

Life in the Real-Time City: Mobile Telephones and Urban Metabolism

Anthony M. Townsend

THE introduction of inexpensive, mass-produced mobile communications has not been as widely heralded nor as closely studied as the advent and explosive expansion of the World Wide Web. Yet the cellular telephone, merely the first wave of an imminent invasion of portable digital communications tools, will, as surely as the development of the Internet, lead to fundamental transformations in individuals' perceptions of self and the world, and consequently the way those individuals collectively construct that world.

Because of this, mobile communications devices will have a profound effect on cities as urbanites weave them into their daily routines. In addition to the neglect by scholars of the social uses of wireless communications systems, urban planners and architects have also neglected the social effects of these technologies, focusing instead on cosmetic issues such as the design and placement of the increasing number of antenna towers needed to support the growth in the use of networks. This neglect is not universal. At least one researcher, Timo Kopomaa, has written that in Scandinavian countries (where mobile communications have penetrated more deeply into social and business networks than anywhere else) these technologies are challenging conventional notions of public vs. private space. Yet architects and city planners have barely begun thinking about the larger impacts of these technologies. This article explores the poten-

tial influence of new mobile communications technologies on contemporary urbanization. While speculative, this work represents an attempt to preemptively explore the possibilities for change that may indicate challenges and opportunities for urban planners and policy makers.

The case for assessing the current development of this technology in an urban planning context is compelling. As Table 1 shows, in North America there are over 95 million mobile telephone subscribers, rivaling the estimated 100 million Internet users. In developing countries, the use of cell phones is exploding while Internet use remains limited to the few and well-educated. According to investment analysts, the market for mobile telephones in China alone is projected to top 120 million subscribers by 2003. While Internet use must ultimately plateau when the world's entire literate population is online, "smart" phones with voice recognition will undoubtedly serve the billions who have no ability to read and write. In fact, cell phones are now appearing widely in the squatter communities that surround the cities of developing countries, places where conventional wired phones have never existed.

NUA

Tanzer

TABLE 1
Mobile Phone Subscribers by Region

<i>Region</i>	<i>Mobile Subscribers</i>
Asia/Pacific	155,400,000
Western Europe	152,000,000
North America	93,900,000
Latin America	36,500,000
Eastern Europe	14,200,000
Middle East	11,200,000
Africa	6,400,000

Source: International Telecommunications Union and The Yankee Group (in Wired, March 2000)

The emergence of so-called "third-generation" broadband mobile Internet devices in the next several years will offer another compelling reason to examine this technology in an urban context. The Gartner Group, a telecommunications consultancy, projects that *wireless handsets will outnumber both televisions and personal computers by 2005*. Another estimate predicts hand-held mobile Internet terminals will quickly outnumber Internet-connected personal computers as well as voice-only mobile phones. It is possible, indeed, that the many complex, time-consuming online worlds of the Web will have less lasting significance than a wireless site that can accurately and reliably deliver directions to the nearest pizza shop.

Smith

International Data Corporation

Graham and Marvin

Ultimately, this article is concerned with the long-term evolution of urban societies as they struggle, change, and evolve after the introduction of new communications technologies. When the societal effects of new technologies are predicted in the popular press and elsewhere, too often utopian visions are painted with a broad and indiscriminating brush. However, social scientists have a responsibility to look more critically at underlying forces and trends. As a result, this article takes an urbanist's perspective on the application of these new technologies within cities by their inhabitants. With this comes a long tradition of thinking about the city in spatial terms—where people and things are located—and about how that space is created and, consequently, how it shapes activity patterns.

Mumford
Jacobs

The intellectual traditions of city planning permit the exploration of the social consequences of new communications technologies from a unique perspective. The telephone is an inherently spatial technology—its sole function is to allow communication at a distance. As scholars in the past, such as de Sola Pool and Gottman, have argued, the modern city of office towers is as much an artifact of the invention of the telephone as the decentralization of manufacturing and residences is to the suburbs. While manufacturing activities worked better on a single floor and demanded large tracts of inexpensive land (away from city cores), the administrative and decision-making functions of corporate headquarters benefited from access to specialized producer services like law, accounting, and advertising by locating in central cities. At a smaller scale, it is inconceivable to imagine a high-rise building without the telephone—the elevators could not support the number of messages travelling by courier from floor to floor every second, every minute, and every hour of the workday. The spatial implications of this technology are clearly very complex and often contradictory. To this analytical problem, the mobile phone adds the complication of freeing this communications capability from a fixed location in urban space.

de Sola Pool
Gottman

Chihara

Throughout the world, in any language, mobile phones increasingly add an element of uncertainty about physical location to urban interactions. Almost without exception, one of the first things cell phone users exclaim in response to an unexpected call is, “Where are you?” And according to a survey by the mobile operator OmniPoint, in the northeastern United States, as many as one-fifth of cell phone users lie about their location when talking on a mobile phone.

Space, Time, and Urban Theory

How might an urbanist begin to think about approaching the study of this new technology? What tools and techniques are available, and what intellectual framework is useful?

Kevin Lynch's most important work, *The Image of the City* was the amalgamation of years of ethnographic research into people's mental maps of spatial relationships in the city. Using three case studies—Boston, Jersey City, and Los Angeles—Lynch was able to determine a typology of physical elements that people use to navigate through cities. His conception of nodes, paths, and edges as descriptors of perceived urban form was so concise and widely applicable that it dominates the education of urban designers to this day. Thus, one method for investigating the urban consequences of mobile communications might be to treat it as an urban navigational tool. Is widespread use of such devices leading to the creation of new kinds of Lynchian elements—intangible informational cues that perhaps are more in the realm of Web designers than urban designers? While making a connection between ethereal virtual spaces and the traditional physical urban environment is a useful first step, relying solely upon traditional urban design methodologies is sorely limiting. For as useful as these techniques are, they are primarily concerned with physical scales that are orders of magnitude higher than the actual point of intervention of mobile communications technologies.

Another possible approach would be to consider the methods used by psychoanalysts such as Csikszentmihalyi and Rochberg-Halton to understand how people relate to, and develop relationships with, objects. For these researchers, everyday household objects act as symbols or signs that are often objective and entice similar reactions from a broad variety of people. Perhaps it would be more fruitful to approach the subject of mobile communications by investigating the relationship between individual and the object. By understanding something about how these technologies both cause and permit the reshaping of individual behavior, there is a better basis from which to speculate on how these changes will aggregate to cause wider transformations of neighborhoods, cities, and regions.

The following section applies this interpretative method to gain insight into the perceived value of this new communications medium. However, this method does not address how the city might behave at an aggregate level, as a system of interacting individuals, under a new communications technology regime. Yet contrary to traditional urban planning, which often assigns agency to a city as a unit ("City A is busy," "City B is unfriendly"), there are tools for understanding complex systems like cities as consequences of many interactions of individuals. As Mitchell Resnick explains, decentralized systems, such as an ant colony or a flock of birds, exhibit complex behavior even though they lack a leader. A flock of birds can easily be simulated

by ordering each bird to simply follow the one in front of it, with random environmental influences causing disturbances that ripple through the flock and cause it to turn or speed up. Cities can be viewed in the same way. By beginning an investigation at the level of the object, it is possible to trace a chain of events leading from the primary point of technological intervention upward to greater levels of complexity through interactions of these technologically enabled individuals.

This article's central argument is that new mobile communications systems are fundamentally rewriting the spatial and temporal constraints of all manner of human communications—whether for work, family, or recreation and entertainment. As decision making and management of everyday life is increasingly decentralized, the complexity of these systems becomes greater and, therefore, less predictable. In parallel, this decentralization creates myriad new interactions and potential interactions between individuals that dramatically speed up the metabolism of urban systems, increasing capacity and efficiency. The “real-time city,” in which system conditions can be monitored and reacted to instantaneously, has arrived.

The consequences of such a decentralization of the coordination of urban activities presents a twofold threat to city planning. First, the broad diffusion of advanced time- and space-management made possible by these technologies may not result in enormous physical upheavals such as those associated with the automobile. Mobile communications technologies reinforce the competitive advantage of central city business districts by making them more efficient, yet at the same time making megalopolitan automobile-based urban sprawl manageable and livable. This dramatically complicates emerging internal conflicts within the field of city planning on issues such as New Urbanism and urban sprawl by undermining the existing technological space-time regimes that have both driven the trends and framed debate.

Second, and far more importantly, massive decentralization of control and coordination of urban activities threatens the very foundations of city planning—a profession based upon the notion that technicians operating from a centralized agency can make the best decisions on resource allocation and management and act upon these decisions on a citywide basis. Furthermore, most planning tools intervene at a much higher level—yet the dynamics of systems for simulating decentralized systems (like the turtle-worlds of *StarLogo* discussed later in this article) suggest that overall system behavior is determined at a very low level by the specific nature of interactions between individuals.

Object and Self: Personal Relationships with Mobile Telephones

This section is a first attempt at understanding the powerful relationships that are forming between individuals and mobile phones. Investigating first how the devices were introduced via advertising images, this section then traces the process by which mobile phones have been adopted and the ways individuals have adapted to the constraints and capabilities of this new technology.

Images of Mobile Phones in Advertising

The presentation of objects to the public through marketing and advertising images is a powerful force shaping how they are ultimately used and perceived. The connotation that telecommunications provide an effective means to overcome spatial constraints on lifestyle is not new to the marketing and advertising of these technologies. It should come as no surprise then that advertising images of the mobile phone, whose unique defining quality is its detachment from visible tethers to the physical telephone network, are heavily slanted in this direction. Promotional images used on the Web site of major wireless service providers are typical of the way the conquest of space through mobile telephones is romanticized. In one example, Bell Atlantic Mobile uses a photo of a woman literally standing on North America, mastering her domain through the use of a nearly unseen mobile phone.

Images from advertising play an extremely important role in both defining and reflecting an individual's relationships with objects, particularly consumer electronics. AT&T's promotions have frequently presented the mobile phone as a woman's best friend, helping her survive in the drab, gray, and annoyingly persistent city.

While for women, the desire to own a mobile phone commonly stems from security concerns or the need to sustain roving ties to friends and family, for men it is most typically marketed as a tool of fashion, power, and virility. One of the most striking examples of this advertising motif appeared recently in the United Kingdom:

Katz

To launch Virgin Mobile, Branson's brand new U.K. wireless power play, he appealed to Brits' basest instincts. Branson and a throng of nude models were recently seen cavorting around on the back of a flat-bed truck with the racy marketing slogan—"Pick me up, Turn me on, Use me to your heart's content"—emblazoned across the vehicle as it snaked around London's West End streets (*Online*).

Quigley

So for women, the phone is sold as a security blanket for the uncertainty of the city, whereas for men, the seductiveness of the anonymity and sexual variety of the city is foremost.

Alcohol and automobile commercials often use the same level of raw sexual imagery, yet there is something about the mobile phone—a device that claims to eliminate the fundamental human anxiety regarding loneliness—that makes these images particularly powerful. If men buy Branson's phone, will nude women be chasing them (or calling them) day and night? While such speculation seems extreme, it is naive to assume any other intent on the part of the advertiser. Yet this association of technology and technological artifact with sexuality and virility offers the opportunity to consider the next stage of human-machine symbiosis: the mobile phone as an extension of the body.

Relationships With the Object: An Extension of the Body

Individuals develop very personal relationships with mobile telephones. Yet it is probably what the telephone represents, more than the object itself that consummates the relationship. It should come as no surprise that in London, mobile phones recently became the most commonly left item on subway trains in the Underground, replacing the umbrella. Still, the physical object fills some significant role in the hand of its owner. Despite the fact that there is no service in the deep tunnels of the Underground, people are still losing their mobile phones *because they are holding them in their hands*.

Adams and Sanghera

The contradictions of this relationship are many. Mobile phones are easily personalized by entering commonly called numbers, adding new songs to replace the standard ring alert, or buying colorful clip-on faceplates to replace the standard black matte. Yet the Subscriber Information Module (SIM), which stores all of the data necessary to tell a phone what its number is and who owns it, makes the object of the cell phone replaceable in an instant. All personal information is contained within a small smart card that can be dropped into any phone chosen on the basis of cost, technical sophistication, or cosmetic appearance. The phone is a commodity, yet the information coordinates of the telephone network that it represents have a powerful pull. They are protected with highly sophisticated encryption schemes. In Manhattan, where a designer perfume "212" now bears the name of the precious area code, the very coordinates themselves have become important status-bearing personal identifiers.

Yet despite these conflicting trends in the personalization and depersonalization of the physical artifact, the mobile phone is more and more becoming perceived as an extension of the body, though

again perhaps more in a virtual sense than a purely physical one. As *Wired* magazine reports:

In the last couple of years, Finnish teenagers have quit referring to their mobile phones as *jupinalle*—"yuppie teddy bears"—and have started calling them *kannykka* or *kanny*, a Nokia trademark that passed into generic parlance and means an extension of the hand (1).

Silberman

From a very physical metaphor of something separate, cute, and essentially useless—a teddy bear—the name has evolved into a more abstract, loaded term: a metaphorical extension of the hand, a serious tool linked to the owner on the most basic level. And this deep cognitive link between the phone and the owner is a persistent theme. Katz reports a study in which:

Relative to either home or work phones, [digital mobile phone service] was judged to be much more like a friend; one user even said that the [mobile] handset began to feel like a "part of my anatomy" (32).

Katz

In Japan, a country with one of the highest rates of mobile phone penetration in the world, manufacturers have introduced "mobile-aware" jewelry. One company, the Osaka-based Sunshine Company, has developed an artificial fingernail featuring a tiny light-emitting diode which glows red or blue when the user's mobile phone is active. The nail can be filed to any shape, and since it is powered by the mobile's wireless transmissions, it requires no batteries.

Boyd

The body metaphor appears in negative contexts as well with regard to mobile communications technologies. In a *New York Times* article, one teen seethes at the invasion of privacy that occurs when her parents summon her by pager:

Originally, Zan said, she wanted a pager so her friends could get in touch with her. But now most of the pages seem to come not so much from her friends as from her mother, she said, and she is having second thoughts.

"It just complicates matters, really," Zan said. "Now it's like I have kind of a dog chain on. If she pages me, I have to call her back. She always has some kind of access to me."

Before she got her pager, Zan said, "It felt almost as if I had a little more freedom." She added that life with a pager made her "feel kind of overwhelmed and cramped, like my personal space is being invaded" (*Online*).

Hafner

In this interview, it is as if the young woman is unable to describe her relationship with her pager's capabilities in terms other than those that suggest a physical attachment—"dog chain," "access," "cramped," and the invasion of her "personal space."

On another level, the commonly accepted name for these devices—technically "wireless telephones"—but more commonly in the United States, "cellular telephones"—has begun to change as well, reflecting these trends of internalizing the technology and attaching it to the body in a figurative sense. The name "cellular" was derived from the geometric structure of the antenna grid that links these devices into terrestrial telephone systems. A city or metropolitan area is divided into a grid of hexagons, or "cells," at the center of which are placed transceiver antennas. As a subscriber moves from cell to cell, the antenna switches the call off to the antenna in the next cell.

The recent explosion in subscribers, however, has coincided with a decisive shift away from the "cellular" designation towards the use of the term "mobile telephone" or "mobile communications." This implies a broad shift in cultural perceptions and marketing campaigns from a position where the usefulness and functionality of the technology is seen to be in the supporting infrastructure (the antenna network) to one where the intelligence is embodied in the device itself, "the mobile." And unlike linking oneself in one's mind to some complex (and constraining) grid of antennas, the idea of augmenting oneself with a tiny "smart" device is very appealing.

In fact, fashion has rapidly adapted to accommodate mobile phones. The Yak Pak, a popular mass-produced line of bicycle courier-style bags sold through the U.S. chain Urban Outfitters, is loaded with handy pockets for holding mobile phones and pagers. Cargo pants have also become extremely popular, as the extra pockets provide more room for the electronic accessories of everyday modern urban life.

More and more commonly, popular culture is accepting and reflecting this perception of the mobile phone as an extension of the body. In a *New York Times* article, a graphic designer producing signs for restaurants to discourage the use of cell phones during meals ponders this link:

A cell phone is "a pacifier for adults," said Maira Kalman, the president of M&Co, a Manhattan product and graphic design group. "It makes you feel connected, that you're not alone on this planet" (*Online*).

Louis

It's hard to imagine a more loaded analogy than the pacifier, a substitute for the mother's nipple. How long before people begin thinking of cell phones as umbilical cords?

Cutting the Cord

At the final extreme, the mobile phone's connectivity is completely subsumed into the body and all other forms of communication become redundant; e-mail, Web sites, and phone calls can now all be delivered over the universal hand-held. As this is occurring, people are becoming more dependent upon the connectivity that the mobile telephone represents. Many who have restructured their lives and personal habits around the device find it difficult to go back to wired phones. Once one becomes accustomed to the flexibility of scheduling, the freedom from punctuality permitted by the ability to constantly update other parties as to one's status, it is nearly *inconceivable* to go back. And in fact, many have instead opted to give up land lines rather than mobiles phones. The Cellular Telephone Industry Association estimates that 2 percent of mobile phone subscribers have terminated their land line services, relying entirely upon the mobile phone. A new term for this act has emerged from the advertising think tanks of Madison Avenue—it is called "cutting the cord."

While reasons vary for terminating land line service altogether, the consequences of such a change are by no means insignificant. Such individuals now forego the option of not answering the phone in many circumstances, as there are few excuses when it is known they rely completely on the phone. Cutting the cord means becoming 100 percent accessible; it also pushes society closer to a point where telephone numbers will refer to people rather than the places where handsets are located. In a society where everyone is accessible all the time, we will have invented telepathy, according to one evangelist of the Nokia Corporation.

Silberman

The most important change that occurs in observations of subjects who completely adapt to the new lifestyle opportunities of mobile phones, however, is that time becomes a commodity that is bought, sold, and traded over the phone. The old schedule of minutes, hours, days, and weeks becomes shattered into a constant stream of negotiations, reconfigurations, and rescheduling. One can be interrupted or interrupt friends and colleagues at any time. Individuals live in this phone-space. They can never let it go, because it is their primary link to the temporally, spatially fragmented network of friends and colleagues they have constructed for themselves. It has become their new umbilical cord, pulling the Network Society's digital infrastructure into their very bodies.

City and System

The power of the mobile phone to transform how we perceive our bodies is nothing short of spectacular. Yet, as outlined in the begin-

ning, the goal of this article is to assess the way in which this unassuming piece of consumer electronics might change the trajectory of future urban form and function. Building upon the dramatic changes in personal time-management described in the previous section, a useful way to think about how this new technology is interacting and influencing urban life is to think about how cities might become “real-time” systems.

Real-time systems are defined by an ability to constantly monitor environmental conditions vital to the operation of the system. Chemical plants employ real-time systems to keep reactions supplied with the proper amount of chemical ingredients and vent by-products from the reactors. Airplanes are equipped with many sensors and computer programs that make up the autopilot system—thankfully capable of real-time operation. Real-time systems operate by using feedback from one part of the system to either induce or inhibit activity in another part of the system, pushing it towards an optimum stable state chosen by the designer. Yet the city, as a system, has never operated at anything remotely approaching real-time.

In the last decade, as mobiles slowly diffused through the more dynamic segments of the business population and among urban professionals, these individuals and subcultures have striven to attain “real-time” lifestyles. Yet, as Silberman writes in *Wired*, it is no longer just yuppies who are changing the way they roam and explore the city. In Helsinki:

Ubiquitous [mobile phones]... have transformed the way young Finns roam the city. They've taken a feature introduced by Nokia in 1993—Short Message Service (SMS), a form of e-mail you can send from phone to phone—and turned it into their primary means of mobile communications. Like schools of fish, kids navigate on currents of whim—from the Modesty coffee bar to the Forum Mall for a slice of pizza or a movie to a spontaneous gathering on a street corner, or to a party, where SMS messages dispatched on the phones summon other kids or send the group swimming somewhere else (1).

Silberman

Kopomaa further reinforces the images of the tribal wandering of the urban dweller of the twenty-first century. However, the focus remains on the spatial freedom of a mobile lifestyle:

Life in a modern city is a social struggle rather than a struggle for physical survival, yet in this role, postmodern humans are every bit as nomadic as their Paleolithic ancestors (5).

Kopomaa

Yet this new mobility is the fulfillment of some latent demand. One technology for this level of personal mobility has existed for decades—the automobile. Yet it is only the recent emergence of mass mobile communications, and the ability to coordinate individual actions and movements in real-time, that make this new urban lifestyle sustainable. The mobile phone breaks the flow of information away from the scheduling necessary to ensure coordination of journeys. Information can be updated in real-time, negating the need to plan anything. In a sense, accessibility becomes more important than mobility.

This new reconfiguration of time and space permitted by mobile telephones—or more specifically, networks of friends and acquaintances using mobile telephones—can best be seen in the lives of people whose work already requires them to be on the go and in touch with a home base.

Taxi drivers are engaged in an archaic profession—the business of carting people from one location to another for cash. In Boston, Massachusetts, most taxis are independently owned and operated, with an association set up to provide centralized radio dispatching services. Yet most drivers now have two communications systems installed in their taxis—the traditional radio that they use to communicate with the dispatcher and the cell phone that they use to communicate with other taxi drivers. Based on interviews with these drivers, the information about potential customers that comes in (from friends and relatives) via the cell phone is more timely and accurate than anything that comes out of the static-plagued radios. As a result, the cell phone is always in use or charging, and the volume on the radio is turned down whenever a call comes in—a telling behavior illuminating the difference in the quality of information between the two systems.

In practice, this new decentralized network results in a far more efficient system for the transmission of information. One driver in Boston explains:

Last night, I was driving in Fenway after I drop[ped] off a fare. My friend tells me there are a dozen people standing outside Sofia's. By the time I get there, I am picking up the last ones. None of them ever called the dispatch, but they did not have to wait 10 minutes either....All the cabbies tell each other on the phone. They call their friends and their relatives that drive taxis when there is work.

Without the mobile phone, the driver would have had a much smaller chance of locating new fares so quickly, with so little unmetered driving. The mobile phone permits dynamic reallocation of the taxi system's resources, resulting in less wasted time searching for fares.

These examples suggest the development of complex new networks of interactions within the city as a result of the proliferation of mobile telephones. What can be expected when these types of transformations are occurring throughout every system operating in the city, not just one isolated system? While it is almost impossible to predict what types of new behaviors could emerge (will it now become impossible to get a taxi from the central dispatch?), it is important for urban planners to begin thinking about how these technologies might reshape basic aspects of urban life.

FIGURE 1
Conceptual Model for Urban Metabolism
in the Real-Time City

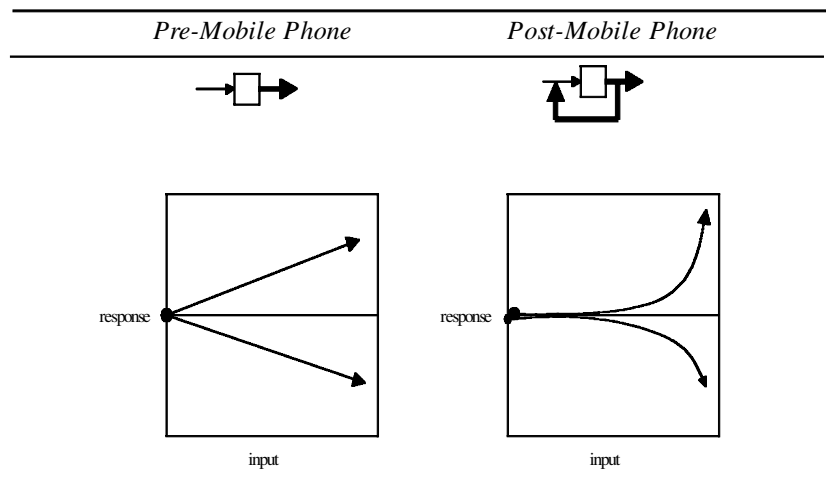


Figure 1 offers a very basic way to begin thinking about the implications of these new decentralized networks on the functioning of social, economic, and political urban systems. On the left is a diagram of any abstract urban system that relies upon reevaluating output to determine the next cycle of inputs. A labor market, a financial market, or even a political system might be envisioned in this abstract way. Growth or decline occurs in a fairly straightforward linear way. However, on the right, is the same model with a feedback loop inserted, representing the effect of mobile communications, which permit the reallocation or redirection of resources while a

process is underway. Fundamentally, it permits the withholding of commitment to a set course of action until the last possible moment, always holding open the window for better information. In the event of an ominous development, resources can be withdrawn and redirected elsewhere. As phones quickly become more geographically aware of user location through triangulation and Global Positioning System technology, the addition of location-sensitive information will add a new level of improvement to this on-the-fly decision making.

This model attempts to illustrate how, under certain circumstances, a feedback loop can quickly result in an intensification of output, which can have positive or negative consequences. The lack of spatial and temporal constraints on the transmission of information through the mobile communications system results in a constant reallocation of resources to their more productive uses. The general result is an intensification of the use of capital over time, or a dramatic increase in urban metabolism.

Conclusions: Rethinking the City

This investigation of the diffusion of mobile communications devices on a mass scale in cities of the turn of the century suggests that a major reexamination of the technologically constructed nature of space and time in everyday urban life needs to be considered. The introduction of a device that provokes such strong longings and desires in people is rapidly diffusing throughout the population, and that diffusion so fundamentally strengthens coordinated, decentralized networks of individuals that the ability of urban theory to provide a convincing explanation of how cities function and grow is seriously compromised. Furthermore, the naive, even disdainful attitudes of city planners towards emotionally charged technologies in the past (particularly the automobile) continue to push the profession to the fringes of irrelevancy. It cannot afford to make that mistake again with respect to the telecommunications revolution.

In city planning, the individual is rarely the unit of analysis. Yet it is clear that the point of intervention of mobile communications technologies is the individual, not the institution, neighborhood, city, or region. Rather, this is an era of dramatic transformation where new institutional and organizational structures are emerging as a result of major technological changes in the economics of these lower-level interactions. Yet most planners remain focused upon large-scale physical transformations even though William J. Mitchell notes “electronically serviced space for information work does not have to

Moss and Townsend

be concentrated in large contiguous chunks, like the commercial and industrial zones of today's cities." As a result, the widespread bit-by-bit reconstruction of cities is going largely unnoticed by planners accustomed to visualizing cities through aerial photographs. Yet while massive physical changes are still rare, the pace (metabolism) and character of activities being conducted in traditional urban spaces is rapidly changing, as boundaries between the home, office, automobile, and street are increasingly blurred.

It seems that the fundamental obstacle to understanding this micro-scale transformative process is what Resnick refers to as "centralized thinking." The leaderless nature of decentralized systems is non-intuitive, often leading to mistakes in identifying them and understanding their behavior. People assume that a flock of birds or school of fish must necessarily have a leader, when the group's behavior is actually determined by a far more complex evolutionary process largely determined by the many interactions of individual neighbors over time.

MIT Media Lab

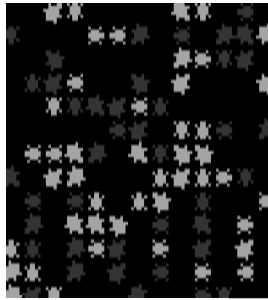
Experiments with *StarLogo*, a software package developed at MIT to make the simulation of decentralized systems more accessible, offer an interesting way to think about the significance of individual-level technological interventions (such as mobile phones) on large-scale social systems such as cities. In the *StarLogo* environment, each individual is represented by a turtle—a simple computational object that can move about the screen, interact with its environment, and interact with other turtles. By giving each turtle a few basic rules about how to behave, it is fairly easy to achieve systems that exhibit very sophisticated behavior yet lack "leaders," like flocks of birds, for example.

As Figure 2 illustrates, using just two types of agents and a very simple rule-based decision system, complex patterns of organization begin to emerge. Furthermore, the complex systems simulated in the *StarLogo* environment often react non-intuitively to changes. In the example below, two "turtle" species are programmed to prefer to be near their "own kind," to a degree specified by an affinity factor. As the simulation progresses, they will move to change the mix of their nearby neighbors.

Slight changes in the affinity factor typically have little effect on the distribution of turtles across space. However, in a very small middle range, slight changes in the affinity factor produce enormous change in the distribution of turtles, as a polynucleated, semi-segregated equilibrium gives way to a new stable state in which both groups are completely isolated from each other.

FIGURE 2

Turtles in a *StarLogo* Simulation



Source: MIT Media Lab

Extending this model to cities, one can envision a set of rules governing the typical urban dweller's transactional exchanges with other individuals, and in fact this is an approach often used in micro-scale urban modeling such as cellular automata. Prior to the introduction of the mobile phone, one would check messages at certain intervals, and then act or react based upon the received information. Communications, particularly for the physically mobile members of society, came in discrete bursts and had to be tightly scheduled and planned to ensure that both parties were at the other end to complete the call. With the introduction of mobile phones, however, communications become fundamentally different—and, as in real-time systems, there is a continuous monitoring of environmental variables and of the feedback returned to the system.

Extending the *StarLogo* analogy, it is as if mobile phones are enabling a massive experiment of reprogramming the basic rules of interaction for urban inhabitants. The introduction of powerful and fundamentally different modes of communication at such a basic level will certainly produce major transformations in large-scale behavior of the system. It is interesting that the technology evangelists of Nokia, the Finnish phone company, see the realization of “practical telepathy” one day as a result of microscopic mobile phones implantable under the skin. While this is certainly a stretch of the imagination, that it is even a conceivable metaphor (and a convincing one) underscores the degree of shift in the temporal dynamics of telecommunications.

More practically, however, there is the question about what effect this simple rewriting of the spatial and temporal constraints on telecommunications and interpersonal interaction will have on cities? As Deutch wrote in the 1970s, we can expect an increase in the “size” of the city as its transactional capabilities are improved:

Deutch

The facilities of the metropolis for transport and communication are the equivalent of the switchboard. The units of commitment are not necessarily telephone calls but more often face-to-face meetings and transactions. For any participant to enter into one transaction usually will exclude other transactions. Every transaction thus implies a commitment. The facilities available for making choices and commitments will then limit the useful size of a metropolis (395).

Considering the preceding arguments in this article, it is clear that mobile communications represent a new point in the growth of such “facilities available for making choices and commitments” described by Deutch.

The mobile phone might lead to a dramatic increase in the size of the city, not necessarily in a physical sense, but in terms of activity and productivity. No massive new physical infrastructure will emerge; rather cities might witness the intensification of urban activity—the speeding up of urban metabolism.

New interactions will have dramatic social effects as well. Kopomaa calls the mobile phone a “postmodern form of communication.” Urban theorists such as Michael Dear argue that postmodern urbanism is particularly characterized by fragmentation. The mobile phone certainly reinforces these patterns; it substitutes chaotic decentralized networks for centralized ones. The emerging network of taxi drivers in Boston, friends and family who use mobiles to gain a competitive advantage, is a perfect example of such fragmentation. Interestingly, some social constructivists might argue that postmodern society invented the mobile phone to achieve this goal.

Meanwhile, David Harvey argues that the conquest of space through time is directly linked to the conditions of postmodernity, yet space and minute spatial variations between places remain as important as ever. The use of mobile phones offers an ever-finer level of identifying and exploiting minute variations in conditions between locations, the micromanagement of space as a result of the micromanagement of time and the always-accessible individual. The use of mobile phones reinforces these trends and directs conceptions of the city away from the rational, modernist conceptions that drive most land use planning.

At its core, postmodernism simply implies the end of modernism and its ability to sustain order and coherence in the face of the acceleration of time and the compression of space in the twentieth century. Yet mobile phones greatly improve the individual’s ability to

manage these forces, even to manipulate them in the way that large institutions have for decades. The use of mobile phones by protestors during the demonstrations surrounding the 1999 WTO meeting in Seattle starkly illustrates the potential. By being able to shift resources to flash points on the city streets faster than the local police, who relied on centralized systems for communications and decision making, the demonstrators were able to gain a decisive advantage. For urban planning, what it all might mean is that the city will change far faster than the ability to understand it from a centralized perspective, let alone to formulate plans and policies that will have the desired outcomes. Despite Michael Batty's assertion that we now have the skills and technological capability to gather real-time data about the city—"the computable city" as he calls it—will the centralized view of cities that dominates planning impair understanding of this data? As Resnick notes, even trained observers make frequent mistakes in attributing "intelligence" when analyzing complex decentralized systems. Without good models for understanding urban systems, no amount of data will produce useful analysis for guiding real-world decisions. Without a concerted effort to develop new knowledge and tools for understanding the implications of these new technologies, city planners run the risk of losing touch with the reality of city streets.

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