card from a specific bank might want to avoid paying extra fees by retrieving cash from machines only specific to the bank he/she is a customer of. This system in place smoothly prevents him or her to get "off road". If he/she were to possess many cards however, he/she could roam according to a more complex path. This scenario of alienation seems to privilege the making of a global infrastructure, a homogeneous system of buildings and automats, as the more globalization extends, the more the possibility for physical roaming (of privileged populations) extends.

It is exactly against this sort of alienation that the Situationism International movement reacted. By cutting and pasting different maps together, Guy Debord created what was called "psychogeographical" maps[12]. To avoid the "society of spectacles"—he meant the modern, functionalist, commercial and bourgeois culture—Debord used the technique of the "dérives", created in fact another kind of spectacle, a game with and in the city. No wonder the Situationists fascinate even more today, although it seems that the modern, functionalist, commercial and bourgeois culture prevail. However, instead of physically cutting and pasting, people zap, link, and use "mobile feed directories" like "ifeedyou".[13] **Neo-nomads personalize the city they roam in**.

Because they can choose, people do not embrace market-driven places, and do not roam without aim either. They do both… at times. Asher notes that less encumbered by traditions, our ability to choose expands, but also is function of our mobility.[14] Furthermore, "We are walking in fields of signs" writes Amar.[15] Hence the urban and architectural environments of the neo-nomad are a matter of signs and invisible—yet perceptible—marks of territories.[16] Signs can be as minuscule as a shotcode or semacode tattooed on one's flesh.[17] Neo-nomads build the ability to decode these signs, collect some, and organize their territory individually or in subgroups.

Neo-nomads decode their environment, and carry with them an aggregated cultural baggage of invented and borrowed traditions, a baggage that constantly gets fed as they move.

They carry luggage—memories, an invented cultural environment, stored information. Their luggage? Like an organic growth that feeds from cities—recognizable or unknown environments—they pass through… However, depending on the time spent and their willingness to get off road, neo-nomads will choose to explore or not a local urban culture. A neo-nomad traveling from London to Tokyo for a three days conference has no time to get lost in translation. In this case, the local urban culture does not influence nor "feed" neo-nomadic patterns of practice.

Neo-nomads do not carry all their belonging with them. When speaking about mobility and architecture, the first images to come to mind are mobile homes, and stacks of standardized containers. Traditional nomads, pioneers of the New World, gypsies… etc… carried all their belonging with them, first on animals then on wheels. Today, the strong image of the container still is very emblematic of our society of storage space. Home fits in a container, or a multiple of containers. With the advent of the internet, and mobile technologies however, home has shrunk to the skin.[18]

If I can find a toothbrush, a bestseller, clothes …etc… every place I pass by, why should I encumber carrying them unless it is for environmental and economical reasons. What is the minimum I shall bring with me, my USB key… my laptop? With my USB I can plug to any laptop, and with my laptop I can plug to any space. I can also decide to bring none of these, as family pictures, mails and bills are stored online, and cyber cafés abound. If on the other hand I always carry a laptop, I would prefer going to a free WI-FI community café rather than an encumbered cyber cluster where I pay a fix rate an hour. Because neo-nomads are always on the move, they develop a curious relationship with material things. A Japanese student at the Harvard Graduate School of design once reported: "In terms of physical urban nomads… I was living in an old one-room apartment downtown Tokyo, sharing it with five other friends; it had no kitchen, and no bath. We used a nearby public bath house for taking baths at night. Since the bath house was closed in the morning, we used to go to nearby sports center for morning showers. We did not need any kitchen because we almost never cooked and could eat at the school cafeteria for a cheap price. So basically, our house was the city itself and we shared it with all the other people."[19]

Many neo-nomads renounce to objects, except to these (fetishes?) which enable the mental link—most of them mobile and digital devices. Personally, home is scattered on many continent. I move all my life in two suitcases, my mp3 and family pictures stored digitally, I use public libraries physical and digital… Also, it is always practical to arrive in a furnished apartment at first. Still I have some boxes here and there, in storage spaces, at my parents, elsewhere in caves of friends. Maybe I should take picture of their content, so I can remember. These items were not the most essential to carry with me. I could not throw them away either. I might not even need them now. When writing about the suitcase of the migrant (yet another type of nomad), David Morley clearly puts forth a strong mental connection: "If the suitcase is usually full of things brought from home, for many migrants there is often another crucial physical container, standing empty in their homeland."[20] Some migrants never open their suitcase, hoping to go back, one day.

Neo-nomads are constantly negotiating what they need to carry. "Home" organizes in a network of physical and mental storage spaces.

Before the time of the "kit" and "parts", and a "do-it-yourself" attitude, an immutable system of objects was perpetrating the attachment between human beings and their habitat.[21] In our society of meta-storage space,[22] and now that neo-nomads carry the genius loci of a place with them, people and habitat are no longer "tied" together. Cities have become dynamic aggregations of storage spaces for "PIG", "People Information and Goods" like Asher says. Hence architecture also needs to feed from all individualities of passers-by to avoid homogeneity and a spatial alienation. The change will reside in an architecture resembling growing organisms feeding from human cultural experience, an architecture that one will digitally customize according to his/her personal aggregate of cultural experience each time he/she connects to a space.

To be continued…

4. AUTHOR

Yasmine Abbas, is a French DPLG architect, Paris Val-de-Seine (former Paris-Conflans) 1997, and holds a Master of Science in Architecture Studies from the Massachusetts Institute of Technology, 2001. At MIT, she explored the spatial impact of new technologies by interacting with the Design Inquiry and the Intelligent Kinetic Systems group which led to the thesis research: Embodiment: Mental and Physical Geographies of the Neo-nomad. Since completing her studies at MIT, she has taught related design studios such as "Home-in-a-suitcase" and "Transit". Currently, a Doctor of Design Candidate at Harvard University Graduate School of Design (2006), she focuses on how neo-nomads reclaim a sense of belonging to places in the age of "multiple mobilities". She is part of the Critical Digital student group at the GSD, and is the founder of the recently created neo-nomad, a digital platform dedicated to design and mobility in the digital world.

A neo-nomad herself, she carries "home" in two standard suitcases, each of 158cm (adding length, width, and height), and weighting 32kg maximum, as well as one additional carry on item of 55x40x20cm weighting a maximum of 10kg.

UbiComp2005, Tokyo

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Groupanizer: a method to enhance groupware application using multi-users position prediction

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ABSTRACT
Groupware or computer supported cooperative work often refers to software tools and technology to support groups of people working together on a project, *often at different sites*. Groupanizer is an extension of groupware and constitutes a development platform to integrate user-centric information for the benefit of groupware applications. User-centric context is used in a collaborative manner to positively link and reinforce everyone's idiosyncrasies within the group. In order to do so, monitoring of the user's daily context is essential, and thus, one aspect we aim at integrating is its physical position. We believe that common visited places and trajectories constitute one user-centric element that should be used to bias transactions namely tasks or scheduling in groupware. Although, actual groupware technologies such as calendars or workflow charts could be used to integrate personal context into group coordination, location sensing could provide an edge in automatically deriving schedules and intentions. Hence, we propose a framework to evaluate the possibility of using physical location to enhance actual groupware applications through a multi-user position predictive model.

Categories and Subject Descriptors
C.2.4 [Distributed Systems]: *Distributed databases, Security, integrity, and protection; Spatial databases and GIS*;
H.1.2 [User/Machine Systems]: *human factors*;
H.4.3 [Communications Applications]: *Information browsers*;
H.5.4 [Hypertext/Hypermedia]: Architecture; User issues.

General Terms
Algorithms, Management, Measurement, Design, Human Factors, Standardization.

Keywords
Location awareness application, Groupware, Name resolution services, organizational knowledge, community ware, wearable community, social capitalism.

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1. INTRODUCTION
The advent of ubiquity and mobility in computer networks has drastically influenced our views about computing platforms and virtual environments. Many efforts have focused on integrating a heterogeneous device environment to optimize the available resources to a group or a work environment through a seamless middleware layer [1,2,3,4,5]. The architectures are mainly based on the Model-View-Controller paradigm creating a device-oriented environment easy to program and structure. The Model-View-Controller metaphor used in the Smalltalk-80 project is a precursor to modular programming for distributed computing and sensor networks. This model defines a flexible and malleable framework to connect devices to a specific context. However, in a ubiquitous environment, not only heterogeneous devices need to be integrated, but also heterogeneous personalities, users' feelings, attitudes or objectives. Thus, Groupanizer aims at reusing this heterogeneity paradigm, but applying it to human behaviors. Its function is to create the ideal context among users to share ideas, setup meetings or activities and distribute tasks. In other words, Groupanizer aims at creating the ideal collaborative community context.

1.1 An Ideal Collaborative Community Context
Toru Ishida [6] pointed out that community computing includes five different heuristics for encouraging social interactions among people within a community. The following table's left column identifies those 5 heuristics and the right column specifies which ones we aim at promoting through our project.

Table 1 Community computing heuristics

Heuristics	Groupanizer
Knowing each other	-----
Sharing preferences and knowledge	Yes
Generating Consensus	Yes
Supporting everyday life	Yes
Assisting social events	-----

Hence, we believe that we can reinforce some of these heuristics while using community member's locality information. Basically, we promote physical encounters versus emailing and location-oriented task distribution among people of a community using a predictive model of everyone's daily schedule.

The following table identifies the means by which we aim to reinforce each specific heuristic.

Table 2 Groupanizer's objective

Heuristics	HOW
Sharing preferences and knowledge	Virtual Notes
Generating Consensus	Physical encounters
Supporting everyday life	Task distribution

All of the above heuristics constitute salient characteristics of actual groupware applications. However, for a groupware application to function properly, each participant must input its schedule manually in order to share his personal time assignations, and thus we believe that this should be automatically derived, since we simply do not believe that people will update it manually [23]. In light of this, what if we could automatically derive a daily schedule or personal intentions of participants from the history of their motion behaviors? Motion behaviors could help us derive the ideal context among users to share ideas, setup meetings or activities and distribute tasks. Needless to say that the efficiency of interpersonal communication builds upon a shared understanding of the past, current and last but not least future context within which interactions take place [28].

1.2 Concept

Groupanizer derives from two words namely organize and group. Its sole purpose is to efficiently manage the organization of groups by reinforcing the above stated three heuristics (table2). The current definition of groupware or computer supported cooperative work refers to software tools and technology to support groups of people working together on a project, *often at different sites*. However, current implementations of groupware applications do not consider any physical location as an input to their system. Therefore, in order to compensate for the geographical distance among organizations or groups, we believe that any geographical location should serve the purpose of efficiently distributing tasks, promoting physical encounter, or sharing knowledge. One might argue that location, as the only used type of context information, is not sufficient to support group interaction [10], and that the integration of three other primary types of context, namely *identity*, *time* and *activity* as pointed by Dey [12] are necessary. We agree that the above argumentation especially becomes a reality in a social context and consequently we define a location naming system in accordance with the above four generic context identifiers: *location*, *identity*, *time*, and *activity*.

Moreover, Groupware often applies to individuals that are already part of a structured group such as a company or a University research lab. Thus we do not intend to derive motion behaviors of random individuals, but we focus on already semi-organized groups such as friends, a laboratory or any organization. As mentioned by Wang et al. [11], groups are often formed for a specific purpose such that their collaborative interactions become predictable. Therefore, the activity recurrence patterns will allow us to derive group motion behavior models that will increase the accuracy of our predictive model at the user level.

1.3 Previous work

Location aware applications have been hailed by the telecom operators as the next killer application, however they are still facing multiple challenges. For instance, most of the current applications seem to focus on location accuracy using several sensor technologies and location driven information delivery. Thus the communication channel seems to remain unidirectional, namely from an information source to a user. Indeed, initiatives like PlaceLab an Intel Research does promote location awareness application development by offering a middleware layer that uniformly binds the hardware resources available, such as GPS, GSM, Bluetooth or 802.11, to provide a current location estimate [14]. However, even though PlaceLab integrates multiple technologies to pin point locations, it relies upon a user community to map radio beacons to a specific area such as http://www.wiggle.net. Groupanizer also relies on the availability of a cellular AP and a community, however we do not emphasize on location accuracy but much more on community location sharing and mapping. We believe that by doing so we create cells (SLMs) of known locations among users, which reflect better the cellular topology of a network.

Cellular based applications have found a niche in areas such as people tracking and local information dispatch. For instance, Mapamobile [17] allows a worried mother or father to query the location of their child. NTT Docomo has introduced location-aware services to offer a local flavor to the weather, shopping or dinning information of a 500 meters radius specific area surrounding the closest AP to the subscriber [19]. KDDI GPS enabled phones can be used to track dispatched employees in real time and even display the movement history of commercial vehicles to improve their mutual efficiency [18]. In a same manner, AT&T offers a close friends mapping service to offer meeting points in a vicinity to both users [20]. Dodgeball offers a social disclosure service to help users gather in their physical locations [21]. Even though, Dodgeball focuses more on the serendipitous encounters and KDDI offers an history monitoring, Groupanizer distinguishes itself from the other applications mainly because we do not focus on spontaneous rendezvous or location aware information service, but aims at identifying a proper moment or an upcoming context to promote social interactions. It uses a history base predictive mechanism to approximate possible gatherings and shares local information lived by local users in their daily environment. Instead of a service provider being the agent responsible for the local information, Groupanizer's community members are the one publicizing their tendencies. Thus a user entering a SLM owned by a specific group of people or a friend will have access to personalized information instead of a unique information source namely the service provider portal. Reno [13] developed at Intel research, also distinguishes itself from the other applications since it uses SMS messaging to dispatch location information. A personal location name is mapped to local GSM AP. Thus when a user needs to notify its location a list of the most probable locations are fetch in accordance with the proximity of GSM AP. This resembles Groupanizer, however no mechanism is provided to share common locations within vicinity of a GSM AP.

One of the first papers to discuss development of CSCW in a Ubiquitous environment using mobile phones comes from Hakkila and Mantyjarvi at Nokia and VTT where they focus on defining the principles behind mobile phone collaboration [22].

Selecting the collaborative party is done according to a set of contextual attributes. Thus communication is not aimed at a single individual but towards individual sharing a particular context. This reflects Groupanizer's ideology, which provides a sample solution to the problem of learning ideal contexts to efficiently trigger collaboration among individuals.

Hakkila et al. also stress the privacy issues like most of mobile location aware applications listed above [13,17,20,21]. On the other hand, Groupanizer offers a good compromise to user privacy since the user controls if a location shall be disclosed or not. Further, the ambiguity related to the naming system promotes location information sharing as verified in [9]. Since location monitoring is done at the group level a user can disappear for a period of time and reintegrate a SLM without possibly loosing his bank of locations.

2. A LOCATION-NAMING ONTOLOGY

Ubiquitous computing has often been defined as a computing environment adapted to its users. In order to do so, one must take in consideration every user's idiosyncrasies when it comes to defining elements part of the ubiquitous environment. Therefore finding a universal naming system for locations constitutes quite a challenge. Indeed, many locations have different specifications depending on its user, but it is important for a location's name to make sense to everyone within the community. For instance, a referencing system must be established in order for everyone to understand their personal location as well as their location within a community context. To some extent, this refers to the common ontology concept stated in Toru Ishida's book, Community Computing Collaboration over global information networks [6], where in order for everyone to understand the others, a common language, more specifically, an explicit formal specification of how to represent objects, concepts and other entities that are assumed to exist in some area of interest and the relationship that holds among them.

Since our project aims at integrating multiple individual within a location-awareness context we must establish a location naming ontology that will serve everyone's purpose at the individual level and at the group level. In light of this, we have established two interrelated levels of location refinements namely the Personal Location Mesh PLM and the Shared Location Mesh SLM.

2.1 Personal Location Mesh

A personal location mesh is constituted of more or less five locations each of them described by a set of five parameters or attributes. First, it is necessary for every user to register to the groupanizer's server, http//:www.groupanizer.com, a set of 5 or less personal prominent locations. For instance one could register, home, school, work, arena, and Roppongi which would represent a user's personal mesh. In this last example, "Roppongi", a neighborhood of Tokyo and "home", represent two entities relatively different in size. However, we will see later how a SLM can refine locations to bring their relative size to a similar scale. Since a *personal location* by itself does not provide any usefulness, each location will be described through a set of 5 attributes derived from the generic context identifiers identified earlier such as *location*, *identity*, *time*, and *activity* [12].

2.1.1 Location name (location)

First, the name identifying the location will be left to the discretion of the user, which has been demonstrated to be a good method, since people prefer to share a symbolic link or a name with others than a precise addressing system [13].

2.1.2 Location purpose (activity)

Second, an attribute word will describe the activity that can be conducted at the selected location within the following list:

- Dining;
- Sports;
- Social;
- Work;
- Rest;
- Shop;
- Commute;

This list has been elaborated in accordance with a typical life pattern, where the main daily activities are listed, and of course it remains non exhaustive and subject to change. However, for the purpose of the experimentation it has been limited to the most common daily actions. This restricted set of words will map location to a purpose that might be different for each user but that can lead to similar required actions. Indeed, if I need someone to buy something for me I do not need to specify an actual location, but rather an accurate purpose or action. In addition, the action→ location mapping will allow multiple actions for one location.

2.1.3 Location attendance frequency (time)

The third attribute specifies a location attendance frequency, represented by a percentage. This estimation will be constantly updated according to our predictive model to reflect group motion patterns.

2.1.4 Link state

The fourth attribute, a binary attribute, will link or not link a location with another possible *shared* mesh. An important distinction has to be made between a *personal location mesh (PLM)* and a *shared location mesh (SLM)*. The PLM represents a mapping of the personal environment of an individual and the SLM describes an environment common to a group of individuals. For instance, a school or a work place often constitutes a shared environment within which a set of fix locations can often be derived. Indeed, a cafeteria, a library, a bookstore, classrooms and a laboratory often describe a school environment. Similarly, a meeting room, office spaces, a cafeteria and a factory often describe a work environment. Also, in the previous example, Roppongi is definitely a location visited by many friends or colleagues and should be linked to a sub-mapping system, namely a SLM. Thus, the purpose of a SLM is to give a zoomed perspective of one of a PLM's location and might include much more possible locations than a PLM. In addition, an SLM will often be created by users very familiar with a particular environment, and thus might provide insider's information valuable to any new member of the community. The SLM will often get updated with new locations as opposed to the PLM, which may remain static for a long period of time. The following figure 1 demonstrates the PLM structure.

2.1.5 *Transition probability*

Finally, the fifth attribute will serve as a PLM global probabilistic link among the listed locations. Transition probabilities will identify the directionality of links among locations or moments as shown by figure 3. These probabilistic transitions will be derived from our predictive model explained in the following section 3.

2.2 Shared Location Mesh

As mentioned earlier, the shared location mesh is a reflection of the common visited places within an area.

In fact, all members of the community contribute to the addition of new locations within the SLM. One might argue that the PLM's liberal naming system becomes litigious at the SLM level, since all community members will be allowed to populate the location mesh. However, in a shared environment such as a University campus we assume that most of the places are tagged with specific names such as the gymnasium, the pool, the general library, the classroom 268, or the Computer Science laboratory restricting the naming options to the most common and unique naming possibilities listed above. Also, if Gil is a co-worker of mine and she is talking about the AM/PM convenience store at work, I believe that even though there are many AM/PM in Tokyo, she is probably referring to the one close to our common work area. However, in order to allow a superior level of accuracy in the nametag used for a SLM, the structure will allow one further level of refinement as depicted by figure 2. As we will see in section 3, a decay function will also serve the purpose of filtering out obsolete names.

```
<?xml version="1.0" encoding="utf-8" ?>
<PLM  user=xxxx@ezweb.ne.jp >
     <location>
      <name>school</name>
       <action>work</action>
       <attendance>60</ attendance >
       <linkSLM>yes</linkSLM>
     </location>…
     <transition>/transitions/tbl_xxxx.mat</transition>
     </PLM>
```

Figure 1 PLM ontology

```
<?xml version="1.0" encoding="utf-8" ?>
<SLM  user=xxxx@ezweb.ne.jp user=yyyy@docomo.co.jp>
<title>Hongo Campus</title>
<type>Student</type>
     <location>
         <name>
         <generic>classroom</generic>
         <refine>304</refine>
       </name>
       <action>work</action>
       <attendance>60</attendance>
       <security>private</ security >
     </location>
<transition>/transitions/tbl_xxyy.mat</transition>
</SLM>
```

Figure 2 SLM location ontology

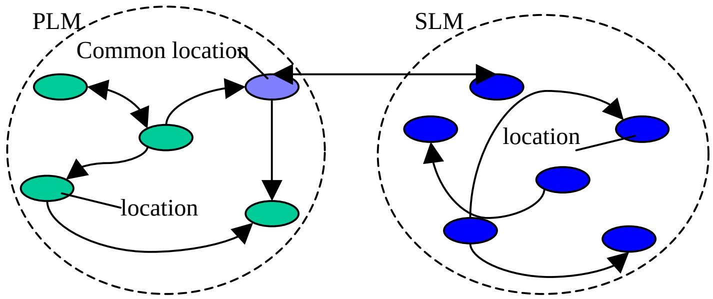

Figure 3 PLM transition mapping

2.2.1 *Creation of a SLM*

As opposed to the easy registration process used for the PLM, the SLM takes more time to establish. First, one must remember that the SLM is an extension or a refinement of one location of a user's PLM. This being said, in order to understand the creation process one must understand how we monitor the motion behaviors of community members.

In order to keep track of every user, personal cellular phones will be used as monitoring sensors. Indeed, cellular phones are commonly used in Japan, and since our application aims at integrating motion behaviors of many users, it constitutes an ideal platform. Therefore, a simple email location reminder will be sent to every user at an initial sampling rate of 30 minutes, which corresponds more or less to the least time required to complete an activity, such as going out for lunch or for a coffee, buying a book, etc. This reminder will take the form of an email linking to a server-side Ruby program querying the user for the possible location within the user's hot list of registered locations, which includes his own PLM as well as locations part of a SLM. Each location will be associated with one radio button for a single click interaction with the user. If one of the locations corresponds to the actual user's position then the user only has to confirm his location by pressing the radio button as depicted by the next figure.

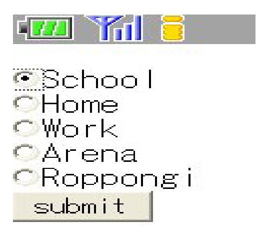

Figure 4 PLM confirmation screen

In the case the location does not show up on the screen, the user has two choices either ignore the location or add the location within the SLM. Thus, if a user decides to input the location into the system, a maximum of four button pushes will be required. One to access the URL serving the location aggregation mechanism included in the email, two to select location confirmation, three to select the user's actual shared location and four to either select his actual position as part of the SLM or to input the new location. The following three screens show the process described earlier (figure 5).

Nevertheless, two related questions remain, how does multiple users access a common SLM for updates and how do multiple users become part of the collaborative community attached to a

SLM? Indeed, Groupanizer does not use precise geographical locations coordinates but instead uses a common ontology to map personal and shared locations.

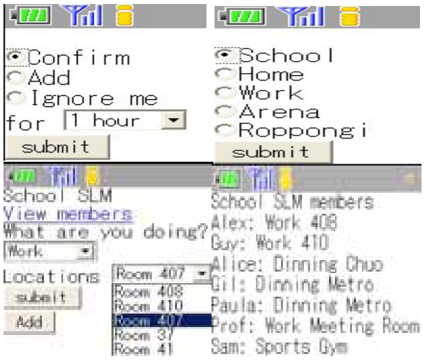

Figure 5 SLM confirmation

Thus, three respective methods exist to integrate or to create a SLM.

- Invitation SLM (*i*SLM);
- Blank creation SLM (*b*SLM);
- Search SLM (*s*SLM).

First, a user can invite friends or colleagues to share his SLM at creation time. This implies that the SLM will remain empty until one of the members adds a location or any information to the shared location mesh. The second avenue is for a user to create a SLM from scratch and then publicize it via the Groupanizer web site. The third way is to search for any already publicly available SLM either through friends or through a generic search mechanism. In light of this, if we compare figure 1 and figure 2, besides the name refinement feature described earlier, the SLM ontology comprises four other distinctions.

2.2.1.1 Participating users

The SLM and the PLM tag comprise user ids (refer to the *identity* context identifier section 2.1) namely the cellular phone email provided by the users upon registration. This tag attribute does not have a great impact at the PLM level and it is mainly use to reach the groupanizer member when a location query is sent. However, at the SLM level its role becomes much more valuable since it binds together users of a SLM.

2.2.1.2 Availability status or security

This tag will block access to certain locations of the SLM. This is mainly beneficial when unknown users download a SLM that might suit their needs. In this case, one can block the access to some locations that could become compromising. Three levels are permissible such as private, public or protected.

2.2.1.3 SLM descriptor

The SLM descriptor can be one of the three following choices *student*, *salary man* and *retired* [29]. These descriptors have been selected to be the reflection of different life stages and will later be associated with the motion patterns of a community (section 3). The *student* descriptor identifies a SLM or a community where new locations are often added and where motion patterns are quite irregular representing the adventurous type. The salary man descriptor characterizes a SLM where locations are quite static and the motion behaviors of the community are likely to be metronomic. The last descriptor, relates to a phase of our lives in which the pace of motion has drastically diminished and in which the visited places do not change quite often. This attribute will often serve the purpose of assigning a proper SLM to a user upon conducting a SLM search.

2.2.1.4 SLM title

Basically, the title tag of a SLM constitutes a refinement of the PLM nametag of the location that links to an SLM. In figure 4 the title represent the name of the University campus, Hongo campus, which is linked to the nametag school of the PLM as seen in figure 2.

The ontology we have just described provides two levels of context refinements namely the macroscopic and the microscopic perspective. Its role is to define salient locations for multiple individuals within a common environment. We believe that it serves the prediction mechanism in that not only it identifies locations visited by a user but also defines other attributes that enhance the prediction mechanism. For instance, the purpose and time identifiers are necessary to the implementation of groupware applications, since scheduling is one of their main tasks. Also, by regrouping people in a location-awareness context we facilitate the location discovery process. This has been a primitive for the Reno [13] initiative at Intel Research, where they believed that due to a large amount of shared social state between friends, co-workers, and family members, the small amount of information contained in a place name is often sufficient to stand proxy for a wide variety of communications. In the next section, we demonstrate how the SLM and the PLM are used to first compute community motion behaviors and then efficiently distribute task/requests or promote physical encounters.

3. THE PREDICTIVE MODEL

As previously mentioned, we believe that the efficiency of interpersonal communication builds upon a shared understanding of the past, current and last but not least future context within which interactions take place [28]. In light of this, efficient prediction of future context, in which interpersonal interactions could occur, is a key to promote effective communication. In the previous sections, we demonstrated how we intend to divide locations in relevant places for not only for a single user but also several members of a community. This segmentation allows us to model motion behaviors according to group activities or shared locations among a specific community. Indeed, one of the inputs to the model is the influence of the group on mobility. Since the venue of the Homo sapiens sapiens 100000 years before our era, the human being has shown a tendency to follow routes of their predecessors. More than that, even though their mobility was influenced by climatic changes or nutrition, most of their movements were orchestrated in groups. They had group objectives and followed paths leading to the fulfillment of these objectives. The 21st century's society does not differ much from these ancient tribes. Even though, our life style has been tagged with the etiquette, sedentary, our daily motion behaviors are still greatly influenced by climate and people with whom we share our life. Hence using common locations to a community makes it easier to map and derive motion behaviors patterns than if we were to model random users. Only location relevant to a group of people needs to be shared among them, thus greatly reducing the variables of our model.

3.1 Groupanizer's Model

Beliefs networks, formally defined to be directed acyclic graphs where nodes are represented by discrete or continuous random variables, are often used to build models without knowing exactly how variables affect other variables in the system. The key advantage of such modeling techniques is that the probabilistic calculations rely only on neighboring nodes, thus greatly simplifying the relations.

Many models, such as Markov Models, have been used in previous research to incorporate location prediction using GPS and signal loss for example in the case of Ashbrook et al. and Marmasse et al. [25,26]. In the case of Laasonnen et al., they make use of GSM cells and transitions among them to identify salient locations. However, in all cases it showed to be difficult to trigger on prominent locations, due to some monitoring imprecision's and the identification techniques. Thus one of the key assets of Groupanizer is its limited set of locations particular to some situations or areas.

Our model revolves around five nodes, namely:

1. A *group*, which is central to our model's definition, influences the salient locations as well as the possible contexts or activities;
2. An activity, as described through 6 keywords, influencing the possible source and destination locations;
3. Time which is essential to the elaboration of scheduled activities, also influences the possible locations, groups, and activities or contexts;
4. The source identifies all possible source locations;
5. Finally, the destination node identifies possible future locations, which is the final prediction objective of or model, indeed linked with the other 4 nodes.

The following figure 6 gives a clearer demonstration of our model and its connections. Abdelsalam et al. at the University of Waterloo proved that modeling a user with a Bayesian network could provide advantages over the sole usage of GPS and velocity to predict a future location [30]. However, as explained earlier, one problem remains the exponential number of locations to store. In our case, not only does the group node is responsible for filtering irrelevant locations, but it also serves the purpose of a decay function. When two names point to the same location, which leads to the multiplication of similar locations under different names, we believe that the natural selection will eventually eliminate obsolete names. As more and more people join a SLM the most common name will definitely win the battle over an inappropriate appellation and the obsolete location name will be erased. By Natural Selection we mean that if a location has not been used for a period of 2 weeks it will be moved to an archive record. For instance, if a location as been reported by only one or a few individuals populating our community, then the system automatically eliminates such a location from the probabilistic equations. The group becomes the central point of our study and we focus on its impacts on other individuals.

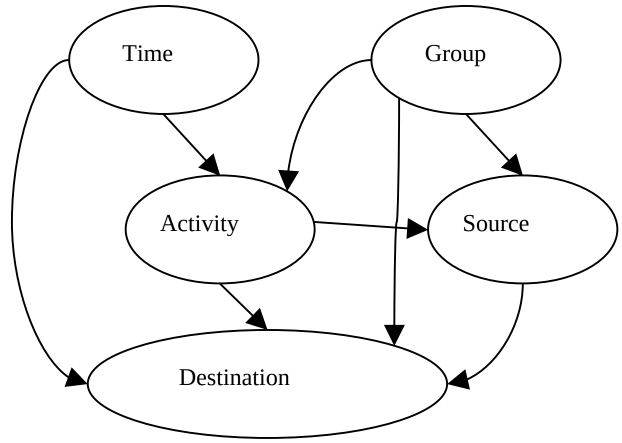

Figure 6 Groupanizer Bayes model

From our monitoring activities, three tables will be built. The first one will introduce transitions between locations and there probabilities, the second one will present transitions probabilities between activities and the third one will depict the probability of an activity based on locations, as shown respectively by table 3,4, and 5. These tables will define the conditional probability tables necessary to the evolution of our model. Thus, all nodes will be defined by a table representing its independence with a parent node.

Table 3 Location transitions probabilities 1st order Markov model

Location Transitions for a specific group and time slot		
Source Location	**Destination Location**	**Probability**
Home	Train	P_{HT}
Train	Work	P_{TW}
Train	Gym	P_{TG}
Room410	Cafeteria	P_{410C}

Table 4 Event location mapping

Activity couples for a specific group and time slot		
Activity	**Activity**	**Probability**
Rest	Sports	P_{RS}
Rest	Commute	P_{RC}
Work	Work	P_{WW}

Table 5 Event location mapping

Group Tendency specified through time slots			
Location		**Activity**	**Probability**
Home		Rest	P_{HR}
Office SLM		----	----
	6th floor	Work	P_{6FW}
	5th floor	Dinning	P_{5FD}
	Room 4	Work	P_{R4W}
	Room 8	Work	P_{R8W}

One cannot assume that a change of activity necessarily generates a change of location. On the other hand, one must remember that one activity can be linked to several locations. These tables will be updated at every user query. Then upon a request about the next location of a member of a specific community the Expectation Maximization algorithm will be used to compute the most probable destination node. In which we solve for the location of the SLM that generates the maximal occurrence probability considering the current location and the current moment.

As explained in "Social Serendipity: Mobilizing Social Software"[29] we expect to be able to withdraw much more information from social history in order to infer acquaintances. We also believe that modeling the user's location patterns based on group motion behaviors will definitely provide an edge to existing methodologies.

4. CONCLUSION

This paper presented Groupanizer, a simple framework to monitor individual context, namely location, with the objective to efficiently share knowledge, tasks and generate consensus among community members. We have analyzed the potential of a structured ontology to derive contextual patterns among individuals. Groupanizer highly depends on the members of its community and thus one design requirement definitely revolves around the simplicity of its integration to multiple portable platforms. Our simple web interface definitely provides an edge over technologies highly dependent on hardware. Moreover, the actual design could easily integrate elements such as Place Lab to bring location accuracy to another level. On the other hand, one must keep in mind that Groupanizer does not aim at tracking nor at delivering location-aware information. It relies on a group behavior pattern to regroup individuals in an ideal contextual environment.

We are currently at the pilot study phase and our future work consists in formulating proofs about the efficiency of the suggested ontology to easily derive ideal group context. Further refinements of the location prediction could provide insightful information on the actual feasibility of integrating context inferences to groupware applications.

As for the privacy issue associated with any location-aware scenario, we believe that the user will dictate its importance. As mentioned earlier, Groupanizer can't work without a minimum commitment from its users, which will consequently lead to our information disclosure analysis. Since we target already semi-organized groups, we also believe that this will greatly influence the amount of location information disclosed by the community members.

5. ACKNOWLEDGMENTS

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Urban Environments as Medium of Communication

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ABSTRACT
Large projection displays are becoming more and more ubiquitous in urban spaces. However, there is currently no methodology for designing display walls as an integral part of the urban built environment. This paper gives a quick review of the application of LCD (Liquid Crystal Display)- walls and large projection screens on buildings' facades. It reflects on influential examples of certain applications in the urban public realms that we have explored. We suggest that in order to achieve real integration on an urban level we need to consider the design of space as a whole, featuring information communicated on an urban scale in respect of social, cultural political or community shared content.

Keywords
Urban Space, display screens, community shared content.

INTRODUCTION
The urban built environment plays a critical role in the construction and reflection of social behaviours. This is reflected in the way it acts to structure space, which does not only reflect and express social patterns, but can also generate these patterns by shaping patterns of movement and co-presence between people (Hillier and Hanson, 1984). However, there has been a number of technologies that have influenced the form and dynamics of cities to a great extent. The skyscrapers, for example, were made possible not only through the constructional innovations, but also by the invention of the elevator and the telephone (Sola Pool, 1976).
Recently information displayed on large LCD and LED (Light-Emitting Diode) screens are gradually dominating the main urban space in metropolises like NY and Tokyo. Most screens serve mainly commercial purposes, advertising information related to big advertising brands that bombard the inhabitants of the city without taking into consideration the surrounding environment. This paper reviews the implementation of display walls and large projections on buildings in urban spaces. The review took an exploratory approach based on qualitative observations, and the examination of relevant sources.

In the following section we outline two main different types of potential applications:

1. THE BUILDING AS A DISPLAY SCREEN
This include various applications and as follows:

Entertainment : Las Vegas, Nevada, USA (1939-recent).

Business : The NASDAQ headquarter, New York, 2000.

Art and entertainment: KPN Telecom Office Tower Rotterdam, The Netherlands, 2000.

Recreation and Entertainment: Crown Fountain

(sculptor: Plensa), Chicago, USA, 2004.

2. THE BUILDING AS A PROJECTION SURFACE
One way of applying moving images in a more flexible way is by covering buildings with projected images. This can be used for different applications such as:

Events: Poppy projection (E\T\C UK), Shell site, London 2004.

Supporting solutions for Heritage: The projection is temporary and does not require high level of intervention. This could be suitable, for instance, for design solutions in the listed buildings (Fatah gen. Schieck, 1999).

Supporting social interactivity: Body Movies-Relational Architecture 6: (Rafael Lozano-Hemmer), Rotterdam, 2001.

Figure 1 participants' shadow projected on the outside of the cinema (souce:Arie Kievit)

DISCUSSION
In the last decade, the architectural landscape in many cities has been undergoing a major transformation. Large LCD screens and LED billboards are appearing as part of the city architecture forming a dominant part of the visual perception of the cityscape. Dynamic moving images form new architectural material, affecting our perception and understanding of the space around us. We argue that perhaps a new form of urban space is emerging that is fundamentally different from what we have known. A form that is different from the spaces in the physical environments for which our analysis tools were evolved, and hence we are ill-equipped to deal with and analyse. The representation techniques learned from architecture are static, contained and two- dimensional whereas the new form is dynamic, open and three dimensional. How can we understand this emergent form or analyse it? It could be argued perhaps, that there is a need for

developing a new theoretical base and new concepts that may help shed light on the nature of it.

Huang et al (2004) have specified four key ideas, as design guidelines that form the basis for an inhabitable interface system, a system that develops the design of the interface elements and software - the virtual architecture - in conjunction with the design of the physical environment - the physical architecture. Building on that, and taking into account potential characteristics of the applications outlined previously, we can identify the following issues that form the basis for the new form of space:

Spatiality: signs in space vs. forms in space

Some buildings in Times Square, for example, the NASDAQ building, represent spatial elements rather than object elements.

Figure 2 transformation of space perception through time(author, 2002)

On the other hand, the KPN building in Rotterdam, for instance, represents architecture of communication over space; communication dominates as an element in architecture.

Figure 3 symbol in space changes throughout one day
source: http://www.ergaster.com/screen/

Social interactivity vs. commercial monologue

Artists across the world are experimenting with the new technology as an attempt to augment the urban public domain through the support of social interactions. Unlike the typical use of new technologies to perform a pre-programmed commercial monologue, the participants' input and feedback- through projections, robotics, sound and local sensors- becomes an integral part of the public space and the outcome is influenced by participants' actions (Body Movies-2001). It seems that in this way the new media technologies not only serve to reproduce and reinforce existing social structures, space and chance encounters, but also hold out a prospect for promoting new social forms (Schnädelbach et al, 2003).

Figure 4 Facial elevations among the skyscrapers, (author, 2004).

Location and mobility

The location of the animated screens or signs plays a critical role in the perception of the animated images and the reception of the communicated messages. Huang et al (2004) have noted that in order to avoid distraction the display surface should not be at the centre of attention in the space, so that users are only passively aware of it. The parameters that can be regulated accordingly include the location of surfaces, orientation of surfaces, size, and resolution and image refresh rate. Mobility of the observer (people) and the observed (the screens) through time is another aspect that should be taken into consideration. High-speed mobility changes the perception of static and dynamic; transforming images from two-dimensional to three-dimensional. More recent observations of the Strip in Las Vegas witness an emphasis on change of position. Big LCD screens are designed to attract from different directions by arranging them spatially on a curved rail, which enables the screen to change orientation and slide back and forth from one end of the curved rail to the other. In this way the screens do not only attract on different levels, but also attract from different directions that change dynamically through time.

Relationship of elements and narrative

The challenge in the creative use of media technologies, as noted by Broekmann (2004), is to develop strategies of articulating the new public domains that connect physical urban spaces and the potential space created by the new technologies. One way of achieving this could be by creating a kind of narrative that makes sense of the visual dynamic information and the interaction space through integrating them into a meaningful whole. This may also promote a feeling of presence – of being there.

Figure 5 symbols on the KPN screen viewed from the platform
source: http://www.ergaster.com/screen/

In the following we illustrate potential problems:

Obsolescence vs. flexibility

One relevant concern is the discrepancy between the durability of architectural material and the rapid obsolescence of technology standards (Huang, 2004).

Privacy concerns and light pollution

The privacy issue may arise and needs to be addressed, especially in the case of capturing participants' input, using projections, cameras, sensors, and projections. In addition "light pollution" might require the implementation of regulations to regulate the amount of light-intensive signage and the massive light displays and its effect.

In conclusion, we believe that in spite of the increasing realization of the application of the new technology on buildings' external facades as a communication medium, particularly through innovative architectural projects, there is still a lack of academic, as opposed to architectural, interest. The combination of the physical architecture with the virtual information and representations displayed on the building facades, both embedded in the urban landscape in the city, can be seen as both an interface with, and the generator of, different social interactions. This paper argues the need for developing a theoretical base on which to found design principles for the new emergent urban forms that **s**ynthesise between the virtual dynamic (information) and the physical environment (public space).

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Evolution of Ubiquitous Computing with Sensor Networks in Urban Environments

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ABSTRACT

A significant increase in real world event monitoring capability with wireless sensor networks will lead to a further evolution of ubiquitous computing. This paper describes this evolution, leading to humans being connected to the real world via computers without awareness. We address an ad hoc communication paradigm, a data-centric approach, and a middleware's task, to understand the ultimate goal of this new world. We also briefly explain our upcoming new traffic monitoring project in the city of Cambridge.

EMERGENCE OF WIRELESS SENSOR NETWORKS

The evolution of cyber space started from mainframe computers and moved to PCs. Then Internet glues computers for information sharing. Later, ubiquitous computing named as the third wave by Mark Weiser [5]. A rapid increase of event monitoring capability by wireless devices brought a further evolution in ubiquitous computing. This new paradigm is about networked microprocessors embedded in everyday objects, surrounding us, talking to each other over wireless links. There will be small nodes with sensing and wireless communication capabilities and they are able to organize themselves flexibly into a network for data collection and delivery [1]. Wireless Sensor Networks (WSNs), which are composed of wireless sensor nodes distributed in the environment, include various sensors (e.g., cameras as vision sensors, microphones as audio sensors, and temperature sensors). Each node is equipped with a wireless communication transceiver, sensor, power supply unit, machine controllers, and microcontrollers on a MEMS (Micro Electro Mechanical System) chip which are only several millimeters square.

AD HOC COMMUNICATIONS

These WSNs can cover a large space by integrating data from many sensors, and can gather diverse and precise information on the environment. Moreover, the integration of smart WSNs with a bigger network such as the Internet increases the coverage area and application domain of the ad hoc network. Based on such a technological vision, new types of applications will rely on ad hoc connections between nearby nodes to establish multi-hop dynamic routes in order to propagate data and messages between out-of-range nodes. Sensors could be attached to any object, which may move around, or be placed stationally. Furthermore sensors could be attached to the human body creating Personal Area Network (PAN). The communication among objects, humans, and computers happens at home, at an office, on a street, at the train station, in a car, in a restaurant, or in other places at any time. Fig.1 shows application spaces for ubiquitous computing with WSNs. Ubiquitous Computing opens communications over tiny sensor networks through Internet scale peer-to-peer networks. WSNs on local ad hoc communications may connect occasionally to the Internet via gateway or mobile nodes, which collect the data from an isolated ad hoc network, or delay/connection tolerant networks [2], where the ad hoc network itself could be created based on the social contacts.

DATA CENTRIC APPROACH

WSNs revolutionize information gathering and processing both in urban environments and inhospitable terrain. Sensors can detect atomic pieces of information, and the information gathered from different devices will be analyzed and provide data that has never been obtained before without these technologies. Combining regional sensed data from the different locations spawns further information. Localized algorithms, in which simple local node behavior achieves a desired global object, may be necessary for sensor network coordination. Modeling such system is attempted by studying biological systems, distributed robotics, and amorphous computing.

An important issue is that the sensed data should be filtered, correlated, and managed at the right time and place when they flow over heterogeneous network environments. It is not easy to provide reliable and useful data among the massive information from WSNs. Mining new information from sensed data is one thing, and deploying how to obtain the desirable information over WSNs is another thing. Combining both approaches will enhance data quality, including users intentions such as receiving data, providing data and passing data. Imagine an urban scenery such at a train station, and your phone obtains a high volume unwanted data. At the same time, data should be managed as openly as possible.

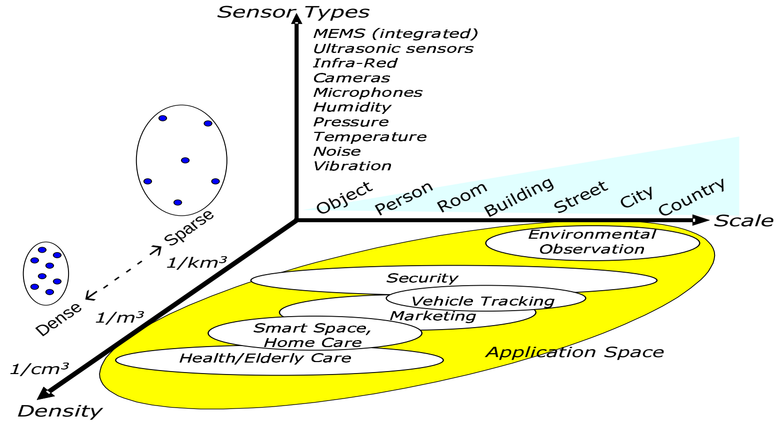

Figure 1: Application Spaces for Ubiquitous Computing with WSNs

MIDDLEWARE'S TASK

The middleware in sensor networks can be defined as software that provides data aggregation and management mechanisms, adapting to the target applications need, where data are collected from sensor networks. This functionality must be well integrated within the scheme of ubiquitous computing. The middleware should offer an open platform for users to seamlessly utilize various resources in physically interacting environments, unlike the traditional closed network setting for specific applications. One of the important issues here is to support an unambiguous event correlation mechanism over time and space in heterogeneous network environments, where middleware should take an active role [6]. The trend of system architecture to support such platforms is towards service broker grids based on service management. When designing the middleware for sensor networks, heterogeneity of information over global distributed systems must be considered. The sensed information by the devices is aggregated and combined into higher-level information or knowledge.

ULTIMATE GOAL OF UBIQUITOUS COMPUTING

What is the ultimate goal of ubiquitous computing? Humans develop the earth in a technology centric way that is bringing pollution, global warming, and extinction of animals. We need to better understand the nature and environments, so that our lives improve. What surface of the roads will prevent raising the temperature in tropical countries? What will prevent freezing the road surface to avoid traffic accidents in snow countries? How much is a green belt in a city necessary to produce sufficient oxygen ecologically and how to improve airplane path control systems with increasing possible paths and at the same time avoiding collisions. Now, we have new sets of data that will give entirely new information to improve our lives on earth.

When smart space is created in an urban society, our life style will get impacts. Communications among family could expand via instant messaging when you are in remote locations that may tie the relation tighter. Business will be processed over the wireless networks that may produce extra time for better life. Early discovery of health problems via sensed data from the body may save many lives.

We have many issues to address for realizing such an ubiquitous society. From social aspects, with use of sensed data, issues will be who can trace whom, who can obtain data, who controls the technology and use (user, government, or device owner), monitoring the society vs. risk control, and protection of privacy and security. Who should be controlled of cyber meetings by ubiquitous devices could be of political interest. From cultural aspects, different degrees of ubiquitousness may be considered such as SMS (Short Message Service) vs. email, or adhocracy vs. deep thinkers. Also how we establish a common ground for the innovation in infrastructure of the society and how to set rules over network use should be addressed. From the economic aspect, realtime sensing will become a new business, and an industry will form a new infrastructure for micro payments of new business.

TRANSPORT MONITORING PROJECT

An upcoming project *Transport Information Monitoring Environment* (TIME) at the University of Cambridge is a framework for research, application development and deployment for transport monitoring in the city of Cambridge in United Kingdom.

Cambridge lies approximately 50 miles (80 km) north-northeast of London and is surrounded by a number of smaller towns and villages. The population is around 125,000 (including 23,000 students). Because of its rapid growth since the 20th century, Cambridge has a congested road network. Several major roads intersect at Cambridge (see Fig.2). The M11 motorway from east London terminates here. The A14 road east-west trunk route skirts the northern edge of the city. This is a major freight route connecting the port on the east coast with the Midlands, North Wales, the west coast and Ireland. The A14 road is considered by many local people to be dangerous, and unnecessarily congested. This is particularly true of the section between Huntingdon and Cambridge, where the east-west traffic is merged with the A1 road to M11 motorway north-south traffic on just a 2-lane dual carriageway. The A10 road is a former Roman road from north London. The city has a ring road about 2km in diameter, inside which there are traffic restrictions intended to improve conditions for pedestrians, cyclists and bus users and to reduce congestion. It has a good park and ride bus service encouraging motorists to park near the city's edge.

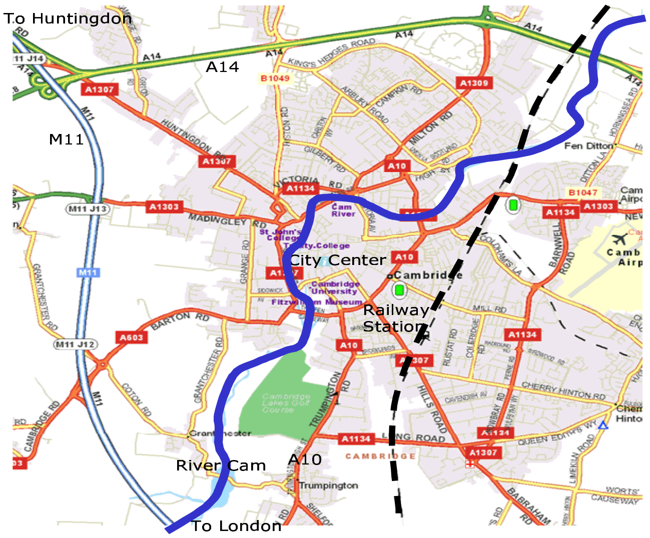

Figure 2: City of Cambridge and Surroundings

The Cambridge railway station was built in 1845 and it has direct rail links to stations in London. The important UK rail hub of Peterborough is also within reach of Cambridge. The railway service connecting Cambridge and Oxford, known as the Varsity Line, was discontinued in 1968. Thus, if you take a train to travel between these cities, you have to travel to London and change the train unless driving a car or taking a shuttle bus.

As a university town lying on fairly flat ground and with traffic congestion, Cambridge has a large number of cyclists. Many residents also prefer cycling to driving in the narrow, busy streets, giving the city the highest level of cycle use in the UK. There are also many beautiful cycle routes in the countryside surrounding Cambridge. According to the 2001 census, 25 percent of residents traveled to work by cycle. The main organization campaigning to improve conditions for cyclists in Cambridge is Cambridge Cycling Campaign. The city will also soon be linked to the growing National Cycle Network.

Cambridge is best known for the University of Cambridge with 31 colleges. In Fig.3, colleges in the city center are marked with black circles. As an English city, there are many pubs in Cambridge. By 1749 the number had risen to 156 inns and pubs, serving a population of 10,000 and in 2002, the 112 pubs serve a population of around 125,000. Fig.4 shows the location of pubs in Cambridge, which covers most major roads within the city and shows that pub culture deeply influences the people's life.

Road congestion in the UK costs in the order of 20bn GBP per annum, and many business investment decisions are believed to be influenced by the quality of transport. The purpose of TIME project is to monitor, distribute and process traffic information so that it will provide a substantial and significant increase in transport efficiency. This would not only improve business efficiency but would also have a profound effect on pollution control and source of UK emissions of carbon dioxide. But lack of a car can be socially excluding, and good public transport is essential for social integration. Timely information is key to the to the acceptance and wider use of public transport.

It is therefore vital that we improve the performance of the UK's transport networks while balancing the need for economic efficiency, social equity and environmental quality. Cambridge has a diverse economy including a high tech cluster of companies, variety of transport links and closeness to London. Existing transport information systems, for example to gather data on traffic density on the M25 motorway (ring road surrounding city of London), to provide information display at the bus stop, to control traffic signals to ease congestion or to give a fast route to emergency vehicles, to display the number of empty spaces in car parks, are single theme and vertically integrated projects that as yet do not fully exploit the potential of fixed and wireless networks.

Thus, one purpose of the TIME project is to provide a common, open interface. The interface will be robust to changes in the underlying technology that allows the gathered data to be shared in a controlled way. An important aspect is to ensure that the privacy of individuals is not violated. It offers programmable interface so that users are able to tailor the data for their needs. At the same time, the interface should be standardized for cooperating with other transport systems.

The ultimate aim of the TIME project is to improve the understanding of transport network performance in the long-term by developing novel traffic data monitoring, management and modeling systems. Initially, TIME will use the city of Cambridge as a compact and convenient test bed, where it has severe congestion problems. Transport providers and other industry partners with interests in the transport sector are being actively sought for collaboration in defining and implementing such projects.

Our upcoming project *Event Architecture and Context Management* (TIME-EACM) project [3] is a central plank of the TIME project. The goal of the TIME-EACM project is to investigate, design and implement a secure but open interface to support the controlled sharing of monitored data from any form of transport.

Concrete outcomes of the TIME-EACM project will be a middleware that hides low-level sensor aggregation from applications, integration of high-level context models with query support, and an evaluation of this support based on prototype, but real world, applications that fully exploit the architecture. Issues include economics of information, building incentives to information sharing, extracting useful information from sensed data, queries (e.g., what is happening) and how the environment can adjust to what it senses. This will be a challenging realization of ubiquitous computing in urban environments. There are many possible applications, including congestion detection and projection, car park status, bus arrival time displays, free taxi location, and support for emergency services. The middleware developed for the project will be made available as open source software as it has potentially wide application for other traffic monitoring projects and for a range of event-driven applications where sensors have been used to monitor state of environments.

The TIME project is in an early stage, and we have a mountain of issues in front of us. What sensors should be used? How should sensed data be interpreted? There are already many sensors deployed in the city at such as CCTV, Car Parks, Bus GPS, Traffic signals, Pedestrian crossing, and Highway. Fig.3 shows the location of CCTV cameras in the city center, which covers most part of the central area. Besides the existing sensors, what will be the best

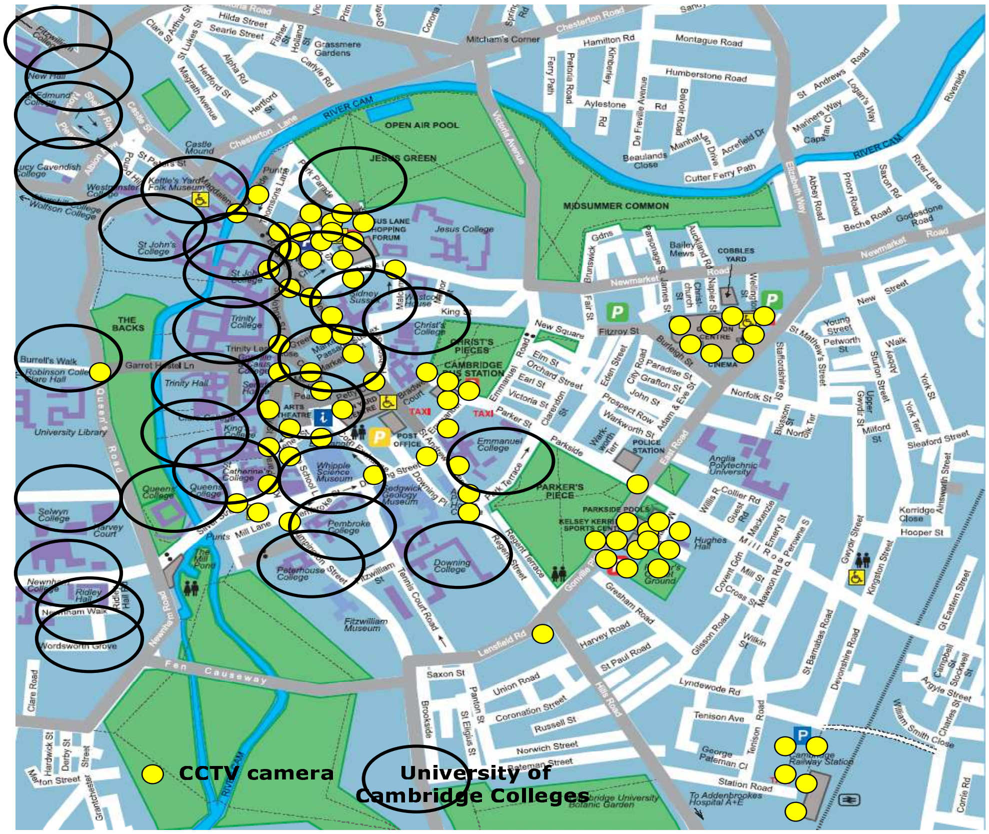

Figure 3: CCTV camera locations in City center Area of Cambridge

way to coordinate new sensors such as GPS on vehicles, RF tags, video cameras, and audio facilities? For data collection, what communication systems (e.g., GPRS, SMS, WiFi) should be deployed? Data collection could be done by forming an opportunistic network such as [2] or preconstructed mesh [4]. How should road-to-vehicle and inter-vehicle wireless communication be addressed? One significant observation in Fig.3 is that University of Cambridge colleges cover most of the central area. Each college has its own computer network infrastructure under the university's control and many of them provide wireless network access. This setting must be used for creating urban spaces in Cambridge. Another observation Fig.4 is that pubs are at almost every block, and people are there building social networks. Most of them carry mobile phones using SMS for connecting people outside of the pub. Many pubs facilitate digital satellite TVs for football matches that can provide high speed Internet access, too. An important issue here is that supply of transportation information and demand, quality of life, safety and environmental impact as well as legal issue and privacy concerns have to be balanced.

CONCLUSION AND FUTURE WORK

We have presented design issues for building ubiquitous computing with sensor network technology, where sensor data provide various range of information. We described our upcoming traffic monitoring project and an initial approach to address complex relationship between ubiquitous systems, urban space and society.

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Bio. Eiko Yoneki is a PhD candidate in the Computer Laboratory at the University of Cambridge, UK. Her research interests are distributed computing systems over mobile/wireless networks, including event-based middleware, delay/connection tolerant ad hoc networking, and event correlation. She has received a postgraduate diploma in Computer Science from the University of Cambridge in 2002. Previously, she has spent several years with IBM (USA, Japan, Italy and UK) working on various networking products. She is a member of ACM and IEEE Computer Society. (http://www.cl.cam.ac.uk/users/ey204/)

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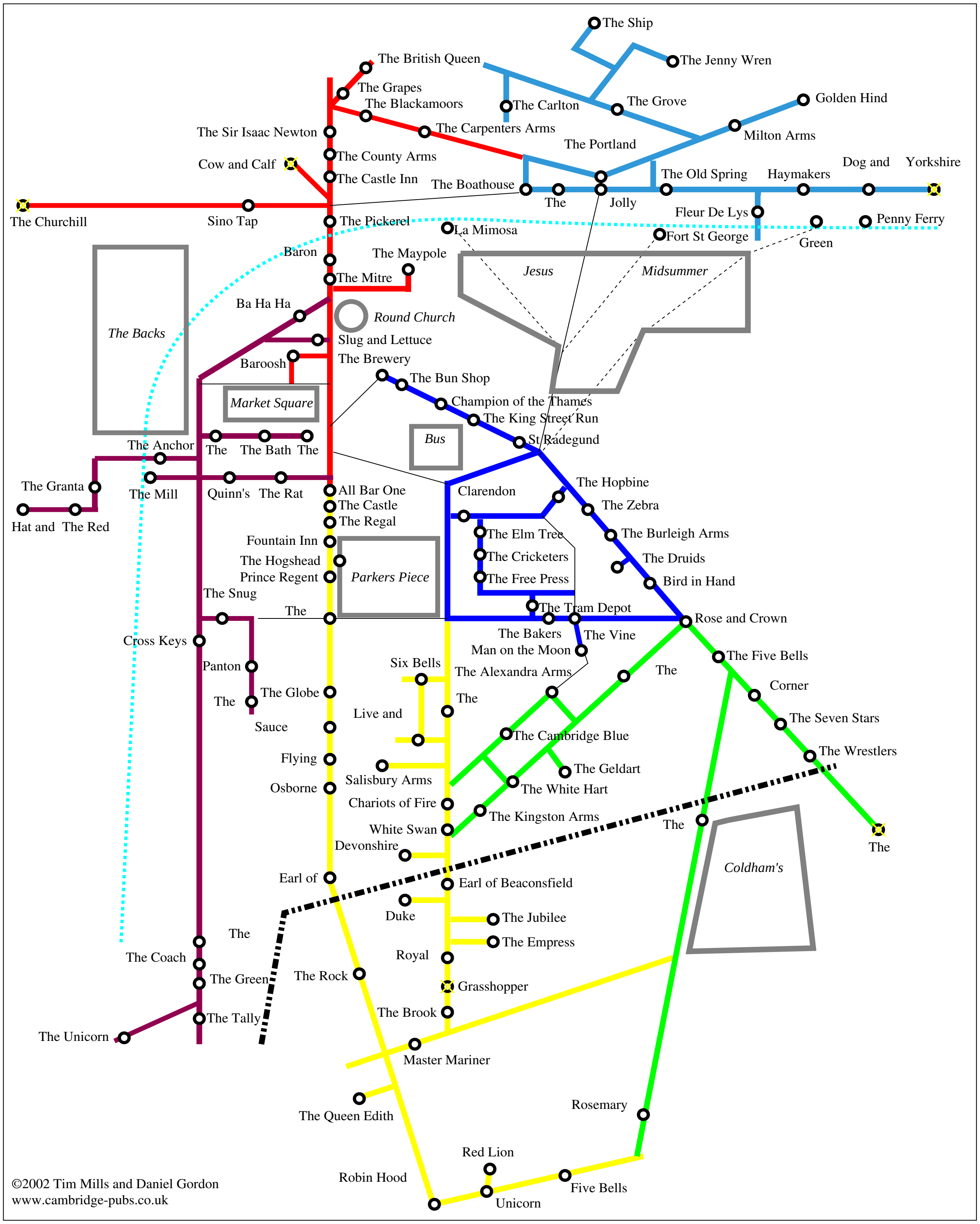

Figure 4: Pubs in Cambridge (from Tim Mills and Daniel Gordon at the University of Cambridge)

***ZAPPED*!** (2004-)
www.zapped-it.net
A project by Preemptive Media (Beatriz da Costa, Jamie Schulte and Brooke Singer) with guest collaborator Heidi Kumao

Project Background:
Zapped! addresses the mass implementation of Radio Frequency Identification (RFID) and its contribution to the ever growing field of technology-enhanced surveillance practices. RFID is not *yet* a household name or a pervasive technology, but Preemptive Media predicts that everyday encounters with this technology—whether known or not—will become commonplace in the industrialized world in coming years.

RFID is designed to record the location of humans, animals and objects. Human tracking is finding its first uses on groups that are traditionally subject to surveillance and control, such as prisoners, the elderly, school children and workers. In the domain of product tracking, commercial and military supply chain managers are breaking new ground with RFID to gain efficiency improvements in expensive labor markets through increased automation. A survey of trade publications shows the desire to expand the use of RFID for tracking employees as well as the products that they handle, as a means of further automating and controlling industrial workers. Meanwhile, marketers and engineers envision RFID-enabled homes that assist and protect us through vigilant awareness of our patterns of consumption. Privacy advocates are voicing concern that comprehensive human tracking is possible if objects carried or worn by people are tracked in retail environments and public space.

RFID systems consist of three main components:
1) RFID tags are small, programmable microprocessors attached to items to track them. Each tag has a unique identification number. Tags exist in the form of stickers, identification cards, glass tubes for injection under animal and human skin, and many other custom shapes.
2) RFID Readers detect the presence of nearby tags, read their data content, and in some cases modify that data.
3) Databases log the locations and data content of RFID tags detected by a network of readers. Databases, of course, have been used for decades to track inventories and record presence; the innovation of RFID is that the flow of real-time information into a database requires little or no human assistance.

RFID is a descendant of several preexisting Automatic Identification and Data Collection (AIDC) technologies, including bar codes and magnetic stripes. In general, AIDC is concerned with closing the gap between objects in the world, and their representations within computer databases. Bar codes and magnetic stripes have both been used for surveillance purposes, though to a lesser degree than is possible with RFID. Originally developed for tracking retail products within stores, bar codes now appear on most forms of personal identification, such as government-issued licenses and “loyalty” cards used by retailers. Likewise, magnetic stripes were initially used only for credit cards, but now appear on many forms of identification.

What differentiates RFID from its AIDC ancestors is that the RFID tags can hold a large quantity of data, this data can be modified easily, each tag is unique, and a tag can be read from a distance without the knowledge or consent of its owner.

Preemptive Media does not intend to contribute to a speculative Orwellian discourse. The expanding scope of RFID need not stir feelings of paranoia if it is implemented conservatively and with awareness that the technology can be used to exert control over people (and that it is a human tendency is to take advantage of such opportunities when they become available). By enhancing automation and surveillance capabilities already present in society, RFID technology makes these issues especially pertinent, but does not introduce any entirely new factor. Retail purchases, Internet activity, travel, and other aspects of life in industrialized, capitalist society are already heavily monitored, and the public is already subject to numerous accepted forms of control. Preemptive Media sees RFID as an opportunity to revisit questions about these accepted forms of surveillance and control practices, and to examine the role that new technologies play in expanding surveillance infrastructures.

***Zapped!* Project Description:**
Preemptive Media has developed the *Zapped! Toolkit* as one response to the RFID situation. The *Zapped!* Toolkit provides devices for detecting the RFID infrastructure, and for inserting personal messages into the volumes of data collected by it. The current toolkit has been developed with two groups in mind:

1) School children in numerous schools in the United States that are currently experimenting with RFID to track the attendance and locations of their pupils, and
2) Activist-minded individuals interested in exploring database jamming opportunities directed against RFID database systems used by many retailers, such as Wal-Mart, Target and Tesco.

The toolkit contains detecting as well as jamming devices. The detection device is currently packaged within a modified keychain that emits sounds when a RFID reader is in range. Preemptive Media has conducted a number of workshops where participants learn about RIFD technology and are instructed on how to build this RFID detection device. Preemptive Media has also developed an approach to jamming using live Madagascan Hissing Roaches to carry re-programmed RFID tags. Madagascan Hissing Roaches make ideal partners for human induced RFID database jamming because they sleep during the day and hunt at night, have access to locations that humans do not and are unharmed by the radiation emitted by RFID readers. Preemptive Media does not promote database jamming for the mere sake of troublemaking, but encourages activists who use the roaches—a symbolically and functionally aggressive approach to jamming—to choose their targets and define their goals carefully.

***Zapped!* at Metapolis in Tokyo, Japan 2005:**
Zapped! at Metapolis will begin Preemptive Media's investigation of RFID within a more global and international context. One site of interest for Preemptive Media is the development and regulation of RFID standards, because industry success and mass deployment of RFID hinges on the acceptance of universal standards by transnational corporations and countries worldwide. EPCglobal, an organization which includes representatives from Wal-Mart, the Department of Defense and Cisco on its Board of Governors, has emerged as the RFID standard-making body within the U.S. and recently put forth a second generation standard to enhance global interoperability. China, however, is slow to endorse these standards that may support or encourage U.S.-developed technologies and Wal-Mart, who purchases more than $100 billion worth of Chinese goods per year, is in a place to listen. This struggle between the leading technology-producing corporations and nations will undoubtedly be an interesting one that will shape the future of RFID as significantly, if not more so, than the engineers in research labs.

Preemptive Media is also interested in learning about and documenting particular manifestations of RFID systems outside of the U.S. Japan is similar to the U.S. in that there is a push to use RFID by businesses for tagging product and by the government for passport identification. But web sites like "RFID in Japan" (http://ubiks.net/local/blog/jmt/stuff3/) also suggest that there are numerous other kinds of RFID systems in place in conveyor belt sushi restaurants, video arcade games, visually-impaired aids and urban tour guides. How are these systems being integrated into the Japanese urban space and, in turn, how are Japanese people understanding and accepting them? What would a *Zapped!* device or intervention made for the city of Tokyo look like? Are there possibilities for more creative and playful uses of RFID made by individuals for individuals that would offer a counterpoint to the track and trace functionality promoted by so many businesses and governments? And, finally, are technologies like RFID that are developed with standardization in mind moving seamlessly across national and cultural borders or do they develop particular character and meaning within specific locations?

Zapped! Workbook with RFID tag and Zapped! pin

Zapped! RFID Detection Keychain

Zapped! RFID enhanced Roach

About Preemptive Media

Preemptive Media is a group of artists, activists and technologists who are making their own style of beta tests, trial runs and impact assessments based on independent research. PM is most interested in emerging policies and technologies because they are contingent and malleable. The criteria and methods of PM programs are different than those run by businesses and government, and, therefore, PM gets different results. PM hopes that their inquiries create new opportunities for public discussion and alternative outcomes in the usually remote and closed world of technology-based research and development. www.preemptivemedia.net

Individuals of Preemptive Media

Beatriz da Costa is an Interdisciplinary Artist and Researcher. From 2000-2005 she worked in collaboration with Critical Art Ensemble, and is a co-founder of Preemptive Media – an art, activism and technology group. Beatriz's interests include social robotics, biopolitics and the politics of surveillance. She is an Assistant Professor in the Department of Electrical Engineering & Computer and the Department Studio Art at the University of California Irvine and a core faculty member of the recently formed interdisciplinary graduate program in Arts, Computation and Engineering (ACE). www.beatrizdacosta.net

Jamie Schulte is an engineer who designs systems that engage human aesthetics, culture and politics. He has been a key collaborator in projects ranging from contestational robotics to video surveillance and interactive installations. Jamie is currently a robotics researcher at Stanford University and is a co-founder of the art, technology and activist group Preemptive Media.

Brooke Singer is a digital media artist and arts organizer who lives in Brooklyn. Her most recent collaborations utilize wireless (Wi-Fi, mobile phone cameras, RFID) as tools for initiating discussion and positive system failures. Brooke is currently Assistant Professor of New Media at SUNY Purchase and a co-founder of the art, technology and activist group Preemptive Media. www.bsing.net

Guest Collaborator

Heidi Kumao is an multi-discplinary artist who works with electronics, digital media and kinetic sculpture. She creates machines and mechanisms for public performances as a way to heighten awareness of ordinary social interactions and their psychological underpinnings. Her work often uses technology to address feminist issues and insert a female point of view into the world of high-tech innovation. She is currently Assistant Professor in the School of Art and Design at the University of Michigan, Ann Arbor.

A Context-aware Collaborative Filtering Algorithm for Real World Oriented Content Delivery Service

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ABSTRACT
In this paper, we present a context-aware collaborative filtering algorithm which incorporates users' dynamic contexts into traditional collaborative filtering algorithms. We also explain how to infer contexts used in the algorithm from multiple sensors. Based on these discussions, we propose a real world oriented content delivery system – CoCo, which aims at navigating users in Jimbo-cho, the largest book market in central Tokyo.

1. INTRODUCTION
When we consider the ubiquitous computing applications in an urban environment, we cannot ignore the participants of the city - a crowd of individuals. How can the crowd inspire the individual through collaboration? We can draw some inspiration from a simple scenario in our daily lives: when there is a long waiting line in front of a restaurant, we can infer that the food in this restaurant is delicious, even if we have never been there. Here we predict our judgment of the restaurant based on other customers' opinions. This is the basic idea of *collaborative filtering* (CF).

In the last decade, many collaborative filtering systems have been developed, such as GroupLens [5], Amazon.com, MovieCritic that recommends movies on the Web, and Jester system that recommends jokes [3]. In all CF systems, the *k*-nearest neighbor algorithms are the most frequently cited and possibly the most widely implemented CF algorithms [1, 7]. The goal of a CF algorithm is to predict the rating of an item for a particular user (we call him the *active user* u_a) based on how other users previously rated the same item. More formally, the rating $R(u_a,i)$ of item i for active user u_a, is estimated based on the ratings $R(u',i)$ assigned to the same item i by users u' who are "similar" to u_a. The similarity $sim(u_a,u')$ is based on the ratings of items that *both* user u_a and u' have rated, and only k "nearest" users of u_a are used for prediction. However, this traditional method has several limitations. Since the system assumes that the users are similar *only* because they assign similar ratings to the same items, it cannot provide very *accurate* similarity. Since a *new user* has very few ratings, it cannot compute the similarity of a new user and other users. Since many CF systems (e.g., Amazon. com) have a large number of items but only few of them have been rated by users, the *sparsity* of ratings is another problem.

Besides these limitations, it is still not easy to apply CF algorithms in a ubiquitous computing environment, since we need to recommend not only "virtual" items like various products in an online store or movies, but also "real" contents, such as a book store near our office or an Italian restaurant appropriate for a couple. Therefore, it is important to incorporate some *contextual* information of the user's situation into the recommendation process.

We are developing a Context-aware Content delivery system – CoCo, which aims at navigating users in Jimbo-cho, the largest book market in central Tokyo, where 150 bookshops and print galleries attract the visitors. Based on a user's profile including the objectives of visit, preferences, contexts (e.g., time, place, environment information, user status), and other users' ratings of shops, the top 10 appropriate contents are recommended. The contents include the introduction of bookshops, cafés, restaurants, and the pastime contents. The system architecture of CoCo is depicted in Figure 1.

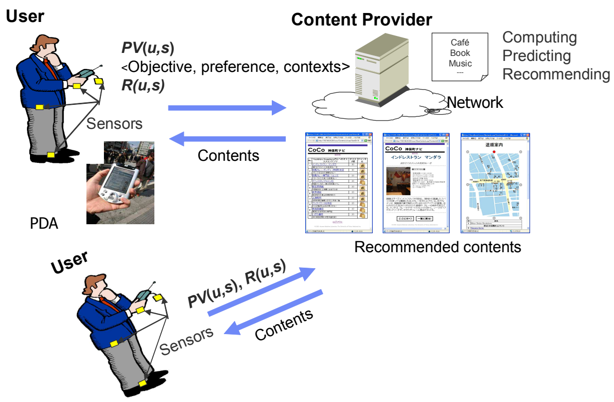

Figure 1. System Architecture of CoCo

As shown in Figure 1, the user's contexts are inferred from attached sensors, and each user sends his profile and ratings of shops to the content provider via PDA or cell phone. The content provider uses the profiles and ratings to predict and recommend appropriate contents for each user. As a result, different recommended contents are returned to different users. The computation of predicting and recommending is based on our original context-aware collaborative filtering algorithm.

The contributions of this paper are: 1) it presents a new context-aware collaborative filtering algorithm; 2) based on the algorithm, it proposes a content delivery system, which can recommend "real" objects by incorporating contextual information into account; 3) it proposes some contextual measures that implicitly feedback users' ratings of contents.

We will firstly describe our original context-aware collaborative filtering algorithm in section 2. Then we will discuss how to infer contexts used in the algorithm in section 3. Finally, we will conclude in section 3.

2. CONTEXT-AWARE COLLABORATIVE FILTERING ALGORITHM

In CoCo, we define a dynamic *Profile Vector* (PV) for each user, which consists of his objectives of visit (e.g., search comic books, fashion magazines), preferences (e.g., Japanese food, Italian coffee.), contexts (e.g., time, location, environment information, user status) as:

Profile Vector =

<Obj, Pref1, Pref2 ..., Time, Loca, Posture, Gesture, Envi ...>.

The objectives and preferences are registered through a web user interface. The contexts are inferred from multiple sensors around the user (see section 3). To recommend appropriate shops to the active user u_a, the system needs to record $R(u_a,s)$ the ratings of shops that have been visited by u_a, and predict $P(u_a,s)$ the ratings of shops that have not been visited by u_a. Our context-aware collaborative filtering algorithm has three steps:

(1) Record the ratings of visited shops $R(u,s)$. The ratings are explicitly rated by users or implicitly inferred by the system. Simultaneously, the users' Profile Vector $PV(u,s)$ are recorded to indicate their profiles when they rate shops.

(2) To predict the active user's rating $P(u_a,s_i)$ of an unvisited shop s_i, we compute the similarity of u_a and the users who have rated shop s_i, and select a neighborhood Us_i consisting of k users most similar to u_a.

(3) Combine neighbors' ratings to predict $P(u_a,s_i)$. After predicting u_a's ratings of all unvisited shops, we can sort and recommend the top 10 shops to u_a.

Let us examine each step in more detail, especially our original implicit measures and similarity computation.

2.1 Explicit and Implicit Rating

After visiting a shop, a user can rate this shop through explicit feedback and/or implicit feedback. Here we use a scale of 1 (unsatisfied) to 5 (satisfied), and the rating is computed as

$$R(u,s) = \alpha R_E(u,s) + (1-\alpha) R_I(u,s), \ \alpha = 0 or 1 \quad (1)$$

where $R_E(u,s)$ is the explicit rating, $R_I(u,s)$ is the implicit rating, and α is a regulating factor that determine explicit or implicit ratings.

Explicit ratings are collected by requiring users to give an integer between 1 and 5 for evaluating a shop. Although this method can provide exact ratings, it forces users to engage in additional activities beyond their normal behaviors. Implicit rating methods avoid this bottleneck by inferring ratings from unobtrusive observations of users' natural behaviors (we call them *Implicit Measures*), and require no extra cost to users. Table 1 shows part of implicit measures in our system and their potential implementations.

These implicit measures are combinations of contexts, which are extracted from multiple sensors. For instance, we can extract a user's location from GPS in his cell phone, and then we combine the location with counter to infer the user's number of visiting a certain shop. Besides the sensors which collect data when a user interacts with real world objects, we also develop some software monitors embedded in the user interface to collect data when a user interacts with the system itself. For instance, in CoCo, the system generates an audible beep to notify the user to see the recommendation list. A software monitor detects the notification, and combines it with time to infer the user's response time after notification. According to what a user interact with, we divide contextual implicit measures into two categories: *object* oriented implicit measures that are gathered when a user interact with real world objects, and *system* oriented implicit measures that are gathered when a user interact with the system.

Table 1. Implicit Measures (examples)

Category	Implicit Measure	Basic Contexts
Object oriented implicit measures	Purchase	e-money system
	Waiting time	posture + time
	Number of visiting a shop	location + counter
	Reading time of a book	gesture + time
System oriented implicit measures	Response for system recommendation	recommendation click
	Frequency of button click	click a button + counter
	Response time after notification.	notification + time

Implicit ratings are generally less accurate than explicit ones [6], so we build a Bayesian network model to combine the accuracy of explicit feedback and the unobtrusiveness of implicit feedback [2]. By using implicit feedback, the system can automatically attain enough ratings even if users do not purposely assign them, and the *sparsity* problem can be addressed. When a user u's rating $R(u,s)$ is recorded, his Profile Vector $PV(u,s)$ is also recorded, which indicates the user's profile at that time.

2.2 Similarity Computation

To predict the active user u_a's rating $P(u_a,s_i)$ of an unvisited shop s_i, we need to compute the similarity of u_a and the users who have rated s_i. As mentioned in section 2.1, when the users rated shop s_i, their Profile Vectors $PV(u,s_i)$ were also recorded. We use the Current Profile Vector of u_a $CPV(u_a)$ and recorded $PV(u,s_i)$ to compute the similarity as shown in Figure 2.

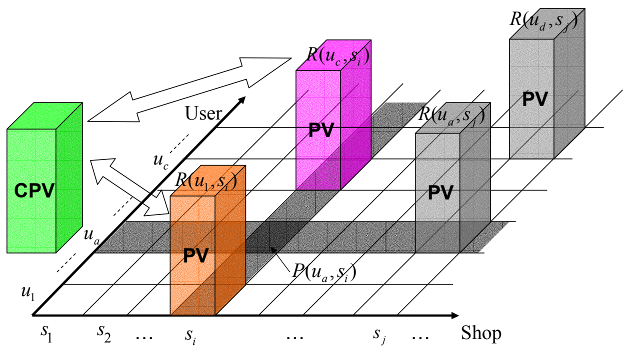

Figure 2. Similarity Computation

For instance, since u_c has rated s_i, we compute the similarity of u_a and u_c as

$$sim(u_a,u_c) = \cos\langle CPV(u_a), PV(u_c,s_i)\rangle = \frac{CPV(u_a) \bullet PV(u_c,s_i)}{\|CPV(u_a)\|\|PV(u_c,s_i)\|} \quad (2)$$

where " • " denotes the dot-product of two vectors. After computing the similarity of u_a and other users, we select a neighborhood Us_i consisting of k users most similar to u_a, and use these neighbors' ratings of s_i for prediction. Since we use dynamic Profile Vectors instead of ratings to compute similarity, the *accuracy* can be greatly improved, and for a *new user*, he can gain his similarity and prediction without rating any shops.

2.3 Prediction and Recommendation

If fewer than k users in Us_i have positive similarity to u_a, then only the users with positive similarity are used. The ratings of these "neighbors" are combined into a prediction $P(u_a,s_i)$ as

$$P(u_a,s_i) = \overline{R(u_a)} + \frac{\sum_{u \in Us_i} sim(u_a,u)(R(u,s_i) - \overline{R(u)})}{\sum_{u \in Us_i} |sim(u_a,u)|} \quad (3)$$

where $\overline{R(u_a)}$ and $\overline{R(u)}$ respectively represent the average rating of u_a and u. After predicting u_a's ratings of all unvisited shops, we can sort and recommend the top 10 shops to u_a according to ratings.

3. CONTEXT INFERENCE WITH MULTI-SENSORS

As mentioned in section 2, in our context-aware collaborative filtering algorithm, contexts are used in two ways: 1) constructing *Profile Vector* (PV) for each user, and 2) combining *Implicit Measures*. In this section, we will discuss how to infer various contexts used in our algorithm from multiple sensors.

Before discussing how to infer context, we should have some considerations in our mind:

(1) The data should be gathered *implicitly*.

(2) The user's contexts should be generated *at the user side* rather than the infrastructure side, since communication is expensive for mobile device.

(3) The sensors should be *comfortable* to wear.

We will explain how to infer user's posture, gesture, environment, and some other contexts in the following subsections.

3.1 Posture Inference

In the old version of CoCo [4], we used 3 MICA Motes (one was attached to the waist, two were attached to each ankle) with 2-axis acceleration sensor to infer the user's posture: sitting, standing, walking, or running. However, during our experiments in Jimbo-cho, some examinees complained that they were not comfortable and convenient to use. Therefore, we develop a more comfortable node with only one 2-axis acceleration sensor to infer the user's posture. Figure 2 depicts the sensor node and configuration.

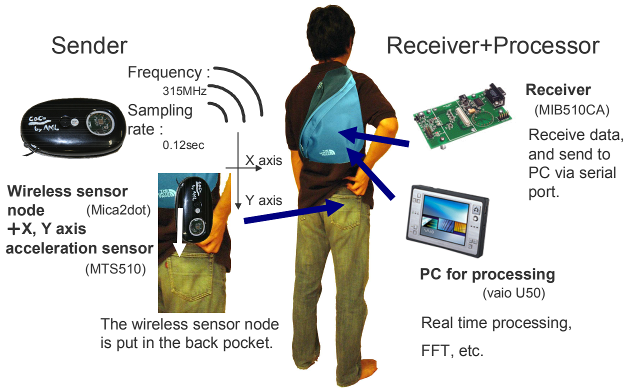

Figure 3. Sensor Node and Configuration

We encase a MICA2DOT node with 2-axis acceleration sensor in a cell phone shell, and put it in the back pocket of trousers. The movement of user's body can be sensed by the acceleration sensor and transmitted by MICA2DOT. This node is just like a cell phone, so it is very convenient for user to take. A receiver and a note PC are in the backpack of the user, and they are connected via serial port. The PC does the real time processing of the received data and infers the user's posture.

We use the average of Y-axis acceleration to estimate the user is sitting or standing, use the variance of acceleration to estimate whether the user is moving or not, use the power spectrum max computed with FFT to estimate whether the user is running or not. Figure 4 shows the context inference from acceleration data.

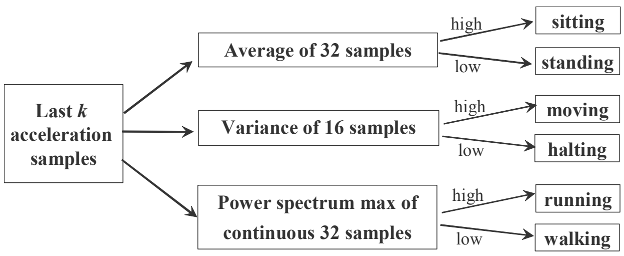

Figure 4. Context Inference from Acceleration Data

A result of posture inference is shown in Figure 5.

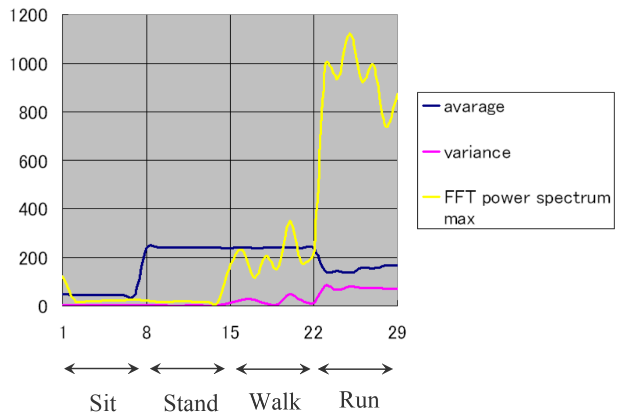

Figure 5. Result of Posture Inference

We also evaluate the accuracy of posture inference. 4 examinees attend our experiment and their postures are inferred. Table 2 shows the accuracy of inference.

Table 2. Accuracy of Inference

Posture	Examinee A	Examinee B	Examinee C	Examinee D	Average
sit	100%(38/38)	100%(34/34)	100%(30/30)	96.7%(29/30)	99.0%(101/102)
stand	100%(38/38)	97.1%(33/34)	100%(30/30)	100%(30/30)	99.0%(101/102)
walk	97.4%(37/38)	100%(34/34)	100%(30/30)	100%(30/30)	98.0%(100/102)
run	97.4%(37/38)	100%(34/34)	100%(30/30)	100%(30/30)	99.0%(101/102)

3.2 Gesture Inference

We also attach a MICA2DOT node with 2-axis acceleration sensor to the wrist of user for inferring his gesture. The method is similar to posture inference, and the result is shown in Figure 6.

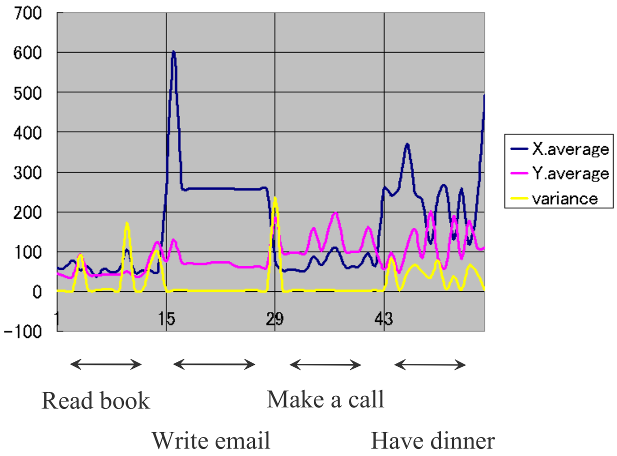

Figure 6. Result of Gesture Inference

3.3 Environment Inference

As mentioned in section 2, we also need to infer the environment context, such as on the street, in a restaurant, in a bookshop and so on. We use a sensor array with brightness, temperature, humidity, UV (ultraviolet), Motion and Alcohol sensors to infer the environment. Figure 7 shows the sensor array.

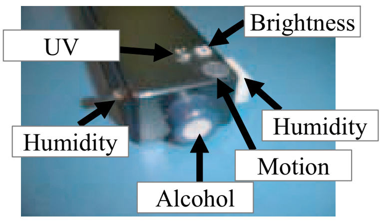

Figure 7. Sensor Array

This sensor array use PIC for A/D conversion and RS232 cable for communication, and the gathered data are processed by the same note PC in Figure 3. We collected some data with this sensor array when we walked around Jimbo-cho, and used them to infer the environment. Figure 8 shows the result.

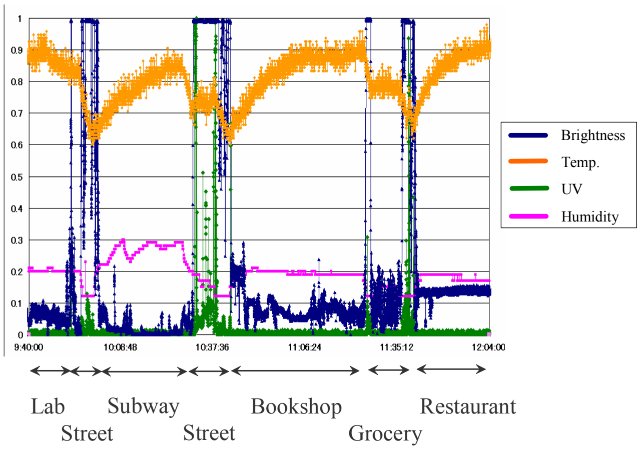

Figure 8. Result of Environment Inference

3.4 Other Contexts Inference

Besides the user's posture, gesture and the environment, we still infer some other contexts. For instance, we use GPS to capture location of the user, and e-money system to detect user's purchasing a book. As to the system oriented implicit measures, we develop some software monitors embedded in the user interface, and detect the user's interaction with the system. We are searching and developing new contexts to optimize our system.

4. CONCLUSIONS AND FUTURE WORK

In this paper, we presented a context-aware collaborative filtering algorithm, and based on it, we proposed a real world oriented content delivery system – CoCo. We also discussed how to infer contexts from multiple sensors, which can be used to construct the Profile Vector and combine the Implicit Measures. In the future, we plan to implement the whole system of CoCo and run user experiment in Jimbo-cho.

5. ACKNOWLEDGMENTS

This work is supported by Ministry of Public Management, Home Affairs, Posts and Telecommunications.

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7. BIOGRAPHIES

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Tomonori Aoyama received the B.E., M.E. and Dr. Eng. from the University of Tokyo, Tokyo, Japan, in 1967, 1969 and 1991, respectively. Since he joined NTT Public Corporation in 1969, he has been engaged in research and development on communication networks and systems in the Electrical Communication Laboratories. From 1973 to 1974, he stayed in MIT as a visiting scientist to study digital signal processing technology. In 1994, he was appointed to Director of NTT Opto-Electronics Laboratories, and in 1995 he became Director of NTT Optical Network Systems Laboratories. In 1997, he left NTT, and joined the University of Tokyo. He is currently Professor in the Department of Information and Communication Engineering, Graduate School of Information Science and Technology, the University of Tokyo. His research activities cover the next generation networking technologies from layer 1 (e.g. photonic networks) to higher layers including middleware for network collaboration, P2P routing, mobile networking, and ubiquitous networking. Dr. Aoyama is involved in several governmental projects such as Japan Gigabit Network (JGN) and the Ubiquitous Networking Forum, and in some non-profit organizations and consortiums such as the Photonic Internet Forum (PIF) and the Digital Cinema Consortium (DCC) in which he is serving as Chairman. Dr. Aoyama is IEEE Fellow and was a Members-at-Large of the IEEE ComSoc Board of Governors. He served as President of IEICE Communication Society. He also served Chair of IEEE ComSoc Japan Chapter. He is a member of IPSJ and IEEE.

Superstar.

Superstar

A photo-based Big Game designed for Ubicomp 2005, Tokyo.

area/code games © 2005 (Frank Lantz and Kevin Slavin)

Superstar is a massively multiplayer real-world game designed to take place in Tokyo during Ubicomp 2005. The game uses Japanese *Puri Kura* sticker-clubs as a starting point for a playful experiment in social networks, automated phonecam image analysis, and urban visual culture.

The goal of the game is to see and to be seen, using swarms of microscopic images woven into the complex fabric of Tokyo streetlife.

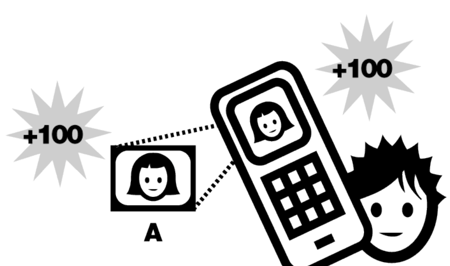
The game is free, and open for anyone to play. Players need:

- a phonecam (quasi-ubiquitous in Japan), and
- self-portrait Puri Kura stickers of themselves (also ubiquitous in Tokyo)

The rules of the game are simple:

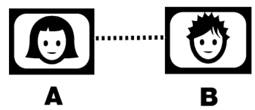
1. Play consists of placing your own stickers wherever you want and then “collecting” the stickers of other players by shooting them with your phonecam.

2. Whenever a player shoots a Superstar sticker both players earn points: both the player *on* the sticker, and the player who *shoots* that sticker.



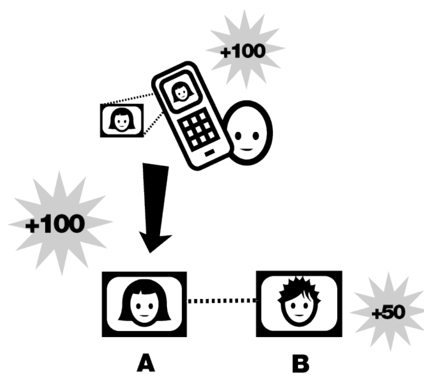
B shoots A, both players earn points

3. A link is then created between the two players for the duration of the game.



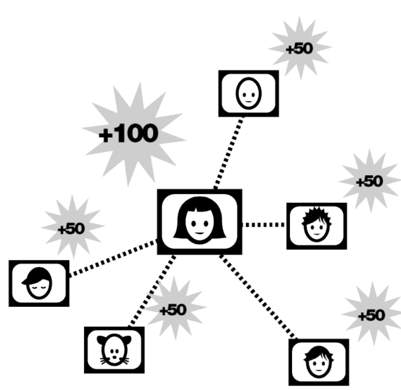
A link is formed between A and B

4. From this point on, any time either player earns points (by shooting a new sticker or by having their sticker shot) the other one will also earn points (though not as many).



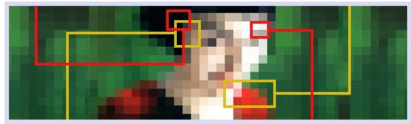
From now on, whenever A earns points, B earns points too (and vice versa)

Superstar thus builds a weighted network of connections that forms a dynamic, social, pyramid scheme. Successful players will be the ones that forge connections with other active players, and the strongest move in the game is to be the first person to shoot a Superstar sticker that is then collected by many other players. Play also rewards very active shooters, as well as those who find clever places to put their stickers.



Whenever any player earns points, everyone she is linked to earns points.

Existing automated image recognition (e.g. Mobot technology) will decipher who is photographing whom when players email their images to SuperstarHQ via their phonecam. A message is returned via SMS indicating points earned.

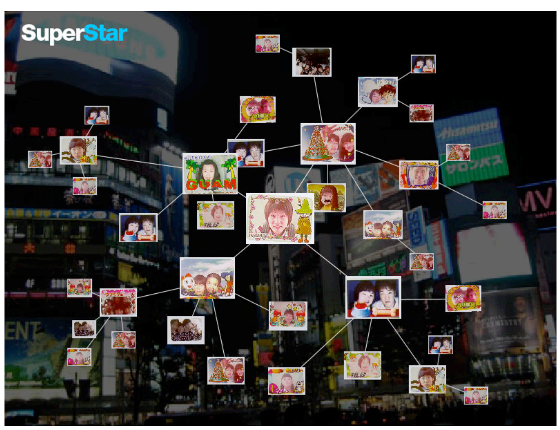


(mobot phonecam image-recognition technology)

Image-matching software will identify star-stickers by comparing them to the images in its database, and simple PHP scripts will execute the game logic. To register to play, players simply send their own sticker (by photographing it with their own phonecam, and sending it to a special e-mail address) and can then start collecting others. No names are ever introduced, except for "game tags" that players can choose.

To make Superstar stickers identifiable to other players (and more easily deciphered by software), players include a prominent star somewhere in their photo. Superstar collectors look for Puri Kura photos that feature people holding, wearing, or standing in front of stars.

The game has a strong incentive for players to recruit other players, since it uses dynamics similar to a pyramid scheme. From a game perspective, perhaps the most interesting aspect is that, while the game is competitive, players can only help themselves by also helping others.



The superstar Flash site shows all the player connections

Besides it's urban presence, Superstar also has a web presence, a flash site that shows the "leader board" and shows the links and connections between players. It is easy to imagine that a player might see a "valuable" face online, and then seek out that sticker in the real world…

Superstar is a playful rephrasing of the private/public world of Puri Kura, in which people offer up images of themselves to the world, and in so doing, become invisible (see the attached “Magic Box” photo taken in Tokyo). For better or worse, this closely resembles the dynamics of everyday urban life itself. By designating some of these stickers/people as in-game, special, *superstars,* the faces begin to appear in places they would not have, and are seen in ways they are not normally seen.

Attention is refocused on this parallel, tiny, sticker population, an echo of the crowds around us. The stickers stand in for the people we pass every day (in Tokyo, one of the densest cities on earth) and provides new criteria to look at the faces around us.

Who, after all, is a superstar?

Superstar is designed to run in conjunction with Ubicomp 2005. Beginning perhaps two weeks before the conference, the results and findings from the game are intended to be presented as part of that workshop.

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area/code will be working together with Kamida (makers of Socialight) to bring the game to life.

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Reading the city: Ubiquitous computing and spatial resonance

Jeremy Hight

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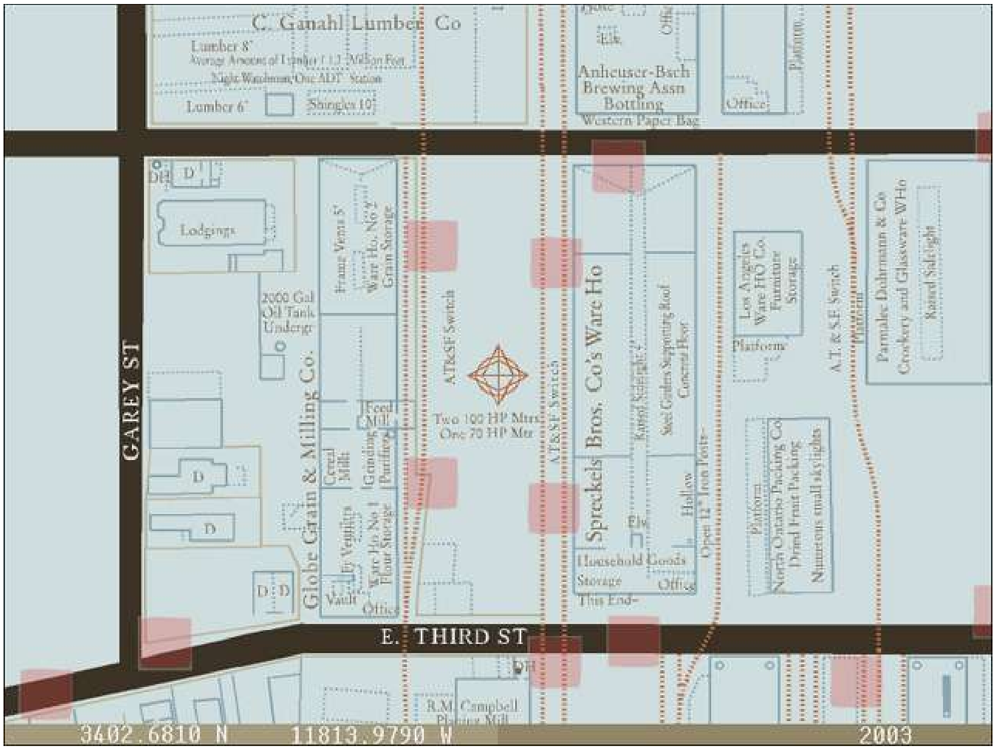
A city is constructed in layers: infrastructure, streets, population, buildings. The same is true of the city in time: in shifts in decay and gentrification; in layers of differing architecture in form and layout resonating certain eras and modes in design, material, use of space and theory; in urban planning; in the physical juxtaposition of points and pointers from different times. Context and sub-text can be formulated as much in what is present and in juxtaposition as in what one learns was there and remains in faint traces (old signs barely visible on brick facades from businesses and neighborhood land usage long gone or worn, splintering wooden posts jutting up from a railroad infrastructure decades dormant) or in what is no longer physically present at all, only visible in recollection of the past.

The pop culture notion of Archeology is one of digging in the ground and finding artifacts of the past in layers of soil. In this concept, time can be literally seen in the layers of ground and in the artifacts pulled from different depths of the dig. The new paradigm of narrativized data utilizing locative technologies (wireless) is one akin to Archeology, but of information and place. Now, the layers in time are unseen until discovered in the author's research and then placed into narrative to trigger at key physical locations. The details, events, patterns shifts, etc may be from 1960 on one corner and from 1900 a few hundred feet away.

It is possible for the creators of the wireless overlay on the city to select elements of the information about the locations where trigger points are to be placed, the area as a whole, its fit and tension within larger spaces both in geography, cartography, politically (demographic shifts,borders, gentrification issues, preservation concerns..), navigation and in time and history. The author can place forgotten or faded histories, lost buildings, previous incarnations of areas, the tension or richness of who has come through the place at what times in waves of commerce, housing, and previous events.

The project 34 north 118 west ***(2003, winner of grand jury prize at art in motion festival)*** utilized a slate laptop and a gps card to “read” a 4 block area of Los Angeles. The participants moved following an interactive map on the laptop and connected headphones for up to 5. Hot spots were set by latitude and longitude to trigger upon passing. The locations chosen for triggers were selected based on extensive research of the history of the area and what would have been there in the past hundred years of development.



The project moved beyond concepts of "digital graffiti" and using wireless and/or gps to leave a trace to be seen by another. Digital Graffiti takes locative technology and leaves a peripheral imprint, while narrative archaeology is an inversion of this. In narrative archaeology, the layers of what is already there is revealed and resonates. 34 north 118 west triggered narrativized data based on lost architecture, layers of ethnography and gentrification of the space.

Moving through a space is not a passive exercise, it is akin to a conversation. The "conversation" is between the place (streets, buildings, structures), its infrastructure (sidewalks, roadways, streetlight timings and traffic speeds in car and on foot, railway crossing, etc) and the movements chosen by the person walking. The place makes certain choices unavoidable, mitigated by its design, condition and controls, but it also makes many other aesthetic choices of the viewer/reader as they move past types of architecture, disrepair, renewal, perceived threat or comfort thresholds, and simply what they are individually drawn to at the time.

Punctuation in language and the written world can be viewed as a mediation and mitigation of speed, movement and flow. Structures such as sidewalks, stop lights, bridges, and roads can be seen also as mitigation of speed, flow and movement; thus both narrative space and physical space are punctuated in a similar fashion.

Movement, speed, direction , these all are elements of the participants' interaction with place and their aesthetic interface (their disposition edits what they choose to experience and thus sequenced as they move) in the sense that unseen layers in space are triggering as one interacts with what is seen and physically present, in infrastructure, architecture.

The city is now a paradigm not simply of city planning, but of connectivity on many levels. The concepts of “alone” and “crowd” are shifted with recent developments in spatially aware social networks (signaling when a person in the network is within range and some that alter signal as the person gets closer).

Examples:

***Embrace** -by Lisa Thomas and Jonathan Fitch-*

i**nteractivefashionablewearable.blogspot.com/** *" a concept bracelet that enables the user to be seamlessly connected to their significant other over periods of separation. It consists of five nodes: an LCD screen displaying images sent via Bluetooth; battery; technical components that fuel this device; a camera lens that constantly records images until the user specifically shoots an i mage by gently grasping each side of the lens node, which uses "touch sensitive" technology; and a scent palette that emits one of five odors chosen by the owner of the device indicating an incoming image from their significant other"*.

Residual Data-Cloud   Diogo Terroso

/www.d-srupt.com/

"The Residual Data-Cloud is an application that loads images from a networked source and generates a data-driven three-dimensional form. Images are collected via a digital camera, or a mobile phone, by the author and participants during presentation. The resulting shape, which resembles a cloud of dust, is a metaphor of residual memory immersed and somehow materialized in a real environment.
Digital appears here as a parallel dimension, in which user's perception is subjected to layers of abstraction and figuration. Its behaviour in the real space, captured by a tracking device, affects data display by revealing different properties of the cloud. Recognizable shapes appear and disappear through interaction. "

The concept of place is shifted as past permutations layer into the present location(s). The information on cell phones and pda's can be layers of pertinent data. There soon will be location aware subscription services that can feed elaborate data sets over the city from specific interests and information to trigger/overlay in place. There will be museum exhibitions that overlay "exhibitions" over parts of cities as site specific relevant to place. This may be artworks, a historical exhibition or a study of architectural theory looking at specific concepts of space with a certain section of the city as the case study for exhibition.

The city can be "read" in many, many ways, and in broad ranges of conceptual to pragmatic contextualization and information. The possibilities are vast and wide ranging. The city is to be read and integrated information of place becomes of the streets, zeros and ones in code, and the air.

Jeremy Hight is a locative media artist/writer/theorist. He worked on the pioneering locative media project " 34 north 118 west" (winner of grand jury prize at Aim festival and internationally renowned). He recently worked on a project utilizing landscape data entitled "Carrizo Parkfield Diaries" that is now in the permanent collection of the Whitney Museum Artport. He has lectured about "Narrative Archaeology" at the University of Iowa, the international symposium entitled "Trace" at the University of Nottingham, and most recently in a conference at MIT.

Modulating Urban Atmospheres: Opportunity, Flow, and Adaptation

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Zero-Th Association (http://www.zero-th.org)

City as Service

Conceptions of the city as a multi-layered service infrastructure have been reflected in past visions of the city, such as in the work of Archigram and that of Situationism. The core idea has been readily applied to experimental and commercial developments related to mobile technology, and has resulted in a spectrum of applications that have achieved varying degrees of relevance to the ways in which we live our surroundings, by facilitating social connections, revealing hidden layers of the environment, and generally in providing hooks for appropriating the informational-relational spaces we traverse [1].

Although pictures of the city articulated by physical, location-based, and otherwise immobile interfaces featured prominently in Archigram's projects, it remains unclear what may be their capacity for relevance to, and positive modulation of, the social and cultural urban fabric. Today the predominant examples, such as video displays, operate purely on the layer of the city corresponding to the sign, and act on our desires in a non-interactive fashion. They compete in a coarse way for the limited cognitive attention we have for visual and auditory stimuli in public space, echoing earlier distributions of image and print based advertising. Although there are a few interesting examples [2,3], the services that *immobile interfaces* have offered remain far from achieving the kind of inter-relational relevance - and the degree of engagement - that mobile communicational applications are beginning to show the capacity to achieve. As a result, they lie within an interesting design space.

Control vs. Serendipity

Purely by the numbers, spatial technology in the city appears to be tremendously biased toward invisible mechanisms for the centralized monitoring and control of behavior in public space, as supported by surveillance networks, RFID tags, etc [4]. These technologies continue to be deployed on a massive scale by a range of public and private institutions. They may well strengthen order and security in public and semi-public locations - improving efficiency, the safe flow of money, and so on. But as the obsessions they manifest are transformed into policy, opportunity and serendipity are squeezed out [5], and we may find that we can no longer wade through the water fountain in the square, or (as we found recently in Latvia) over-zealous security guards intervene to prevent us from taking a photograph of the marvelous canned-fish stands in the public market.

What we instead would like to envision is the provision of physical and mental space for interactions which fit just as seamlessly into our physical surroundings and routine as do these invisible control technologies, but which afford interactions capable of facilitating, through qualities of our physical surroundings, interactions as serendipitous as many applications of mobile computing seem to be capable of achieving. An advantage of such interactions is that such aims may be possible to achieve under the cover of existing functions, traffic, and infrastructure.

A much longer term goal of this project is to build an array of community-focused alternatives to the centralized urban services which predominate for the regulation of various urban activities (e.g. traffic, security). This could only be achieved if it were possible to provide tools for the bottom-up management of activity that were sufficiently relevant to current and imagined use patterns of space and resources in the city that they would be come a political and economic inevitability. Self-organization is seen as a key concept related to such a model for appropriation of the city, and perhaps a significant first step could be achieved by augmenting citizens' abilities to discover optimal behaviors locally [6,7].

Acting on Flows

The sign is the common technique employed for directing people traveling by foot or in car, and, more recently, through mapping services accessible though mobile devices. *Public flows also self-organize through attractors* *and personal desires*. The most effective modes for interacting with our desires are usually more indirect than the sign (as various trends in marketing likewise suggest).

There are flows of purpose (How do I get to the post office? What is the quickest path from my office to the station?); Flows of resistance (Which way do streets point? Where is traffic heaviest?); Flows of opportunity (Is this side street more intriguing than the main avenue? What's that music up ahead?); Flows of diversion (What is the quietest path I could take? Is there something unusual going on along that farther path?)

How might we approach the design of spatial interfaces in the city which act upon these flows? For this workshop we would like to focus on the range of continuous urban experiences consisting of pedestrian movement. Since the history of ambulation in the city is so large, we look to past urban theorists for inspiration. Among them, Debord [8,9] conceived of design in terms of the specification of a process (the dérive or détournement), and posited a role for the urban practitioner founded on the study (called psychogeography) of the specific effects of the geographical environment, consciously organized or not, on the emotions and behavior of individuals; and de Certeau [10] has written of walking in the city as that process which spatializes and articulates the body of the city itself, bringing it alive in the same manner as speech does language.

Engagement and Atmosphere

"The future cities we envisage will offer an original variety of sensations ... and unforeseen games will become possible through the inventive use of material conditions, like the conditioning of air, sound and light. Urbanists are already studying the possibilities of harmonizing the cacophony which reigns in contemporary cities. It will not take long to encounter there a new domain for creation, just as in many other problems which will present themselves." (Constant, *Another City for Another Life,* 1959 [9]*)*

To interact with pedestrians in order to alter the urban flows they embody, we need ways in which to affect them. We are most interested in elements capable of doing so by altering the physical and informational *atmospheric qualities* of a location, and which extend traditional components deployed in the course of urban design, either by technological augmentation (active shading, lighting, sound), or by abstraction of existing devices, such as traffic or sound signals, fountains, sidewalks, trees or trash cans. A focus on sensual, as opposed to informational, channels of affect is motivated by the little attention we have available for new sources of communication [11].

The design of such interfaces would draw from results in ambient computing [12], in order to provide the citizen with peripheral, low-attentional stimuli (such as modulated surface lights or water flow) intended to highlight alternative routes of cultural interest, traffic congestion, hidden treasures. Atmospheric changes would be modulated immediately, subtly, and playfully, according to the motion and gestures of those moving through the space, and would change over time based on the conditions of the neighborhood, and the aggregate movement of those passing through it. They would interact with mobile devices through complementary low-attention cues, and in order to personalize environmental changes according to the remembered identity of the passer-by.

The strength of the city is in many ways evidenced by the connections that are made within it, according to often inscrutable logics, between its actors. Sociality and inter-relational interaction is the primary modality for new and emerging services in the urban environment, and these may have the greatest success in affecting our experience of place.

We have used similar strategies in earlier experiments in public space [13,14,15], including the installation *Kontakt*, which permitted touch between its users to affect atmospheric changes in light, video, and sound, and the series *Recycled Soundscapes,* (Fig. 1) which played with the notion of environmental stressors, by enabling one to continuously capture and recompose sound in its surroundings, including ones cohabitants, through an array of sculptural and kinetic interfaces.

In the present context, such mechanisms of interaction would express the language through which we may exchange mutual influence with a space that is posited as both an active participant and a behavioral agent, capable not only of sensing and reacting, but of responding in intelligent ways, out of harbored desires reflecting those of its inhabitants and the community that hosts it.

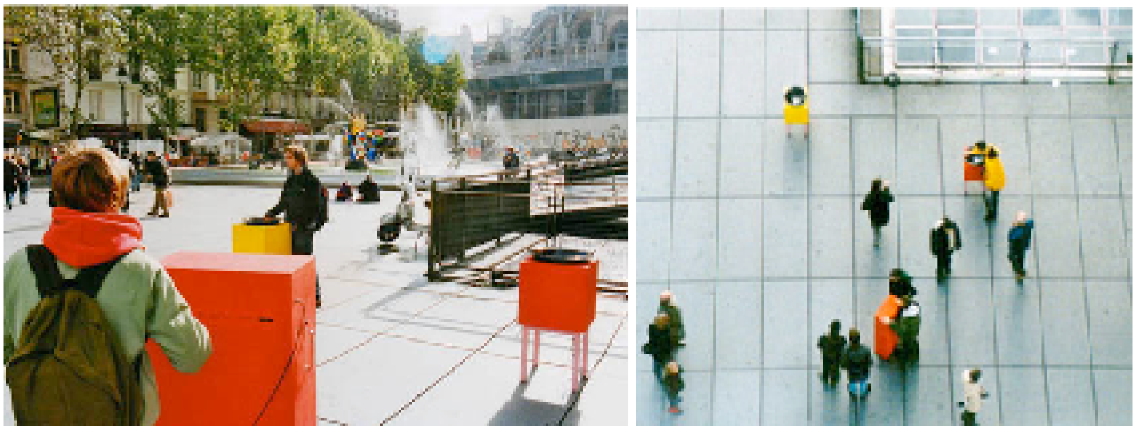

Figure 1: Views from the installation *Recycled Soundscapes* (Centre Pompidou, Paris, 2004)

Adaptive Modulation of Behavior

"An active architecture – and this is really what we are about – attempts to sharpen to the maximum its power of response and ability to respond to as many reasonable potentials as possible. If we could get to an architecture that really responded to human wish as it occurred then we would be getting somewhere." (Archigram 8, Editorial [16])

At the heart of the current proposal would be a public location, such as a sidewalk, including an array of sensors and simple effectors for interacting with pedestrians passing through the space, and embodied by a computational entity capable of negotiating such interactions in ways that support common goals embodied by itself and of its passers-by.

The technical innovations needed to support the project include a computational embodiment of the location, capable of interacting with large populations of people in realistic urban settings, and of interactively adapting to their behavior, learning the most effective mechanisms for exerting influence according to appropriate goals.

Relevant research in this area has been carried out under the guise of ambient intelligence and responsive environments (with most applications, however, confined to supporting specific human activities in non-public settings, including office spaces and smart home environments), and in robotics. Specific progress has been made in the Ada project [17], which successfully leveraged a model of animal learning called distributed adaptive control [18] in order to permit an environment to learn what combinations from a basic repertoire of stimuli were most effective at altering the movements of large numbers of people within its space.

The location would attempt to influence pedestrian flows by means of well-chosen peripheral and engaging cues, in order to achieve goals such as highlighting detours, or facilitating a good distribution of foot traffic in the surrounding area. The notion of which goals are appropriate might be determined dynamically, based on environmental conditions, from sources of local information, and other contextual information, and this information could be augmented at a local level through user recommendations to a mobile information service.

While many people would certainly pass the system either uninfluenced by it, or perhaps without noticing that their behavior may have been modified, the location would learn, over time and through mechanisms such as that identified above, which interactions are most effective in meeting communal goals, and so improving its performance.

Prospects

This work is clearly in its beginning stages, and substantial design research, experimentation, and iterative prototyping, will be needed to support it. Accompanying illustrations (see Fig. 2, 3 below) show two early design concepts as examples. One is a pedestrian passage augmented by dynamic rain which, although avoiding those passing through it, might seek to modulate their paths. The second shows the interactive play of sequences of colored lamps embedded near a pedestrian intersection. Both could be responsive to human movement, and under the right conditions, might engage in more playful interactions.

The effectiveness of such an interactive space could be measured, over time, based on public installations. Eventually, from local performance information, simulations might be developed which would be capable of predicting the impact of deploying similar systems in a wider fashion across the city, as is done in urban planning research related to traffic, growth, or other features are modeled today, and this would be an important step in justifying such work on an urban scale, and a useful tool for exploring the capacities for self-organization that have partly motivated us.

Situation

The role of place in the kinds of interaction we have in mind is primary. The exploration of, immersion in, and experimental perturbation of its target environments (through mock ups or other interventions) will enrich, challenge, and reshape the discussion more than any degree of theorizing. We look forward to the knowledge and inspiration that may be won by venturing into the Metapolis of Tokyo.

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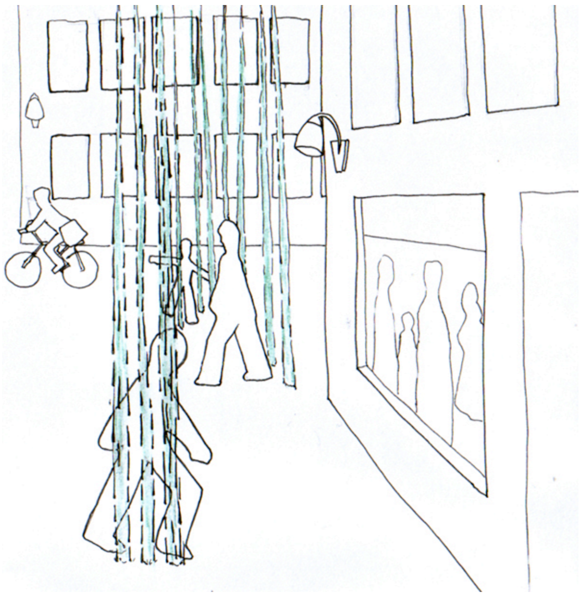

Figure 2
A pedestrian passage might be augmented by dynamic rain which, although avoiding those passing through it, seeks to articulate and subtly to modulate their paths.

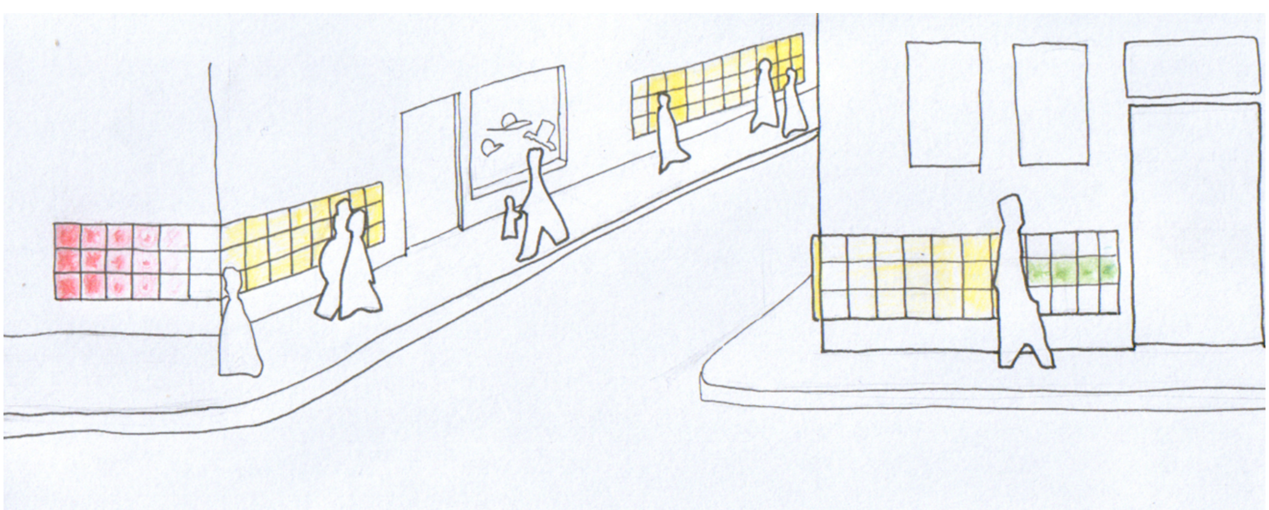

Figure 3
A system based on the play of sequences of colored lamps embedded near a pedestrian intersection, and responding to those interacting with it.

Yon Visell is a physicist moved by such things as the interactive dynamics of disturbances including sound and light, perception, behavioral systems, and their interactions. He studied the physics and geometry of elementary interactions including superstrings at The University of Texas at Austin, and his subsequent background includes interaction design, award-winning music software development at Ableton in Berlin, perceptual signal processing and speech recognition research at Loquendo, auditory display research, and interactive media design. He is a Ph.D. candidate in the Center for Intelligent Machines at McGill University in Montréal.

Karmen Franinovic is an architect, artist, and designer focused on the creative, critical and active use of interactive technology. By introducing the latter into physical structures and intangible space, she seeks in her work to stimulate the social and bodily interaction and to raise awareness of the surroundings. Karmen received Laurea degree from Istituto Universitario di Archittetura di Venezia and Master's degree from the Interaction Design Institute Ivrea. Prior to founding her own studio, she has worked on architectural projects with AltenArchitekten, Studio ArchA, Studio Sottass, Arata Isozaki and Associates, and Arup. She is an adjunct professor of studio arts and Ph.D. candidate in communications at Concordia University in Montréal.

Zero-Th Association (http://www.zero-th.org) is a non-profit, non-governmental cultural research organization based in Pula, Croatia, with newer operations in Montréal, Canada. Its main activities concern research and development related to space, time, ecologies, and their dynamic relations, with the aim of understanding and influencing the evolution of the multidimensional urban fabric, together with the presence and condition of its inhabitants. Its work is strongly interdisciplinary, manifesting itself variously in architecture, urban interventions, film, interactive digital art, interaction design, social analysis, critical theory, science, and engineering.

Zero-Th operates throughout Europe, and its members have performed sound and interaction design research on behalf of clients including FIAT, Phaeno Science Center (Wolfsburg), Telecom Italia, Illy, the Interaction Design Institute Ivrea (Italy), and the Associazione Giovani Artisti Italiani. Its designs and research have been presented at academic and cultural forums, including Salone del Mobile di Milano, ACM Designing Interactive Systems (Boston), Ircam/Centre Pompidou (Paris), Ars Electronica (Linz), V2 Institute for Unstable Media (Rotterdam), the Museum of Modern Art (Ljubljana), and others.

How I Learned to Stop Worrying and to Share (Almost Everything)

Lia Bulaong

The near-ubiquitous cameraphone is changing the way we think of photography. And that, in turn, is affecting our sense of shared space in the urban environment. For example, during last year's Republican National Convention, there were two moblogs (1, 2) anyone could send their photos to, as well as the RNC group and tag on Flickr. Hundreds of people in a shared urban space were covering the same event from different angles in mostly real time, to record the moment for history and the benefit of people who couldn't be there, but also to compare their own experiences with those of the people around them; a photographic approach to community mapping. My project 24in48.org (which started as my thesis at ITP last fall) is a riff on this idea, a group moblog event sharing the lives of 24 people over 24 hours in a city, New York and San Francisco so far but soon other cities across the U.S. and in other countries as well.

Because of cameraphones and all the other ever-increasing number of connected devices we bring around with us at all times now, there seems to be a fear that we will eventually turn into what Neal Stephenson refers to in Snow Crash as "gargoyles", people who constantly carry around gear to record and upload all the data they physically encounter, as well as to monitor what others have uploaded. Always connected = too connected = not really engaged with the real world. Is this how the future is going to be for us? I've been to many parties where it feels like there are too many cameras out to document something and it gets tiresome, because the focus is (completely on, and therefore wrongly) recording the moment instead of actually living it. At the same time, I'm the first person to go on Flickr as soon as I get home to see what other people have decided to upload from the event (and in New York there are always many others covering any given event).

As with any new technology, first we adopt something and go crazy with it, trying to figure out every nook and cranny of our lives that we can insert it in; then second, we either decide how it integrates with our routine or we drop it. Cameraphones are now at the point at which we are realizing the ways in which interaction is broken (too many steps, focused on 1-to-1 push instead of real-time sharing) in which ways it succeeds (low barrier of entry, ubiquity, spontaneity), and where we want to go with them: facilitating the creation and sharing of information from the ground up. Flickr is one site which people, myself included, are using both to share our personal narratives with friends and to document the cities that we live in; Dodgeball manufactures serendipity by telling users both where their friends are and if there is anyone in the area they should probably meet; FoundCity allows people to easily annotate city maps with both tags and photos of what they've decided are important at particular locations

The problem that's coming then isn't that we'll waste our time documenting instead of living, because that simply isn't human nature; what we will soon face however, when it comes to community mapping in shared urban spaces, is information overload, what happens when more and more of us are always connected and sharing. The tricks will be in figuring out how to balance the urban need for information within the space with the personal need to share, to build new organizational structures and interfaces that let us both categorize and search on levels that are useful to both intimate circles and the public. What these structures and interfaces will be is hard to predict because clearly the most important thing about them is that they be fluid; the only way those of us concerned with these things can even begin to understand where we need to go is by studying the nature of the content created, as active participants and creators of content ourselves, and how we choose to use and share it within our communities.

Lia Bulaong got her first camera at 11, her first cellphone at 16, and her first cameraphone a lengthy nine years later. She recently received her master's degree from NYU's Interactive Telecommunications Program,, obsesses about the intersections of pop culture, technology, art and politics at cheesedip.com and shares her life via a near-daily moblog.

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(UbiComp 2005, Metapolis and Urban Life Workshop position paper)

Representations for Understanding Inhabitation in Physical + Digital Spaces

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Urban designers use a variety of approaches to understand how people inhabit the physical environment, and these approaches generally include the production of graphical representations. Producing graphical representations plays an essential part in understanding inhabitation in urban design. Making graphics helps designers' clarify their thinking about the built environment. It is not a matter of determining the lesson and then creating graphics to illustrate it; the lesson emerges by making the graphics. Graphics codify understanding about inhabitation and connect that understanding to specific elements of urban form. For example, a time-series of sketches showing changes of light and shadow across a plaza combined with graphics representing how long people sit in a particular place links behavior to the environment.

One factor of the success of traditional graphical representations is that they work at multiple levels of abstraction. For example, some people that have no trouble navigating through their neighborhood are unable to sketch their route on a map. However, the abstract representation of the map can embody the more experiential representations of place. For example, the route information can be based on photos taken by residents after giving them cameras to photograph their paths through the neighborhood.

Route map through neighborhood.

Street enclosure diagram.

The application of traditional urban design representations to understand hybrid physical-digital spaces is more problematic. Traditionally the representations are used to *evaluate* existing places and to *design* new places, but these representations must be modified to help technologists evaluate and design hybrid physical-digital spaces. With the evolution of ubiquitous computing, new location-specific content is creating exciting experiences interleaving physical place and digital content. The lack of appropriate representations is an obstacle to improving the user experience for hybrid physical-digital spaces because it diminishes opportunities for evaluating the current experience of inhabitation.

The need for new types of graphics is critical because the naturalistic observation by professionals and experience capture by residents favored by urban designers for learning about inhabitation does not work that well for understanding how people use technology in the city. Naturalistic observation alone is insufficient because the current experience of the hybrid physical-digital city is generally private. White earphone cords suggest someone listening to an iPod, but what are they listening to and where did it come from? Someone stopping on the sidewalk to open a cell phone and starting to press the keys appears to be accessing text messages, but what are the messages about? Are the messages triggered by something in the physical world? Where are the senders/recipients? To get answers to these questions researchers must either intrude on the private experience or give participants a tool analogous to a camera for them to capture their own experiences.

New kinds of representations are needed to help technology designers codify their thinking about inhabitation of hybrid physical-digital spaces. These representations must be able to embody the lessons from enhanced methods that go beyond the traditional urban design methods of naturalistic observation and personal experience capture. By giving people new tools to capture their own experiences of hybrid physical-digital spaces, developing new methods for naturalistic observation, and creating new representations for embodying lessons about inhabitation, designers of ubiquitous computing technology can create exciting new experiences emphasizing the best aspects of physical and digital spaces.

Bio

Ame Elliott is a Research Scientist at PARC. She is as an ethnographer and interaction designer in the Socio-Techno Interaction Research group. She designs and evaluates interfaces for working with multimedia beyond the desktop. So far this year she has spent 6 weeks conducting fieldwork on the streets of Tokyo for the design of a mobile technology prototype. After completing her undergraduate degree in Environmental Design from the University of Colorado at Boulder, Ame earned a Ph.D. from the University of California, Berkeley for her hardware and software interfaces for supporting the architectural design process. Her past projects have been supported by the National Science Foundation, the National Endowment for the Arts, the Lawrence Berkeley National Laboratory, and the United States Census Bureau.

Enhancing Urban Community Enclaves with P3-Systems

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A college campus in an urban location such as Newark, New Jersey is a semi-public place, with some areas open to the public and others locked and protected for "members only." It is an example of what might be called an "urban enclave," which is an identifiable physical area "owned" by or identified with a specific organization or purpose. The urban enclaves in which we are interested have multiple buildings or venues and a permanent or semi-permanent core of members, but also have visitors and considerable change in population over time, and are typically sized between 1,000 and 30,000 people. Other examples might be corporate office parks, and large museums. The large number of people who come and go in such urban enclaves potentially have interests in common and could use tools to discover others with similar interests, or to keep track of the presence or absence in the space of those who are already acquaintances or collaborators. We are exploring how systems that connect **P**eople-to-**P**eople-to-geographical-**P**lace, or P3-Systems, can be used to support communities in such urban enclaves.

A number of systems that link information and communication to the actual physical locations of people and places have been prototyped and made commercially viable. Recently systems like Ulocate (http://www.Ulocate.com/) have been deployed that support the tracking and use of location histories of specified users. In Japan *LoveGety* allows the swapping of simple profile information, to match and alert co-located people with similar interests. Rather than developing and studying one such application, however, we will be developing, deploying, and studying the impact of an integrated family of applications, some synchronous and some asynchronous. The suite of applications we will deploy will cover all of the basic P3-System techniques as shown in Table 1.

Table 1 Taxonomy of *SmartCampus* P3-Services

***SmartCampus* Services**		**Synchronous Communication or Synchronous Location Awareness**	**Asynchronous Communication or Asynchronous Location Awareness**
People Centric	Absolute User Location	Provide remote awareness of current user location of authorized "buddies" (research partners)	Utilizes people's location histories
	Co-location / Proximity	Real-time inter-user co-location for the exchange of social information	Utilizes co-location history to enable future interactions.
Place Centric	Use of Physical Spaces by People	Online representation of user's current use of physical spaces (e.g., is this conference room empty now?)	History of People's use of a particular space
	Interactions in Matching Virtual Places	Synchronous online interaction spaces related to physical location.	Asynchronous online interactions related to physical location.

Ideally, the emergence of P3-Systems will strengthen community by helping individuals leverage location information to: meet appropriate people and turn acquaintances into friends; and coordinate better the interactions with family, colleagues, and friends to reinforce existing social ties [1]. To achieve the first of these two goals, namely leveraging location to meet new people and to turn acquaintances into friends, system designers and developers need to: 1) understand how to capture and utilize geotemporal histories to identify social matches; 2) provide users with trustworthy face-to-face introduction tools; and 3) understand how to provide geotemporally relevant social alerts/recommendations that do not overly interrupt the users or invade their privacy. Unfortunately our knowledge in regards to each of these key issues is lacking. We do not know how to effectively manage the capture of personal geotemporal histories from mobile networks of heterogeneous devices in order to compute social matches that take into account place types, recurring patterns of co-location, and place-linked roles. Nor do we have a basic understanding of how to effectively enable face-to-face introductions between users while simultaneously ensuring appropriate exchange and control of personal identity data: In what order should basic demographic details be exchanged between users? How is the revelation of identity data affected by situational variables such as place and time? How do we tie the revelation process to social networks in terms of reputation and trust?

We will study these key issues intensively using the New Jersey Institute of Technology's (NJIT) NSF supported SmartCampus location-aware community system test-bed. The SmartCampus test-bed will provide 500+ users (students and faculty) with heterogeneous wireless, locatable, lightweight, mobile, cost effective computing devices and deploy a variety of P3-Systems.

A key SmartCampus P3-System that will be used to support this research is CampusMesh, a location-aware geotemporal social matching and reminding application. The CampusMesh system will support the proposed research and inform the design of future instantiations of *trustworthy* P3-Systems. It will support social introductions and ongoing relationships between members of the NJIT community through social alerts and reminders (e.g., "there is a user nearby that you should meet" "Fred, whom you met before and put on you friend list, is in your vicinity", "get Joe to show you his new camera, while he is adjacent to your current location"). We anticipate that CampusMesh will encourage the formation of new friendships, support goal directed team formation, and geotemporal personal relationship management through geotemporal social matching, social network visualizations, and user diaries/scheduling. We aim to make the system trustworthy by providing users with appropriate levels of control for the revelation of their personal data to other users, especially between individuals who have had little contact with each other.

Other planned "P3" applications for SmartCampus include:

- NJIT's *ActiveCampus Explorer* [2] (modified from UCSD version), which enables map based "buddy tracking", location aware instant messaging, and digital graffiti;
- *SmartCampus* WiKi-web which provides context aware editable web pages about NJIT places, people and organizations according to location and season via an analysis of wireless access point used and DNS lookup; and
- *GeoMemory*, an in situ multi-media and location aware capture tool for mobile phones.

Privacy concerns, related concerns about the spread of biased and perhaps damaging or even libelous information, and the way in which these concerns may conflict with the desired services and convenience of others, are expected to be a major design challenge and topic of our research studies with prospective and actual users [1]. These concerns are likely to differ by role. For example, students might find it useful or amusing to have "digital graffiti" commenting on the quality of a professor's lectures stored on the digital map of the classroom in which the most recent lecture took place. A professor whose lecture has been cuttingly critiqued might consider this to be an invasion of the assumed relative privacy of the classroom and an incorrect and perhaps libelous assessment of his or her teaching. Should such digital graffiti be allowed? If so, how long should it remain? Must it be signed with the "real" name of the person creating it, which of course would have a chilling effect on perceived freedom of expression of the students? Many researchers have explored privacy and security issues in collaborative and ubiquitous computing systems. The P3 systems framework can help us identify the privacy concerns associated with the various techniques used in location-aware community systems.

For absolute user location techniques, a key issue of concern is the possibility of "stalking" or simple violations of users' desire for privacy. In fact, users consider absolute user location techniques more problematic than alternate approaches [3]. This suggests that using this technique makes sense only in the context of strong social ties between users, a clearly defined work setting or task, or law-enforcement situations. Planned semi-structured interviews with prospective users will help us to understand the number and nature of social ties (relationships such as room-mate vs. simply co-member of a club) that are trusted to be able to discover one's specific current location, versus the types of social relationships for which users desire only very general location information to be shared, such as whether the person is on campus now.

For collocation proximity techniques such as Campus Mesh, the key concerns are associated with geotemporal social matching, which is the leveraging of location data to bring people together for interaction and potentially new relationships. In systems that synchronously match people based on user profiles, there is the issue of information overload and identity management. For example, do attractive-looking individuals waiting for a subway on the edge of the NJIT campus want to be inundated with notifications to meet strangers or have fellow passengers be able to identify them without some sort of permission? It's vital that systems provide trustworthy tools so that users can safely and progressively reveal their personal identity data.

Other issues arise when asynchronous processing is added to the mix. Consider a system, deployed within an organization that records when people are in proximity. Such a system could analyze collocation data to identify ad hoc work groups or find people a squash partner who usually visits the gym at some of the same times; this information might in turn be useful for organizational or personal planning and the allocation of resources. However, the same type of data and the same type of analysis might inappropriately reveal a budding office romance.

We plan to use a variety of research methods to explore these socio-technical issues, including:

- laboratory studies of how "strangers" engage in progressive identity revelations [4],
- semi-structured interviews exploring user attitudes towards issues related to privacy and interruptibilty,
- protocol analysis (thinking out loud") of prototype use to improve the usability of various software applications on different types of devices [5], through
- large scale field trials on the NJIT campus that will include user surveys and longitudinal monitoring of who-to-whom network traffic, to examine social issues and identify changes in social networks.

For example, we have begun conducting semi-structured interviews with representative prospective users, in which we describe applications such as Campus Mesh and provide an illustrative scenario of use, and then explore what privacy concerns they spontaneously mention, and the kinds of words they use to describe these concerns. Probes and follow-up questions will request them to specify how these concerns vary depending on the nature of the relationship with the current or prospective "buddy" and their location and activities at the time. The qualitative interviews will feed back into the design of both system features and the creation of structured questionnaires to be used in field trials. We hope in the future to study the generalizability of our findings by engaging in field trials in other urban enclaves.

To enable viable P3-Systems meaningful places need to be identified. The approach we are currently exploring is computerized prompting of users to label and share a small subset of locations identified through analysis of their personal geotemporal histories. In turn, we are testing the hypothesis that the difference between meaningful and less important places inside individual urban enclaves will relate to P3-System information seeking and sharing preferences and practices. We believe that the findings from these studies will provide significant insight into P3-System design.

Biographies:

Quentin Jones is currently an Assistant Professor in College of Computing Sciences, New Jersey Institute of Technology, after working in the HCI group AT&T Labs research. Prior to living in the United States Quentin was a Ph.D. student, educator and independent consultant in Israel. His Israeli activities included building the Israel Defense Force's first public website and exploring online mass interaction through the systematic analysis of Usenet and Email list discourse. In Australia in the early 1990s Quentin's activities resulted in the first internet based ethnic community network. Quentin's current research and teaching focus is social computing with an emphasis on the design of collaborative environments.

Starr Roxanne Hiltz is Distinguished Professor, College of Computing Sciences, New Jersey Institute of Technology. She conducts research on applications and social impacts of computer technology, publishing widely in books and in journals including JMIS, MISQ, and Communications of the ACM. Her research interests currently include Group Support Systems, Asynchronous Learning Networks, and Pervasive Computing.

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NAVIGATING SPACES OF CONSCIOUSNESS: A DIALOGUE

Vincent: The city....those spaces where the biped reigns supreme,where nature has become almost totally subordinate to his mastery. The ultimate ground of the cyberworld.

Toyin: Yes,but even so how do we escape the fate of disappearing in the swarm of the urban beehive?Our intelligent devices,the PDAs and smart environments,will progressively strip us of the control even of the forms of the spaces we traverse. Walls that interact with you as you pass,objects that can inform another person whether or not you are alone. Sooner or later,the pervasiveness dreamt of by the cybergenies will mean that our individuality will be eroded even further than it has. We find in the metropolis the freedom of anonymity,the thrill of being part of a vibrant mass that is greater than any one,yet,in this finding,the space between myself and the person at the Tube is as wide as the gulf of unbridged human hearts..

Vincent: True,but does not have to be so.

Toyin:Why?How?

Vincent: Technology is a double-edged sword. Just as the fire that burns also cooks and is vital to our mastery of nature. Ubiquity could actually imply further anonymity within the mass,reducing even more the need to interact with other humans since smart environments,intelligent machines,seamlessly embedded into the formations constituted by the human being and the spaces they inhabit, could negate the need to interact with humans. You can travel any distance by Tube and bus in London without speaking to a single person since you simply interact with the ticket recording machines. But can that happen in Lagos, a zone of low technology,where the absence of the invasion of human space by machine facilitators creates a more human interactive space where one could be saved from despair by a chance meeting with a stranger to whom one can speak of the one's burdens?But that is only one possibility. See,for example,the MIT media lab project that is actually designed to connect people by matching people of similar interests so as to bridge that gap we are at times find difficult to bridge in the metropolitan mass[1].

Toyin:The one in which as you shake hands with someone,you are able to gain information about that persons interests so that,as it is described, put sensors attached to objects are able to give you data about other users of that object,so that,before you meet certain people you could have been alerted to their interests so that,for example,you could strike up a conversation on the strength of that information?

Vincent: Exactly. It works through sensors attached to objects that gather data signals from those objects,enabling the interpretation of contexts associated with object in terms of who has handled them earlier,contexts abstracted from a databasewhich tracks and correlates a broad range of subjects and those who are interested in them.

Toyin:Uncannily like the claim for the possibility of sixth sensing,in which on handling an object,you could sense information and emotions associated with that object,information that could have been imprinted by the magnetism of the previous handlers. Psychometry[2].

1 A reference to the Ambient Semantics project carried out by the Ambient Intelligence research group at MIT as described at http://www.media.mit.edu/research/ResearchPubWeb.pl?ID=955.

2"In parapsychology, **psychometry** is a psi (or psychic) ability in which the user is able to relate details about the past condition of an object or area, usually by being in close contact with it. The user could allegedly, for example, give police precise details about a murder or other violent crime if they were at the crime scene or were holding the weapon used. Psychometry is a type of retrocognition. Psychometry, like all other paranormal abilities, is unconfirmed and hotly debated in most circles.This term refers to bursts of energy and/or memories, both negative and positive, which have left an "imprint" upon an object or place. For instance, a house where a traumatic experience has happened, such as a murder or suicide, may feel distinctly chilled or "bad;" while a favorite childhood toy or play area may feel light or "good." A place or thing may be so charged with emotions and memories that it may even seem haunted"Wikipedia at http://en.wikipedia.org/wiki/Psychometry

Vincent:That's true. Some conceptions and even productions of artificial intelligence applications have correlates in accounts of extra-sensory capacities,perhaps because they both represent efforts by humans to project and possibly actualize possibilities that are beyond their present cognitive capacities.

Toyin: Possibly. Along those lines, one could see relationship between two models of augmentation of human consciousness,the metabiological and the technological.

Vincent:What is metabiological?

Toyin:A development of human capacities in terms of a cultivation of its inherent possibilities rather than an augmentation through developing a relationship with nonhuman forms,such as with technological aids,as in prostheses.

Vincent:By metabiological augmentation,you mean, forms of physical,mental and spiritual exercise,like yoga,where human capacities are developed,beyond the conventional scope of human capacity,but carried out in terms of integral human capacities?

Toyin: Yes. The dominant Western model seems to concentrate on technological affordances,on manufactured objects as means of augmenting or amplifying human possibilities,while pretechnological models emphasize the development of enhanced human capacities though the cultivation of innate capacities through their exercise or their stimulation by a variety of forms,including ethogenic plants.

Vincent:Is there any relationship between these issues about metabiological and technological models of human augmentation of human cognitive capacity and the point we were discussing about human dwelling and navigation in urban space in relation to ubiquity in computing?

Toyin:I would say so. The question has to do with models of augmentation of human awareness that unite,bond,rather than alienate humans. The argument has often been that the more advanced a technological civilization,the more alienating between human beings it tends to become. Developing models from metabiological conceptions of cognitive augmentation could help us develop technological complements to human consciousness that would enable us to break out of that loop.

Vincent:Do you think that sensor models that capture and transmit data about individuals in relation to objects,and possibly,at a later stage of development, even in relation to situations,experiences and attitudes could be related to to such biological-technological models?

Toyin:Yes. That inclusion of the situations,experiences and attitudes within the data base that maps communities of interest,as it were,would require some subtle rethinking of the technology,but if successful,would provide a much more precise information map that would enable the tracking of people's interests. Two people could relate with the same objects,but respond to them in significantly different ways. I would think that it is in that nexus of response to similar phenomena that the distinguishing characteristics of personality can be found. The technology, therefore could be calibrated to register emotions and attitudes,beginning from the techniques used in lie detectors,which if I understand it at least passably,employ a device that monitors the rate of the heartbeat in response to particular questions. But the issue would be what exactly does the quickening of the rate of the heartbeat signify?What kind or level of response? Does it have to imply an intention to lie or even a knowledge pf the question?How do we record and interpret accurately the range of possible human responses to phenomena,whether abstract or concrete?

Vincent: Perhaps we could develop a database of physiological responses and their interpretations based on a broad population sample from a particular social framework. This could be done though recording of physiological responses and the working out of their closest possible meanings through interviews with the subjects,and through careful observation that would enable us to develop controls that would assist us in assessing the subjects' interpretation of their own physiological responses.

Toyin:An adaptation of the the RFID device used in the MIT project,then,would abstract from a database of these physiological responses and their interpretation in relation to objects, rather than simply in relation to those who have handled them. In relation to situations,people could wear devices that would establish correlations based on shared attitudes and responses to similar situations. So we would develop a database based on emotional and attitudinal filiations,maps of affectivity,of coordinations of response, so we have psychologically based rather than physically based sensor and information capture system.

Vincent: We would navigate a landscape, therefore,of potential attitudinal and emotional correlations so that the humanscape is realized in its possibilities as an attitudinal and psychological, rather than a simple physical field.

Toyin: Fascinating. So,the metropolis in reaching its potential as metapolis could employ such metabiological models, as the Ambient Intelligence project is adapting, to become more connective between humans.

Vincent:Yes,but beyond that other possibilities emerge. You spoke earlier about enhanced consciousness in relation to interaction between humans and intelligent devices. You know that most of the time such enhancement of consciousness is often associated with withdrawal from society, as we mentioned earlier We also noted that it can also be encountered through the stimulus of action. Can't one harness the density of interaction generated by the metropolis in generating the kind of stimuli that could stimulate the kind of enhancement we are speaking of?If this can happen through intense action,may we not speculate about the intensity generated by large groups of people as an energy matrix that can be harnessed to such ends?

Toyin: Begins to sound like science fiction to me.

Vincent: Not any more than anything we have discussed so far and today's fiction is tomorrows fact,at least take or give the length of time allowed by the scope of human ingenuity and the power of the skills and technologies available at any point in time. I expect the space between innovative developments to increase as we move further ahead in time,in a kind of exponential growth on account of what has been achieved so far and the boldness of thought we encounter today.

Toyin:Even then....

Vincent: Ill come back to that pint I am trying to develop. The idea is still growing. Meanwhile,in terms of correlating the experience of ubiquitous computing and the experience of the urban,I am particularly interested in two major aspects. The human density of these spaces,the scope and variety of interaction that takes place within them,and the enormous spaces they often encompass. It should be possible to harness these aspects of urban space to computing within a ubiquitous framework in order to move towards the experience of enhanced consciousness.

Toyin:How?

Vincent: A key aspect of the ubiquitous computing model deals with the navigation of space in relation to smart devices. Spatial navigation is a central aspect of human construction of the pattern of individual and social existence. Our material existence is made possible by spacial frames. Our experience of time is developed in relation to space. Now,note that contemplative disciplines often involve the transcendence of space and time in order to arrive at sense of unity with the cosmos. What of if we exploited the ubiquity of space and time to develop a sense of existential grounding in the world,and therefore,a sense of depth,of burrowing to a metaphysical ground which is itself founded on the experience of space and time?[3]

Toyin: Please explain.

Vincent:: Good. Note that one of Kant's truly beautiful expressions expresses his sensitivity to the correlative internal and external universes that constitute the world of the human being. What he described as

3 The Sentient Computing research group at the University of Cambridge,for example,explore in depth the development of world models that would enable ubiquitous computing devices to function in relation to mobility within space as described at http://www.cl.cam.ac.uk/Research/DTG/research/sentient.

“the starry heaven above me and the moral law within me”interpreting both of them in terms of the sense of the infinite. With the infinite in the physical world on account of the scope of the physical cosmos and the infinite in the inner world on account of the scope for reflection,for response, that transcends the confines of our physical existence[4]. Could we not cultivate a similar sense through the use of techniques of mapping individual space,as actualized in the individual's peregrinations in space?

Toyin: I'm listening.

Vincent:At one time,I used to look back at my day at day's end and try to go back in memory over every place I had gone,everything I had done and everyone I had interacted with and try to reflect on the significance of that for the progression of my life in terms of both its immediate progression and its ultimate direction. That is similar to contemplative techniques designed to take advantage of human action and interaction in society as a means of cultivating what the Buddhists describe as mindfulness,which would engender a sense of participating in the flow of life without being caught up unthinkingly in it,and of cultivating the capacity to reflect on its deeper implications. I wonder if we could not develop a means of tracking individual action and activity in such a manner as to facilitate abstraction in relation to a metalevel of evaluation of these experiences.

Toyin: Interesting. But that can be readily done through a diary.

Vincent: What I am proposing is what I would describe as a cross between a tracking device and a programme,that is based upon a massive database of interpretations of life's experiences culled from various sources. It would correlate your day's experience with ideas that could suggest their philosophical significance. This ideational mapping would then act as a framework,a scaffold,on which one could then go further in the exploration of these experiences. Most of the time,we do not take time to examine our experiences,not to talk of exploring them *sub specie aeternitatis*,in relation to the flow of our lives in terms of the posterior and anterior darknesses of birth and death. Such a device would assist in that. A kind of electronic guru.

4 Quoted in A.W.Moore,*The Infinite*(London:Routledge,1990)p.xiii.

Toyin: Fascinating. How exactly would this database would be developed?

Vincent:Each possibility of experience can be correlated with a broad range of interpretive possibilities,a range of ideational correlates that could suggest its potential significance which the individual could then explore in relation to their own experiences. My eventual conception is that the totality of interpretations of specific experiences and situations can then be correlated in terms of a matrix that constitutes an interpretation of the ultimate significance of one's life,in relation to the activity one has engaged in any particular day and eventually expand this to embrace the totality of one's daily progression as this is developed day after day. So one would be enabled to keep a philosophical log,more or less,of not only the progression of ones life in terms of its incidents but possible interpretations of those incidents,both at the microlevel in relation to the immediate significance to ones life,but also a macrolevel of interpretation,in terms of what Kant described as the convergence of the infinite possibility of the external universe and the infinite possibility of the internal world.Infinite,I think,in terms of the interpretive scope that can be developed in terms of our interpretation of phenomena,both concrete and abstract.

Toyin:Certainly ambitious. I seem to perceive you drawing together the strands of research paradigms from different sources. From the space modeling research at the Cambridge computer science lab and the MIT Ambient Intelligence project which utilizes a data base correlating objects and people's interests in order to predict possible interests of people who are assessed in relation to the system.

Vincent:Yes. The pints of correlation have to do with mapping space as developed by the Cambridge project,mapping human interests in relation to various phenomena,particularly objects,in relation to the MIT project and developing correlations between various classes of phenomena,objects,situations,attitudes in relation to a structure of ideas which facilitates interpretation of causes of human experience and suggest causes of action,as developed by divinatory systems,particularly the Nigerian Yoruba Ifa system[5].

Toyin: Interesting. I see you are correlating the pretechnological,spiritual and metaphysical mapping of Ifa

5 The Yoruba Ifa system is described,among other works, in Wande Abimbola,*An Exposition of Ifa Literary Corpus*(Ibadan:Oxford UP,1976).

with futuristic technological conceptions and forms.

Vincent: Certainly. What matters here is the abstraction of underlying methodological principles and correlating them in a manner that enables each of these systems to enrich each other. The ambient intelligence project database represents a mapping of objects and correlative attitudes,the development of world models also represents a form of mapping space,in this case through the electronic agency of sensors while the Ifa cosmography represents a means of mapping situations,attitudes and concrete phenomena in terms of a cosmographic scheme. A map that would facilitate the development of guides to human behavior,in this case suggested courses of action,which by analogy could be correlated with the effort to develop what the MIT team call "assisted serendipity."Serendipitous because it generates data in relation to chance encounters in which similarities between strangers could be revealed to them and thereby facilitate interaction by making available information that would otherwise not have been available and so enable possibilities of interaction where otherwise undeveloped encounters would have been all that would result from the meeting. The Ifa system, on the other hand, represents a database that would enable the interpretation of possibilities of experience and response to situations by making available knowledge that would otherwise more difficult to arrive at,if at all.

Toyin: Increasingly interesting, although a little complex. What about what you were saying earlier about generating energy generated from the population density and range of activity of the metropolis as a means of developing enhanced consciousness?

Vincent: I am still thinking about that. The idea is not clear enough yet. The basic framework remains though. The idea of developing the distinctive characteristic of spatial navigation,particularly in urban space,as a means of developing a philosophical approach to the configuration of our lives by our navigation in space.

Toyin: Okay. Perhaps we can see what we have been talking about,as our ideas have branched out in various directions from basic premises,as reminding one of the nodal networks that occur in electronic circuitry,in electronic distribution systems,all modeled,it would seem,on the patterns of of roads,which radiate in various directions from a central artery

Vincent:Yes. Nodal centers branching out into distribution patterns,nerve centers of electronic processing,navigational routes of energy and information flows,evocative of our navigation of various possibilities of our exploration of the issues we discuss. Hermeneutic navigators,then,developing possibilities of understding,as we go down various paths of thought.

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