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New media urbanism: grounding ambient information technology

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Abstract. The design challenge of pervasive computing demands new emphasis on ambient, embodied, and habitual experiences. This emphasis connects the younger field of interaction design with the more venerable disciplines of the built environment. In terms of knowledge representation its central problem becomes location modeling. This turn from the universal aspects of computing to its situated practices becomes both a defense of architecture and an agenda in urbanism. To complement more particular research compiled in this journal issue, this paper offers a connective overview of that position.

1 Understanding the challenge

Models of context have assumed a new role in design computing research. This role draws ever more deeply on core principles of architecture and urbanism. As a consequence of a more general paradigm shift from cyberspace to pervasive computing, the understanding of activity in context amongst the environmental design disciplines has become invaluable to a wider range of research endeavors. This current stage invites a far deeper application of domain knowledge from the built environment than was possible under the earlier cyberspace paradigm.

Context is particularly relevant in the rising field of interaction design, which formerly confined itself to the task and the onscreen interface, but which now, in response to mobile and embedded computing, must expand its scope to a more generalized notion of place (Moran and Dourish, 2001). This new scope aligns interaction design and architecture as disciplines. Together these fields share a concern for design objects that are lived with over time, in the periphery of awareness, until they give a bias and a cast of aspects of everyday life. Both fields work at framing organizational intentions. Both build relatively durable social infrastructures.

This crossover requires each field to adjust to outlook, however. The interface designer may no longer study only the deliberative focal attention on a task; the architect may not dwell only on figurative form. Instead, the core design sensibility becomes a concern for that which is experienced 'habitually, in a state of distraction' (Benjamin, 1969). One descriptor that fits this new orientation well is 'ambient'. This word suggests that, if computing is pervasive, it should also be experiential and unobtrusive.

One way to approach the ambient is to study place in new ways. It is helpful to put aside notions of place based on nostalgia, tribalism, or touristic consumption, and to emphasize notions of place based on how we organize, cue, and channel our many, often concurrent, participations in daily life. It helps to recognize how we often belong to multiple places and communities, partially, by degree, in ways influenced by many fields of design (McCullough, 2004).

In one particularly authoritative treatise on the topic, Casey (1997) has emphasized attitude—'getting into place'—as a way to consider place as being beyond form, or behavior, and especially with concern for intentions. This fits well in interaction design; the experience of getting into place is increasingly mediated by technological infrastructures.

Contexts help us to connect mental states with available opportunities for participation, and that is the very basis of interactivity (Nardi, 1996). One change wrought by pervasive computing is that much more of this mediated participation becomes ambient. Instead of supplanting the form and protocols of the city, it overlays them. To the extent that interaction designers study how uses and practices with systems are revealed over time, this stage of development enriches the field, and elevates it into much more of a cultural endeavor.

To model context must be much more than reducing it to position, as some early developments in pervasive computing have done; or to identify politics, as prevailing studies of cultural geography tend to do; or to approach place mainly as something lost, as tourism and sometimes environmentalism can; or as the site of a guaranteed experience, as themed consumerism and branding do. As a means to mediate relationships among multiple, often competing, sets of intentions—for example, to manage streams across the various visible and invisible borders in an individual's or an organization's life (Mitchell, 2003)—situated computing has become inevitable, particularly in some culturally unappealing ways; what is in question is whether the design disciplines rise to temper some bad side effects and to discover some happier ones. This is a cultural opportunity. Attention to situated interactions can transform the notion of place, an otherwise slippery and sentimental concern, into more useful subject matter for design research.

2 Conceptual background and terminology—a dozen interlocking phenomena

Because pervasive computing raises more challenges than any one field tends to take into consideration, some survey of what may appear quite disjoint can be useful here.

2.1 Pervasive computing

Papers throughout this theme issue offer explanations of 'pervasive' computing. Consider the many adjectives applied in recent years: mobile, embedded, physical, tangible, environmental, invisible to name a few. 'Ubiquitous', perhaps the most widely used adjective, often implies universality: standardized, always on, Internet access everywhere. That is of course problematic.

2.2 Situated computing

Troubles with universal one-size-fits-all computing have become more commonly recognized. The desktop metaphor becomes overloaded. Usability is engineered for beginners or casual users, and so practiced mastery has little reward. Differences in organizational and physical context are ignored as well. But when you have the same experience any time, any place, then perhaps you are nowhere. Good urbanism depends on one place meaning something different than another. Anything beyond mechanical usability has been increasingly shown to depend on social context anyway. Consider, then, a complementary form of pervasive computing that is not universal, but situated (table 1).

Table 1. Universal versus situated forms of pervasive computing.

Universal	Situated
Anytime, anyplace	Responsive place
Mostly portable	Mostly embedded
Ad hoc aggregation	Accumulated aggregation
Context is location	Context is activity
Instead of architecture	Inside of architecture
Fast and far	Slower and closer
Uniform	Adapted

2.3 Interaction design

Partly as a consequence of the paradigm shift from virtual 'cyberspace' to physical 'pervasive computing', the word 'interaction' has been badly overexposed. In just about any relationship between people, object, or even shapes on a page, things are said to interact. More properly, the word implies deliberation over the exchange of messages. A message sent is merely transmittal; a message received and acknowledged constitutes communication; a message sent back becomes two-way communication; only when the message sent back is affected by the message received does interaction occur. Thus you do not interact with a book, you just read it. But, using electronic communication, you can interact with other people who are not physically present, or who take part in the exchange at some other time. That mediation demands design.

Interaction designers study how people learn, operate, and assimilate technology, especially information technology. They also study how technological mediation influences what people are doing. Increasingly, they do so in terms of work practices, social organizations, and physical configurations—in a word, context. The use of the term *interaction* design instead of *interface* represents a cultural advance in the field (Preece et al, 2002). Recent mission statements by firms, schools, and publications commonly acknowledge this. Interaction designers claim to know at least partly what is wrong with information technology. Today we can no longer assume that mechanical efficiency is the root of usability, that more features mean better technology, or that separately engineered devices will aggregate into anything like optimal wholes. The kinds of judgment necessary for establishing appropriateness in interaction design are at least as professional as they are artistic or scientific in character. By turning attention to how technology accumulates locally to become an ambient and social medium, interaction design brings this work more closely into alignment with the concerns of architecture.

2.4 Embodiment

Place begins with embodiment. Body is place, and it shapes our perceptions. Buildings are the embodiments of their owners' organizations. Entire cities, as it has so been said, are the embodiment of societal aspirations and histories. This is not just a state of being, but, as Dourish (2001) has examined, an emergent quality of interactions. Tangible computing advances this quality by configuring and constraining tasks and communications in physical space.

2.5 Activity theory

The study of activity in context has become a central focus of interaction design (figure 1). It has also formed a recent paradigm shift in its own right. Earlier cognitive science had emphasized mental representations at the expense of context. As Nardi (1996, page 11) observed: "[we] have produced reams of studies on mentalistic phenomena such as 'plans' and 'mental models' and 'cognitive maps', with insufficient attention to the world of physical artifacts."

Activity theory serves considerations of place because of its emphasis on intentionality. "When we speak of 'direct manipulation', 'intelligent agents', 'expert behavior', and 'novice behavior', we are really positing concepts in which consciousness is central" (Nardi, 1996, page 11). Intent makes people different from machines in any flow, and it gives an asymmetrical cast to the relation between people and things.

As people learn from their settings, they come to associate them with particular states of intent. Intent is important because it causes engagement of context to be, as Nardi put it, 'about' something. This is why meditation teachers insist that a particular spot in the house be set aside for no other purpose.

Figure 1. A concept map of activity in context.

2.6 Periphery

As a vital principle in the original coinage of pervasive computing, Brown and Weiser (1996) introduced 'periphery' as a strategy for managing information overload. "Periphery is background that is outside focal attention but which can quickly be given that attention when necessary ... . Periphery is informing without overburdening." Trying to keep too much in the locus of attention tends to be stressful. We find it more natural to use our considerable powers of sensing the surroundings, and then to experience more capacity and resolution where our attention is focused. Thus, as Brown and Weiser observed, bringing something back from the periphery to the center of attention is a fundamentally engaging and calming process.

2.7 Typology

A theory of place for interaction design must recognize these qualities in architecture. Through background cognition, embodiment, and situated action, the built environment mediates life inobtrusively. Despite architects' taste for formal and social reinvention, that background quality is deeper in longer-established patterns. Skills and knowledge build from accumulated knowledge of persistent structures. The discipline of architecture provides, and debates well, a workable design philosophy of *types*. Here this is a generative design abstraction and no mere functional classification. Typological design is not a rigid set of rules, but instead a body of phenomenal essences which play themselves out differently in each instance. In a single notion, type unites periphery, passivity, phenomenology, adaptability, affordance, facility, appropriateness, and scale. In one of the seminal declarations of urban design Rossi (1982, page 41) asserted that "Type is the very idea of architecture, that which is closest to its essence."

2.8 Service ecology

Consider a parallel between a recent critique of ubiquitous computing and that 1960s critique of the modernist city. In questioning universal design, both of these critiques launched a compensatory movement in its field—situated interaction design within

computer–human interaction and urban design within architecture. In finding latent value in local situations, both critiques have advanced an understanding now known as 'service ecology'. As Jacobs (1961, page 222) put it, "intricate minglings of different uses in cities are not a form of chaos. On the contrary, they represent a complex and highly developed form of order."

In a local situation, value arises from knowing where to obtain what one needs, in what arrangements of urban space and time, and now, increasingly, by what degree of technological mediation. This tacit form of insideness has been found to be more essential than more overt design objects at building an experience of place (Relph, 1976). Furthermore, service ecologies have become a central focus of sustainability in urbanism (Manzini and Jegou, 2003). When more activity is devoted to upkeep than to expansion, when elements at very different scales depend on one another, when elements coevolve on the basis of context, and when resilience operates at the level of whole systems, then some sort of ecology is at work. One of the main social upsides of pervasive computing is in implementing produce-service systems and infrastructures.

2.9 Place and community

The shift from cyberspace to pervasive computing demonstrates wider reorientation, spanning many intellectual disciplines, from space back to place. According to one often-cited authority (Casey, 1997), the central thesis could be stated that, although place has been 'dormant' in Western thought for hundreds of years, now it has returned to respectability. Space has been 'supreme'. Whether by scientific, theological, or architectural construction, modern space has been abstract, absolute, extensible, metric, universalizing, objectifying. If it has not been lost outright amid these spatial tenets so central to modernity, place has at the very least been reduced to mere location.

One simple distinction holds that "space is movement; place is rest" (Tuan, 1976). A more complex distinction by the same geographer fits well with concerns for more local technology: space is the anxiety of global indifference; place is the comfort of local malleability (Tuan, 1992). Distinctions also support a move toward experiential concerns in information technology: space is an ordering of understanding; place is an ordering of experience (Relph, 1976).

We value places enough that housing is usually a family's greatest living expense, tourism is the world's number-one industry, and environmentalism has assumed aspects of a religion. Places are a way of taking part in the world, for, with a resonance unequaled by many other aspects of existence, they are both socially constructed and personally perceived. Place imagery permeates language and legend, and place ownership dominates history and economics. Places are not just passive containers, but are indeed the very expression of cultures. As expressed by Tuan (1992, page 41), "place and culture are interchangeable ways of looking at the same issues."

Embodiment has been one such necessary but unquantifiable phenomenon that has regained academic stature. The phenomenological thread in 20th-century thought led to the interpretations of embodiment (Merleau-Ponty), contextual perception (Gibson), and situated action (Suchman) that ground current work in interactivity. When interpreted at the social scale, this history also led to urban typology (Rossi), habitation patterns (Alexander), and place identity (Norberg-Schulz). According to the last, "Most modern buildings exist in a 'nowhere'; they are not related to a landscape and not to a coherent, urban whole, but live their abstract life in a kind of mathematical–technological space which hardly distinguishes up from down. ... The environmental crisis is evident [even] in the flat neutrality of a domestic interior wall" (Norberg-Schulz, 1983, page 190).

In urbanism, place phenomena are upheld as attributes of community—causal encounters, tacit belonging, and support networks, for example. Here is another word that has been badly abused, however. 'Community' has come to mean any aggregation of people, whether by shared interests, shared market behavior, or proximal location. One better usage that aligns with present topics is to describe active participation based on a shared intent. Another is to connect it to service ecologies.

Place and community differ in that the latter is often distributed and without physical features. Place and community are similar in that each involves a perception of insideness. In the case of community, the perception is all the more social. A location may be very much a place to one person and not at all to another. For community, however, there must be some commonly held perception, not only of its existence, but also of its purpose. This is a prime example of how contexts affect intent and how institutions confer identity.

Life takes place. Our accumulated experience of intentional settings means a great deal to us, both as individuals and as societies. Design practices that foster this experience never go out of style. Perceptions of place may be subjective and fleeting, but the grounding of life in effective contexts remains absolutely necessary.

This bears repetition: at least to the more mobile and networked of us, place has become less about our origins on some singular piece of blood soil, and more about forming connections with the many sites in our lives. We belong to several places and communities, partially by degree, and in ways that are mediated. With the rise of pervasive computing, more applications must enhance, and not undermine, our perceptions of grounding place.

3 Toward new media urbanism

From this broad diffuse conceptual background, pervasive computing research has focused much more interest in urbanism than was previously expected. Design research now builds a conceptual framework for new media urbanism.

3.1 Urbanism

Under the widest scope of urbanism itself, which could be stated as the belief that the good life is a city life, interest has increased in what we could call ambient character. What happens between the buildings matters more than it once did. The amenities of a city are increasingly understood to be economic generators in their own right, much like factories and highways, and sometimes much more effective regional investments than those (Florida, 2002). These amenities include the types, scales, and configurations of the physical environment. This has been illustrated by the consistent preference of the knowledge economy for neighbourhoods and cities with architectural advantages. Although such a coupling of character with usefulness is not a recent discovery, as it was important to Jacobs (1961) for example, it has come fairly recently to electronic communications, whose previous visions more often did away with context. More than centripetal effects, such as Tofflerian electronic cottages, information networks are causing unprecedented intensification of some locales, such as the global financial capitals. This has been primarily concentrated on production support services; but with mobile communications it is quickly expanding into social linkages.

This digital layer accumulates better in some places than in others. Networking is neither as uniform, as universal, nor as nonmaterial as its proponents sometimes imagine. Effective layering of successive technological infrastructures amplifies the advantage of particular neighbourhoods and cities. Although the dematerialized and tunneling effects of global communication certainly exist, the local integration and tuning of crossovers between these and preexisting infrastructures also becomes an important competitive

advantage for a city. To put it another way, not all is flow in the space of flows. Much as a river needs banks if it is not to become a swamp, the flows of people, goods, and information require fixed channels, switches, and fittings to become most effective.

Like architecture, these infrastructures are owned, maintained over time, and used to represent organizations and institutions to their constituencies. As a result entire cities assume much more distinct niches than were previously possible or necessary (Graham and Marvin, 1996). Distinctions in the experiential quality of situated interactions slowly become an aspect of those niches. Technology does not all fit in one's carry-on: the mobile meets the embedded amid the institutions that constitute the city.

3.2 Locative technology

Even before considering such broad cultural dimensions, there exist abundant purely technical reasons for understanding information technology as something local. Location models prove essential for pervasive computing. The early work of Brumitt et al (1999) at Microsoft offered a clear enough standard for this: "For computing to move off the desktop and be accepted, it must have a comprehension of physical space which is related to that of the user, else the proliferation of smart devices will only increase the complexity of the user's experience, instead of simplifying it."

The web has not completely negated geometry. Furthermore, geometry is important to location modeling (Brumitt et al, 1999). Internet protocol (IP) addresses are often bound to the hardware addresses of connection devices, which in turn are managed by physical location. Geolocation services on the web can trace the country and most often the city of origin of connections to clients' sites. But it is the act of bringing a mobile device into contact with a site-embedded system that most distinctly dictates a need for location models. Specialized site-embedded systems cannot operate independently in large numbers, but must corroborate one another. Architectural elements of physical space often frame and cue actions. Accumulations of technology need to be housed, maintained, and tuned by their owners.

Furthermore, technical interoperability itself is increasingly ad hoc and local. Much of it occurs at a much lower layer than TCP/IP (TCP—transmission control protocol); many devices do not need the Internet to link locally. Similarly, in cases in which physical relationships matter to these connections, global positioning may not be the best fit. Effective integration demands corroboration as systems of sensing, actuating, and tagging layer into a site. The more such systems aggregate, the more they need to share some representation; otherwise they may produce contradictory results (Brumitt et al, 1999). Thus the technical argument for physical geometry builds from the first principles of pervasive computing.

Meanwhile, in the information sciences, work in geodata and location-based services has exploded. The most visible instance of this has been the Internet search engines. Other areas, such as radio frequency identification tagging, intelligent transportation systems, onboard navigation systems, social meetup systems, and the like, now drive locative media research.

In another key category of evidence for new media urbanism, geodata have quickly advanced beyond common notions of fixed wayfinding to embrace a more dynamic notion of social navigation. For example, in a process that makes their owners into 'living cursors', mobile phones that identify a caller's position can be used to receive information about the location. The capacity to engage annotated locations and to change subjective frames of reference (figures 2 and 3) have been advanced through personal, mobile gadgetry. Yet this is where markets have emerged most quickly. Social navigation may indeed have become the dominant application of information technology among certain demographic groups (Rheingold, 2003). This partly explains why

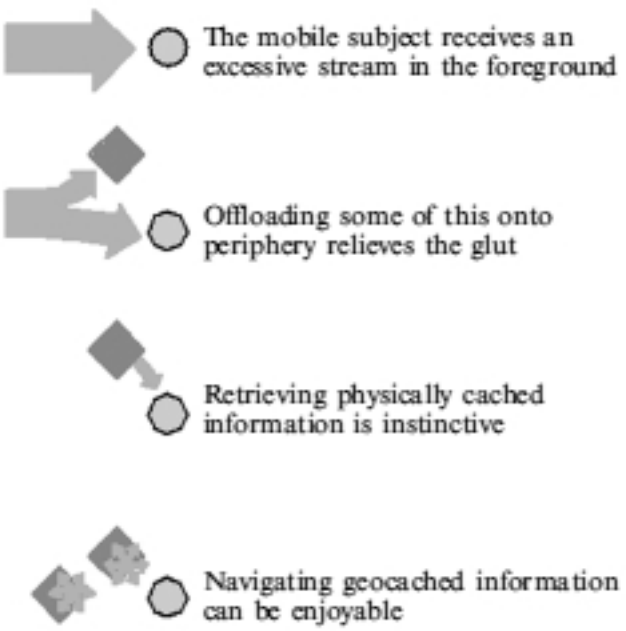

Figure 2. Offloading onto periphery is a fundamentally calming process.

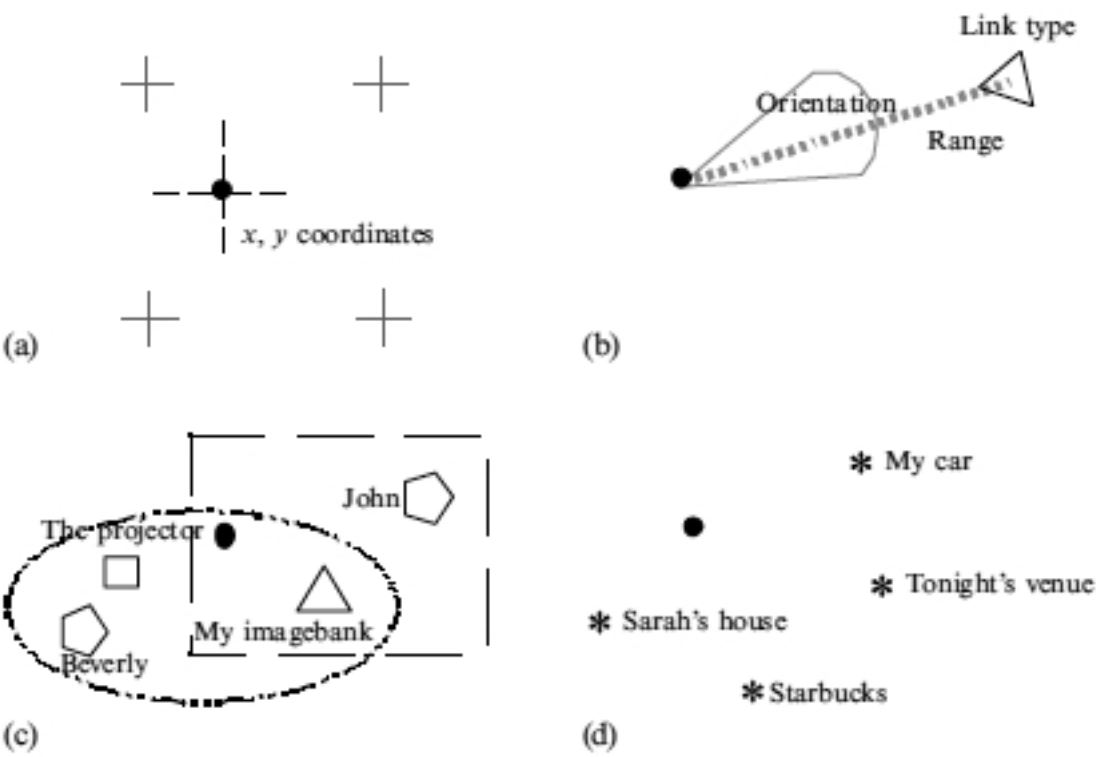

Figure 3. Alternative frames of reference in location mapping: (a) position, (b) aim, (c) actors, and (d) sites.

pervasive computing, like automobiles before it, appears to have become a fashion accessory. In particular, the emergent and transient effects of large-scale social navigation have become a form of culture.

3.3 The challenge of location models

Among the lasting consequences of the dotcom boom, practical implementations of network computing have developed a provisional ethnography of activity in context. No longer just about procedures and automation, computing shapes the very contexts and communities of knowledge. Contextual inquiry into the circumstances of technology usage often reveal technical, social, organizational, and physical factors. These influence the successful adoption of new technology at least as much as the functional feature of graphical user interfaces. Technology designs thus depend on how organizations have gone about representing work.

In what became a standard textbook in interaction design, Beyer and Holtzblatt (1998) codified a set of processes by which software developers could gather field data on their customers before beginning work on technical solutions. Methodology with context has become a cornerstone of interaction design education.

Location models present wicked problems for research; this is arguably the key agenda in pervasive computing. More ambitious methodologies generally represent contextual knowledge with an abstraction layer based on some ontology of a physical location or situated set of actions. This is increasingly necessary in applications in which interoperability is ad hoc.

Without some sort of local model, and without some sort of physical scope for local connectivity, pervasive interactivity quickly becomes too complex. Location models must tame this complexity with representations of presence, protocols, and better-presented possibilities for action.

Service ecology has become a favored theme for modeling location. First, device ecologies emerge within the ad hoc encounters of mobile and portable technologies in contexts. Second, designers increasingly recognize information ecologies, which manage knowledge by a combination of software models, contextual configurations, and human reflection in action (Nardi and O'Day, 1999). Third, such situational types increasingly become subject to the design of interaction ecologies. Diversification and clustering in interfaces makes as much sense as diversification and clustering in the urban form. Fourth, in the many ways described in this essay, these agendas become those of architecture.

3.4 Playing the city: social navigation

Design education approaches these challenges with more receptivity to the premise of a project, rather than the performance of a product, as its cultural contribution. Figure 4 lists one set of projects to illustrate this preference.

The playful orientation with which people get in and out of locations, groups, and conversations through the use of digital technologies has become subject matter for design. Play has often been ignored by an older generation that equates computing

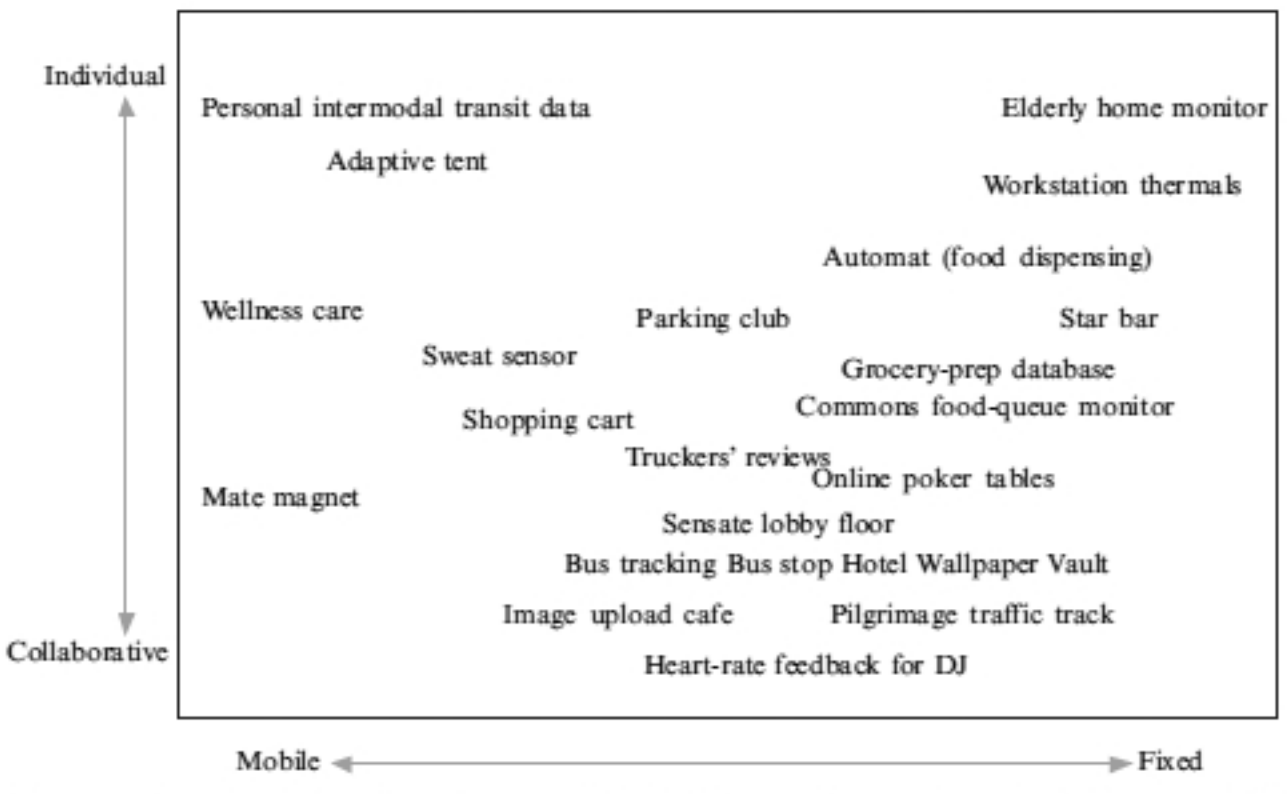

Figure 4. The diversity of premise, according to degree of mobility and collaboration. Project titles from recent course workshops at the University of Michigan on new media urbanism.

with production-task automation; but to a younger, more multiplexed generation of information technology navigators, play has become an ethic (Kane, 2004) and a way of life that cannot so readily be dismissed as diversion, entertainment, or undue levity. Like place, play is an attitude that one casually crosses into. With its dynamic notations, even in the most serious of work, computing fosters this. There is something about the nature of digital media that remixes art and industry, use and beauty, work and play (McCullough, 1996).

The rise of interaction design brings evidence of a need for more ambient computing. Longer intellectual histories in environmental psychology, known to this journal, now add a new chapter. Theories of embodiment, developmental learning, skillful activity, peripheral awareness, habitual contexts, institutionalized metaphors, architectural types, assume a new life under the paradigm of pervasive computing. Where once the disciplines of architecture and urban planning dug furthest into these concerns, today the domain of interaction design renews and extends the knowledge of how people and organizations not only play their physical contexts, but would be lost without them.

4 Qualifying the argument

To reiterate the central thesis: under a paradigm shift from pervasive computing, interaction design must serve a basic need for getting into place, and architects' and urbanists' knowledge can serve this. Given the conceptual framework and domain developments described above, we are in a better position to qualify this overarching claim into a more practical agenda for new media urbanism.

4.1 Objections to pervasive computing itself

Powerful objections arise immediately in response to pervasive computing itself. Whether this movement is inevitable, just a passing way of understanding, or an outright bad idea is beyond the scope of this issue. My purpose is to temper present movements with due consideration of the built environment.

The most common objection needs to be taken apart, however, because otherwise it brings this work to a halt. By far the most common concern with pervasive computing is its implications for surveillance. Wireless connectivity, local-hop protocols, affordable sensors and cameras, and the general advance of device economies have made much more widespread sensing much more practical. One usual response has been to revive Orwellian fears of some unblinking, totalitarian Big Brother. Despite real concerns for the erosion of civil liberties, especially in the United States, the stereotype of the panopticon seems fairly out of place here. The loss of privacy has become much more of a bottom-up than top-down social phenomenon, for one thing. Instead of Big Brother, this is more like ten thousand little brothers. So much information pollution has been added that clear omniscient views through it have become the exception rather than the rule. Even sleek telecoms companies, much less blundering government agencies, have trouble making sense of their data about you. Like the physical smog produced by automobiles, this data smog has become a bad side effect of a valuable technology, but not one bad enough to make us surrender that technology.

Information pollution also occurs in the form of autonomous annoyances. Displays and actuators bring this annoyance into the physical world, where it is more difficult to turn off. Media moguls regard space not filled with advertising and entertainment as underdeveloped. Many of the rest of us regard the relentless feed—commercials coming out of gas pumps, for instance—as pollution.

When those autonomous objects are vital to human activities, a third, ultimately most critical, objection arises: smart devices inevitably force humans to do stupid things. In medicine, for example, patients are often uncomfortably subjected to the preprogramming of instruments. In transportation systems, human error can result from a misinterpretation of preprogramming, and device errors can sometimes occur autonomously. In much more banal instances, VCRs everywhere flash 12:00 because nobody can be bothered to reprogram them. In short, we lack the time or ability to program all the systems around us, and the patience or rigidity to accept how they have been programmed by others.

Last, 'by others' raises what researchers are likely to overlook as the most universal objection to computing. Most people remain on the underprivileged side of the digital divide; and among computer users, at least on the desktop, most people remain confined to tedious data entry and retrieval operations.

Though advances in mobile communication are bringing information technology into milieus and populations formerly without it, the multiplexed, multiplaced way of life under consideration here generally requires education, opportunity, and plenty of voluntary physical mobility.

4.2 Objections to new media urbanism

Although the ideas investigated in this theme issue do aim to mitigate and qualify the many problems with pervasive computing, they are not without difficulties of their own. Some of these difficulties appear as most general challenges, that the brighter side of this movement needs to be built, culturally, whereas the darker side seems inevitable. Some are very specific problems in the logic of the medium—for example, how to infer changes in frame of reference in a speech-recognition system in a responsive conference room. But a focus on urbanism raises three particular objections, the response to which now forms much of the basis of useful work in this field. These may be characterized as duration, socialization, and representation.

Good urbanism depends on the endurance of edifices. Rossi (1982, page 47) recognized this shortcoming in the disposable nature of modern space: "Naive functionalism ends up contradicting its own initial hypothesis. If urban artifacts were constantly able to reform and renew themselves simply by establishing new functions, the values of the urban structure, as revealed through its architecture, would be continuous and easily available. The permanence of buildings and forms would have no significance, and the very idea of the transmission of a culture, of which the city is an element, would be questionable."

Socialization of course asks who uses the forms and technologies of the city, and in what intentional context. Much of the present research has been driven by the move of information technology beyond the workplace, and indeed into social navigation, even fashion. Although this trend brings more people across the digital divide, it also raises the need for an ethnographic component to many more forms of design. As noted, this debate moves interface design into interaction design, for example. Success factors in the social assimilation of design objects into everyday life are mainly the subject matter of the market-research disciplines. As in the domain of housing, the design professions can lag the market in the recognition of social change in the structure of demand. And all this is generally beyond the methodological orientation of this issue.

Methodology for location modelling remains, then, as the essential research pursuit here. Different domains need to find common terms and valuations, for example. Different applications need to share their data, and therefore sometimes their abstractions. Models of individuals and organizations involve agreements about tagging and identities. Models of processes require assumptions about physical context and scope.

4.3 Focusing the research

When the social impact of a technology increases, especially in unintended ways, research into inherently objectionable phenomena may yield socially positive results. When conceptual categories acquire too much sentimentality or overexposure, refocusing them in terms of emerging rather than perpetual challenges can make them more useful again. Such is the case with computing and place. Both of these categories, which are otherwise too readily assumed to be opposite or unrelated, benefit from reconsideration in light of the other. In particular, many of the objections to pervasive computing itself can be tempered with increased consideration of the intent behind the existing social infrastructures of the city. Many of the objections are to the uniformity, universality, and ubiquity of computing. Pervasive is not yet the idea category; we are really talking about socially situated, physically enduring, experiential, unobtrusive computing. Many of the background terms for this paper should be normal within both architecture and computing design discourses; yet so far they are not. Few of us want our experiences designed for us; yet just about every one of our experiences that is mediated by technology could be better designed. It is to address this paradox of programmability that the new discipline of interaction design has emerged.

5 An agenda: toward soft architectures of ambient urban computing

As ambient information technology becomes subject matter for design, it becomes a form of architecture. That word applies when social infrastructures are being built irreversibly. It applies when solutions to underconstrained or overconstrained problems of spatial experience must be proposed synthetically rather than indicated analytically. It applies when the results of information technology represent organizations to their constituencies, configure bodies in space, or become the settings of everyday life. All of these qualities have been arising in pervasive computing. Despite technology researchers' preference for determinacy, the design challenge of ambient media increasingly values a merely descriptive model of a situated information practice over a predictive model of a context-unaware monoculture. The expression 'soft architecture', which first gained currency during the first wave of interest in environmental systems integration in the 1970s, has returned to use in these regards.

The field of interaction design has mainly devoted itself to usability in the deliberative onscreen task in the workplace. This computer–human interface is the usual meaning of the 'CHI paradigm'. But because the task under study has so often become mobile, social, and ambient, the field has begun to embrace a greater range of cultural situations. By acknowledging its foundations in the study of embodied activity in habitual contexts, interaction design implicitly aligns itself with architecture. Through reorientation beyond usability metrics on the desktop to social play in the city, the field engages a richer form of cultural production. The more that principles of locality, embodiment, and environmental perception underlie pervasive computing, the more it all seems like architecture.

Usual objections to pervasive computing help to qualify this shift toward a more productive engagement of existing social contexts. Concerns about surveillance or the overprogramming of activities must be addressed through a greater awareness of how architectural type and social dynamics give tacit protocols to everyday life. Location models have become a prominent research concern in knowledge representation for pervasive computing. Service ecologies have become a prominent research concern, both in web design and in urban design. To achieve a valuable synthesis of these opportunities appears to require a multidisciplinary embrace of 'ambient urban computing', or, in a less technocentric phrasing, 'new media urbanism'.

This agenda becomes a position in the field of architecture as well. Interactivity becomes a remedy for architecture, which as a discipline has often ignored usability, performance, and inhabitation in its quest for attention-seeking novelties in form. 'Ambient' qualities enhance architectures, both hard and soft. Architecture needs to rejuvenate itself with interaction design. Physical architecture is relieved from its struggle to be at the fashionable center of attention, and returns to what it does better in any case, namely the enduring formation of periphery.

Architecture provides a fixed form for the flows engineered by pervasive computing. As a much older form of technology it has shaped psychological geographies more fundamentally. It remains an important part of our cognitive background. In the relation of environment and technology, buildings are among the oldest, best understood, and least obtrusive of artifices.

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