Seeing Like an Interface

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ABSTRACT

Mobile and ubiquitous computing systems are increasingly of interest to HCI researchers. Often, this has meant considering the ways in which we might migrate desktop applications and everyday usage scenarios to mobile devices and mobile contexts. However, we do not just experience technologies in situ – we also experience everyday settings through the technologies we have at our disposal. Drawing on anthropological research, I outline an alternative way of thinking about the relationship between technology and "seeing" everyday life and everyday space.

Categories and Subject Descriptors

H.5.0 [**Information Systems and Presentation**]: General

General Terms

Measurement, Documentation, Design, Economics, Experimentation, Security, Human Factors, Standardization, Theory, Legal Aspects.

1. INTRODUCTION

This is a paper about legibility. Where legibility occurs as a topic in HCI, we are usually concerned with the ways in which information might be readable on a screen. Instead, though, I want to address a different sort of legibility – how do computer systems help us read the world?

Computers, as we all know, are tools. They are mechanisms for getting things done – not only in working domains, but also in domestic, leisure, and cultural settings. HCI has, since its inception, been concerned primarily with the effectiveness of interactive systems when viewed from this instrumental perspective. How well does a system match its needs, and how well does it get the job done?

I want to argue here for a different perspective, one that focuses on interactive systems as a means for encountering the world around us. I am interested here not simply in interactive systems as tools, but as cultural objects – objects that structure and organize the world around us in meaningful ways.

My concern here is with the relationship between social and technical, which can be understood in various ways. One common approach is to examine the "social impacts" of technologies, attempting to uncover the ways in which aspects of social life may be transformed by the arrival of new forms of technology and practice. While technologies clearly do have impacts, this approach tends to regard technology as inevitable and to fail to acknowledge the range of relationships between technology and social life. A second approach, by contrast, is to examine the "social shaping" of technologies, looking at the ways in which technological and design decisions are made within social, organizational, and economic circumstances that collectively shape the technologies that emerge. Subsuming both of these, to some extent, my concern is with information technologies as sites of social and cultural production. Social and cultural realities are no simply givens; they are performed, enacted, and reproduced in the course of everyday life. I want to examine information systems here as one particular site where these activities take place. I find this position particularly instructive for design, because it provides not only an analytic perspective but one that encourages intervention and transformation.

1.1 The Case of Mobile Computing

As a particular case to ground these concerns, consider the current interest in mobile and ubiquitous computing.

As a relatively recent technical development, mobile computing has arisen in the context of a dominant model of conventional desktop computing. As such, then, the primary concern of mobile computing designers has been to resolve the problems imposed by the new context of mobile computing, that is, the ways in which mobile systems fail to match a series of expectations associated with desktop settings. There are three particular problems to which mobile computing applications typically respond [9]. First, the problem of disconnection refers to the ways in which mobile work might be separated from resources – artifacts, people, documents, and activities – that would be accessible in desktop settings. So, the interest in "anytime, anywhere" access to information figures mobile computing as inherently deficient in this regard, and frames disconnection as a problem towards which mobile computing must be oriented. Second, the problem of dislocation addresses the fact that the computer and its user might find themselves in unfamiliar surroundings that cannot be navigated easily, and so suggests that a significant opportunity for mobile computing is wayfinding and resource identification – finding a path from A to B, and locating points of interest along that path (including friends, places, and objects of interest). Third, the problem of disruption refers to the ways in which, while desktop systems are used in stable and known contexts, mobile systems are used in settings that vary, so that the systems themselves might disrupt the social contexts in which they are deployed. Efforts need to be made, then, to ensure that mobile systems react appropriately in different settings, and much work in context-aware systems is directed towards this end.

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The emergence of mobile and ubiquitous computing as areas of research inquiry has opened up new questions of interaction design and directed our attention towards the connection between technology and the world in which it is deployed, in a variety of ways. One of these has been a concern with new forms of interaction that go beyond traditional keyboards and mice, and see physical objects as potential sites for interaction with computational systems [13]. However, a second and potentially more significant transformation is to look at the interactive system as, itself, a means by which people encounter and understand the world around them, both the built environment and the social setting in which they find themselves. However, in order to do this effectively, we need to find new conceptual tools and lenses for understanding the role that computational and physical representations might play, which is my concern here. I want to suggest some ways in which we might think about the relationship between representations and interaction design. However, although my overall concern is with design, that is not where I want to start. I will take a rather meandering path towards information systems design by starting somewhere much further afield.

2. SEEING LIKE A STATE

In his book "Seeing Like a State: How Certain Schemes for Improving the Human Condition Have Failed," anthropologist James Scott [18] sets out a broad account of the recurring patterns of failure of central planning and social engineering. Scott's primary target for investigation is the ideology of high modernist statehood – the application of scientific rationalism to the governance of peoples. Two ideas are central to Scott's investigation.

The first is the idea of simplification. Modern statehood – by which he means a state as an institution that takes responsibility for the planning and management of resources, including human resources – relies first on accounting, and that accounting rests in turn upon a system for organizing the complexity of everyday experience into calculable abstractions:

> Officials of the modern state are, of necessity, at least one step – and often several steps – removed from the society they are charged with governing. They assess the life of their society by a series of typifications that are always some distance from the full reality these abstracted are meant to capture… The functionary of any large organization 'sees' the human activity that is of interest to him largely through the simplified approximations of documents and statistics… These typifications are indispensable to statecraft. The invention, elaboration and deployment of these abstractions represent… an enormous leap in state capacity – a move from tribute and indirect rule to taxation and direct rule. (p. 76-77)

Scott is concerned, then, not just with the forms of abstraction and represention that are introduced, but with the ways in which these come to constitute the legibility of everyday life to the practice of statehood; they are the forms of "seeing" in which states can engage.

Scott's second insight is that these forms of simplification are not simply the means by which states understand everyday action, but also the means by which they act upon it. In other words, in high modernism, these are also the means by which action is effected:

> All the state simplifications we have examined have the character of maps. That is, they are designed to summarize precisely those aspects of a complex world that are of interest to the map-maker and to ignore the rest. … In case after case, however, we have remarked on the apparent power of maps to transform as well as merely to summarize the facts that they portray. (p. 87).

In other words, once maps – or similar representations – become tools of governance, they become the basis of actions which tend to bring the world into line with the map. Maps are inherently partial, though, and so the simplifications of representation tend to re-impose themselves upon the world.

To the extent that the process of developing information systems is one of abstracting and representing the world for the purposes of making it computationally tractable, these are arguments that are very familiar to those working in HCI, CSCW, and related areas. Research in Participatory Design, in particular, has emphasized the importance of a sensitivity towards the ways in which practices of representation and abstraction are enmeshed within broader power relationships. These are not simply arguments against the practices of abstraction and representation at work; they are, after all, necessary. As Scott notes:

> To complain that a map lacks nuance and detail makes no sense unless it omits information necessary to its function. A city map that aspired to represent every traffic light, every pot-hole, every building, and every bush and tree would threaten to become as large and complex as the city it depicted. And it would certainly defeat the purpose of mapping, which is to abstract and summarize. A map is an instrument designed for purpose. We may judge that purpose noble or morally offensive, but the map itself either serves or fails to serve its intended purpose. (p. 87)

So it is not partiality that is at issue here. Instead, Scott wants to explore how these abstractions are put to use in service of statehood and governance, and what happens when abstraction and reality butt up against each other.

Scott draws effectively on a wide range of examples of the practices and consequences of high modern statehood. A number of examples, for instance, discuss the impact of modernist approaches on the spatial organization of everyday life, looking for instance at villagization programs in Tanzania and Ethiopia and at modernist cities such as Brasilia or Chandigarh. The uniform layout of layout of villages, based on straight lines and exact grids, simplifies planning and management but at the cost of ignoring the local conditions and natural toplogy that dictate patterns of movement and habitation. In Brasilia, the utopian city, with vast formal plazas, identical apartment buildings, and streets designed for cars rather than people, is surrounded by an informal, unplanned, peripheral jumble of residential neighborhoods that, ironically, prospered and grew much faster than the city itself.

A second area that occupies Scott's attention is the central planning of agricultural projects. Large-scale industrial agriculture is characterized by the same sorts of simplification and rationalization that Scott has outlined elsewhere. An emphasis on yield, on consistency, and on large-scale production results in a highly regulated approach to agriculture based on monocropping, control of genetic diversity, etc. However, while successful in the industrialist West, these processes have generally failed when imported (or exported) to Africa. Again, Scott argues that part of

the problem is the failure to adapt to local conditions and to realize the complexity of the local environment. Invoking the example of African polycropping, for instance, he notes that what seems to industrialized scientific agriculture as unsystematic and inefficient is, in fact, a careful and intricate response to local soil conditions, patterns of erosion, flooding and other location particularities that are erased in the large-scale models associated with most centrally planned agricultural efforts.

Scott's primary concern, throughout these examples, is with the ways in which centralized decision-making depends on systems of standardization and regulation that, by definition and necessity, erase local particularities, even though those particularities may be critical to effective planning and resource management. It is important to recognize that there are two simultaneous issues at work here. The first is a pragmatic and empirical one – simply to note that conditions "on the ground" are inevitably more complex than most views from afar will reflect, and that approaches that value the local will frequently yield more effective solutions. The second is an epistemological one – that normalization and abstraction are part of the ideological apparatus of modernist rationalism, and, where they are called into question, the modernist model is itself undermined. Scott's argument, then, does not simply concern the failures of particular forms of scientific rationalism as a tool for large-scale governance, but rather questions the very institutional practices of scientific rationalism.

2.1 High Modernism in Information Systems

There are two reasons why Scott's argument is particularly relevant to the development of interactive software systems.

The first is that that practices of software development are themselves often very much in line with the systems rationalism of high modernity that Scott describes. Information systems traffic in ideal types in the form of data structures and abstractions that represent people and activities. The processes of representing elements of the everyday world in order to make them available for processing, ordering, and managing through computer systems is bound up in the same modernist enterprise that Scott describes. Bowker and Star [3] have extensively analysed the processes surrounding standardization and categorization in information systems, and Suchman [21] has explored the politics of computerized formalisms when put to work in workflow systems. Scott's analysis highlights the problems that emerge when representations begin to substitute for the phenomena that are represented, and where the process of abstraction and homogenization is erased or disappears from view. It highlights the ways in which practices of information representations in interactive systems are part of the broader modernist enterprise.

Given that software is inherently representational, interactive systems can never be built without engaging in these kinds of processes. However, in contrast to the prevailing modernist tradition, a variety of authors have, over the last ten years or more, begun to articulate an alternative position in which the relationship between representation and action is refigured, and computational representations are seen as themselves embedded within socially-organized encounters between people that give them meaning [2, 6, 19, 22].

The second particular relevance of Scott's argument is that information technology has long been implicated in the kinds of resource planning and management that he ascribes to high modern statehood. As Agar [1] has extensively demonstrated, the history of the development of computing machinery – from mechanical tabulators to digital computers – has been intertwined with the efforts of states and governments to manage their own processes. If high modern statehood is fundamentally data-centered, then computer systems have become the essential tools of state governance. It is hard to conceive how a contemporary state could function without them.

While, as Agar notes, this is a long-standing relationship, it is one that is being reconfigured and reinforced by the contemporary transformations of state-hood that go under the broad umbrella of "neoliberalism." Neoliberalism is characterized by the deliberate reduction in the areas of state responsibility, which manifests itself in the privatization of state-owned industry (e.g. transportation), the application of market models to state functions and the outsourcing of government functions to private industry (e.g. private prison services) and the delegation of state functions to non-governmental regulatory agencies.

Organizationally, then, neoliberalism manifests itself in part through the breakdown of monolithic state enterprises into constellations or networks of entities, some public and some private, linked together by market-based exchanges. Critically, they are also linked by extensive information infrastructures. Arguably, data networking is a necessary precursor to the effectiveness of these kinds of networked organizational forms. Digital information systems play a critical role in the distribution of governance roles between the state and private firms:

> Under the contemporary "mode of information" or alternatively "cybernetic capitalism", administrative control of social life by the state is facilitated by the systematic surveillance of consumption by private capital, while the administrative control of consumption by corporations is facilitated by the systematic surveillance of social life by government. [12]

So, Scott's account of high modernism is particularly relevant to the design of interactive information systems both because of the parallels between the roles of systems rationalism in state governance and in information systems development, and because of recent developments that give information systems an increasing prominence in the governance of everyday life. The essence of my argument here, building up on the arguments of Sengers and others, is that Scott's argument motivates particular sorts of design interventions that refigure interactive systems as points of reflection and engagement with the social structures within which they are embedded – not so much "seeing like a state," but "seeing like (or through) an interface."

2.2 Mobile Computing and Legibility

These issues show that Scott's analysis is relevant for information systems, but can we go further than that? I would argue that it is relevant not only for the analysis of information systems and their use, but also for design. I will outline some specific examples towards the end of the paper, but in order to set some context for the discussion, let me note here that there are two ways in which we can see this position as being generative for design practice.

The first is that, while mobile computing systems inherently depend upon representations of both space and activities, Scott's account of the relationship between the practice of abstraction and

the power relations at work opens up the opportunity not simply to use such representations but to make them the focus or topic of the system. That is, we can look for ways in which mobile systems might expose and present the representational systems at work as a focus for examination and reflection. In this mode, mobile systems become devices through which the representational practices that govern everyday space can be encountered, brought into view, understood, and questioned.

Of course, we might be able to do this through any sort of interactive system, but there are some particular resonances that make mobile systems especially interesting sites for these sorts of encounters. Mobile and ubiquitous systems allow us to create spatially-situated collisions between the abstract and decontextualized rationality of rationalist representations and the messy detail of the everyday world.

The second link to design focuses on the ways in which interaction with the world through mobile systems is part of the way in which the social reality of the world is constituted. The widespread adoption of mobile systems, perhaps most especially mobile telephony but also wireless internet services and mobile computers, has been accompanied by a series of transformations in our understanding of the spaces that we occupy each day. Such phenomena as people working from WiFi hotspots in cafes, "silent" coaches on trains where mobile phone calls are disallowed, and hypercoordination achieved through SMS messaging all speak to a complex series of mutual accommodations between emerging technologies and evolving understandings of space [8]. Our experience of everyday space is not pre-given, but continually being negotiated and produced as a consequence of individual and collective action From this perspective, the relationship between technology and spatial representation is much more complicated; representations, explicit and implicit, are means by which spaces are not only encountered and managed but produced. For instance, geographers Rob Kitchin and Martin Dodge have recently suggested that cartography be rethought as processual, rather than representational; that is, that we think about maps as things that emerge through practice rather than as capturing and documenting underlying realities [15].

This suggests a second avenue for design practice, then, which focuses on the ways in which spatial representations arise out of patterns of inhabitation. Mobile technologies can act as sites for the production of new forms of spatial experience, connecting people to each other in space and creating representations and "mappings" that reflect emergent patterns of activity rather than a surveillant gaze.

I will present specific design examples towards the end of the paper that illustrate these approaches. First, though, it's useful to examine two critiques of Scott's argument that elaborate his arguments around the homogenizing practices of high modernism.

3. SEEING LIKE A CITY

Legal scholar Mariana Valverde has used the term "seeing like a city" to describe an alternative to the homogenizing strategies that Scott reports [23]. Valverde's concern is with "the tools of urban ordering." Concerned particularly with urban legalities, she observes that cities have different concerns than states. She notes in particular that municipalities and their ordering tools do not suffer the same sort of "territorial anxieties" as states; with the threats to their sovereignty against which states must defend, their borders are marked by considerably less fanfare and visibility. In consequence, unity is a less prounced feature of urban ordering.

So, while municipalities are certainly subject to the same rationalizing tendencies as modernist states, the municipal experience develops differently and in particular is characterized by a fragmentation of jurisdictions and responsibilities. Cities are patchworks of districts and regions reflecting different – neighborhoods, zip codes, postal routes, school districts, tax assessment zones, conservation, electoral wards, catchment regions, police precincts, and more.

If the high modernism of state governance resulted in a series of process of homeogenization and standardization, urban governance is characterized instead by plural and heterogeneous orderings – but orderings none the less. As Valverde notes, the various issues with which municipalities have cocnerend themselves – public hygiene, transportation, crime, etc – are irreducible both to each other and to some other fundamental order. Fragmentation is a matter here, then, of scale, of perceptions of risk, and of the nature of the municipality's affairs.

Valverde's goal is not to set up the notion of municipal as conceptual dual to Scott's state ordering, but rather to highlight the different forms of administrative gaze and the ways in which they reflect political, pragmatic, and historical considerations. To think of the gaze as plural and heterogeneous is to start thinking of the many different simultaneous perspectives and representations at work. What is perhaps particularly valuable, from the perspective of mobile and ubiquitous computing, is the ways in which one might, at any given moment, be situated within an overlapping set of infrastructures, systems, domains, and representations. One is positioned, at any moment, in relationship to different organizations, infrastructures, and regulatory regimes arises both from "above" (regimes of governmental authority) and from "below" (the actions of self and others).

As a legal scholar, Valverde is interested too in the ways in which these kinds of regulative systems are invoked. She points out that the forms of urban regulation are quite different from state regulation; urban law enforcement is largely (although not entirely) a response to citizen complaints rather than a consequence of vigilant surveillance. Regulative schemes, then, vary in the extent and circumstances in which they are brought to bear upon the world; the processes of alignment between representation and reality are themselves heterogeneous.

4. SEEING LIKE AN OIL COMPANY

Finally, here, we will consider another exploration of Scott's ideas in a different context. Ferguson's brief article "Seeing Like an Oil Company" [11] sets out explicitly to explore the relevance of Scott's arguments for neoliberal global capitalism, drawing in particular on his fieldwork on the operations of multinational mineral extractive industries in Africa. As Ferguson notes, Scott himself comments that the monolithic forms of statehood that he describes might be seen as somewhat archaic relics from the perspective of the early twenty-first century, but suggests that global capitalism depends every bit as much upon "homogenization, universality, grids, and heroic simplification." It is this latter claim that Ferguson contests. Ferguson raises several issues, but I will focus on just two here –extractive enclaving, and the relationship between production and violence.

By "extractive enclaving," Ferguson refers to the common pattern of presence of multinational extractive industries in Africa, where they are located within but separated from the countries in which they operate. Offshore drilling is perhaps the most clear-cut example; in extreme cases, neither the oil nor the money that it generates even touch the soil of the country in question. However, even in cases where oil or other minerals need to be mined on land, it is quite common for the mines to be located on private land managed entirely by the company, policed and secured by private firms, with foreign workers accommodated on site, bussed in directly from the airport or transported by helicopter so that they scarcely set foot outside of the protective regime. As Ferguson notes, these territorial enclaves are often tightly connected to the headquarters of the relevant multinational corporation while largely disconnected from the nation within which they are located. The homogenizing grid has not been *extended* to incorporate the developing world, then, as much as it has been *overlaid*, passing over those areas that it cannot control or in which it is not interested.

We can see this in particular in the second issue of Ferguson's I want to raise here, the relationship between mineral production and endemic violence. During the major period of African decolonization and reconstruction, the dominant ideology suggested that the interests of global capital and of nation-states overlapped; foreign economic investment would provide emergent nations with the resources they needed to build civic and material infrastructure, and in turn the stability and increasing economic well-being of these nations would make them attractive partners for global enterprise. As suggested above, however, multinationals have been able to operate quite effectively while by-passing the nation-state altogether for a range of their needs, and indeed one could argue that not only do they not depend on national stability for their effective operation, but they seem to thrive particularly in conditions of endemic violence, from low-level criminality and insecurity to outright civil war. The dependence upon private security firms rather than civil police or armies means that multinational firms may, in fact, operate most effectively where states are least effective. As Ferguson reports, it is precisely the countries that are, from the perspective of the IMF or the World Bank, the biggest "failures" as states that are the most successful at developing these transnational extractive enclaves.

Like Valverde's discussion, Ferguson's analysis opens up a series of interesting questions around the centrality of the grid and practices of homogenization that Scott discusses. Scott talks about the ways in which systems rationalism fails when the grid is rigidly imposed upon local realities; Ferguson highlights alternatives for bringing grid and world into alignment. As he notes, capital does not simply "flow" uniformly in the systems he is exploring; it hops from place to place. Similarly, the imposition of uniformity may not, itself, be uniform. Where Valverde points to systems of urban ordering as plural and heterogeneous, Ferguson notes that the ordering systems of global capital may not be strongly aligned with those of nation states which it comes into contact. Both recognize the power of Scott's analysis, but provide us with new examples that suggest that we need to pay attention to the many ways in which standards and grids might manifest themselves. Indeed, it is just these issues – the complex, multi-faceted, and multilayer nature of grids, regulation, and representation in contemporary space – that motivate a series of potential design interventions when we take these ideas and apply them in the context of interactive systems.

5. SEEING "SEEING": TOOLS FOR LEGIBILITY

As I have suggested, information systems are implicated in the kinds of projects that Scott (and Valverde, and Ferguson) describe in two significant ways. The first is that the representational practices that support much of information systems development are strongly related to the systems rationalism that underlies the phenomena that Scott analyses. The second is that information systems have always been strongly involved in the development of these kinds of rationalist projects on a large scale. Contemporary developments, especially in the form of networked organizations and distributed governance, have only deepened the connection between information and interactive systems and forms of administrative control.

If we accept the deep link between forms of information system development and the homogenizing character of high modernism in its various manifestations, what might we want to do? Clearly, there is a range of responses. One is simply to develop a set of conceptual resources for the analysis of information systems and their use; arguably, the emergence of social informatics [16] is precisely this, an attempt to understand the linkage between social systems and information systems. A second response is that represented by the Participatory Design movement, in its classic Scandinavian tradition, which looks upon information systems design, implementation, and deployment as sites for democractic action.

In recent work, colleagues and I have been concerned with a third response, in line with Agre's concern for "critical technical practices" and Senger et al.'s "reflective design." [2, 19] At the heart of the Critical Technical Practice agenda is to see information system design as, itself, a critical practice and to see interactive systems as a tool for critical inquiry. In her account of reflective design, Sengers discusses the ways in which systems design can provide a point of critical reflection on underlying assumptions for both system designers and users. She comments, "reflection is not a purely cognitive activity, but is folded into all our ways of seeing and experiencing the world." It is just this issue – seeing in particular – that motivates the exploration here, both in conceptual terms and in design terms.

As a design strategy, we have bee interested in the ways in which we might be able to use information technologies to turn attention towards modes of seeing – strategic modes, tactical modes, surveillant modes, practical modes, and more. Our concern is to highlight the forms of representation and standardization at work, to turn attention to the processes through which they emerge and the sites at which they are negotiated, and so to make visible the various grids in which people are enmeshed and which they enact in the course of daily life. I will provide two examples here from ongoing work.

Datascape [14] is tool for exploring urban space and its representational analogues. Datascape provides a vehicle-mounted display that can be used, much like a periscope, to examine the surroundings while moving through them. The system, then, combines two visual experiences of urban space. One is the sight of the surroundings as viewed from the vehicle. The second, presented on the display, is a virtual world with a topography

generated on the basis of geo-referenced data sets such as census records, block-by-block geodemographic marketing data, disease incidence records, etc. This is Valverde's urban patchwork mapped into a virtual world; what is particularly interesting here is the superimposition of the representational space with the physical space, so that one can explore the landscapes of daily life in the terms in which they are organized for marketers, epidemiologists, and others. By linking different databases for the same space, spatial correlations can be made; while this can also be achieved with conventional geographical information systems, a radically different experience is achieved when these can be grounded in the space through which one is moving. Datascape is at is most powerful when it used not as a tool for exploration but as a tool for reflection, and when the spaces being examined are the familiar uses of daily experience. Initial, static versions of Datascape have already been exhibited; the mobile version is currently in the prototype stage.

It is clear that Datascape responds to the considerations presented in this paper by exposing representational grids. However, Datascape attempts to go beyond this, in at least three ways.

First, by drawing together multiple different forms of information and different databases, Datascape is designed to expose the relationship between multiple grids and multiple practices of homogenization and representation. What becomes particularly interesting as a matter for exploration is the ways in which those grids do and do not line up, the elements that they have in common or separately, the boundaries that are shared and those that are unique. Datascape provides a view of this complex of representations as much as it does any single one.

Second, Datascape doesn't simply allow one to explore georeferenced data via a digital system (e.g. through a web browser), but instead situates people within the spaces that are represented, as a means to explore them. Critically, it uses these familiar spaces as ways of contextualizing the data. In other words, it is not simply demonstrating the legibility of everyday spaces through the use of large-scale data sets; it is also attempting to *make those data sets legible through the use of everyday space*. Using familiar space as a lens through which to view and understand things like scientific, environmental, and epidemiological data invites new stakeholders into conversations for whom the source of legibility is the inhabited space itself rather than the abstract representations of graphs, charts, and scientific or mathematical formalism.

Third, when used as an authoring tool rather than purely as a visualization tool, Datascape offers the opportunity for people to create tours and routes simultaneously through physical space and data space, offering a very different form of legibility, one based on communities and peer communication. Here, again, the data sets that are not being used to make space legible, but rather are the objects of representation and critique.

While Datascape is primarily concerned with the sorts of data sets that make everyday space legible to organizations, bureaucracies and states, our second example is one that draws in particular on the forms of emergent legibility that arise out of habitation and movement in everyday space.

Undersound [4] is a music-sharing system design for the London Underground. It responds to a number of aspects of the urban experience within which the London Underground is enmeshed, including the social and ethnic diversity of London, the complex relationship between above ground and below ground, and the non-instrumental aspects of public transportation. In studies of public transit in both California and London, a strong concern emerged with those aspects of transit that went beyond "getting from A to B" and focused on the elements by which people would understand trips as good or bad, including the skill of execution, the experiences or people encountered along the way, and more. This turned our attention to the aesthetics of the journey, broadly construed, and to the collective rather than purely the individual elements of riding together on public transit. Undersound is a music sharing system for mobile phones that allows Tube riders to browse and exchange music. Music files, though, are strongly tied to the geography of the Tube itself; they originate, terminate, and are transferred in particular places. So, from another perspective, Undersound is a system by which music hitch-hikes around the Tube on people's mobile phones. Music circulates, much as people do. What we are interested in here is the ways in which the system can provide people with an understanding of two otherwise obscured elements of life in public transit. One is the connection between places and regional or ethic styles, as captured by the forms of locally-produced and uploaded music that characterize stations or regions of the city. The second is the flow of bodies within which one is enmeshed as a traveler along particular routes at particular times of day.

Here again, then, we are concerned with questions of legibility, although they are of quite different sorts. In his writings on the practices of urban life Michel de Certeau distinguished between strategic modes of encounter with urban forms, and tactical modes. The strategic modes are the modes of design; they are concerned with the creation of urban forms in order to control, manage, and regulate activities within them (shaping urban growth, creating points of assembly, routes, etc.) By contrast, the tactical modes are the modes of use and appropriation; the ways in which people's movements through space create new forms of local meaning, on the individual level (e.g. personal choices between different routes taken to work that reflect different moods) or on the collective level (e.g. the emergent and transitory associations between particular ethnic or subcultural groups and regions of the city and the impacts that they have.) Our concern is very much here with the tactical, then. Undersound makes visible, as a site of examination and reflection, the urban flows within which people and artifacts are enmeshed, making them meaningful by placing them in the contexts of journeys that themselves are suggestive of particular purposes, needs, and characters. This is legibility from below rather than above.

6. INFRASTRUCTURE AND INTERACTION

One of the considerations motivating this work is to reconsider infrastructure as a site of interaction. Much of what we do in creating interactive systems is to create infrastructures – data representations, storage mechanisms, networks, frameworks, and other technical elements that are designed to stabilize elements of the world and make them accessible and manageable. The essential features of infrastructures is that the lie "beneath" the level of conventional interaction or, indeed, of conventional interest; they are relied upon for everyday task, but largely unremarked and invisible in use.

Leigh Star makes a compelling case for infrastructure as a site of ethnographic inquiry, noting that the processes by which

infrastructures become infrastructures – that is, the processes by which complex and unruly objects are stabilized and subdued so that they can withdraw into the background of everyday use – are important ones that deserve attention when we look at technological systems [20]. These are the processes by which standards are established, services configured and offered, and conventions developed that, through their ubiquity and uniformity, start to be taken for granted.[1] Infrastructures are not purely technological; they are political, legal, and economic entities, and the processes by which they are established, transmitted, used and overturned need to be examined also in those terms.

However, when we think of technological systems as tools through which we experience the everyday world, then the interactional consequences of these kinds of infrastructural processes become even more pressing. Infrastructures are tools of interactive experience; they become manifest in interaction, and they structure those interactions. Despite claims of an emerging world of "ubiquitous" computing, it is precisely the disjunctures, boundaries, and seams that infrastructures are designed to erase that are of interest to us here [10]. We find this a compelling and fruitful area for design.

7. CONCLUSIONS

The work presented here forms part of three larger and related programs.

The first is the burgeoning interest in a reflective approach to HCI – one that is itself concerned with the critical dimensions of design, and is also oriented towards promoting reflection and critical inquiry into technological devices on the part of "users." One of the underlying considerations here is that computers, as cultural artifacts, participate in, reflect, enact, and reinforce cultural values and assumptions, and so that, first, computer system design is an effective site at which to engage in these kinds of critical engagements with everyday practice, and, second, critical approaches to technology design are both appropriate and necessary. Reflective HCI suggests an approach to interaction design in which cultural assumptions and values play as important a role as traditional usability metrics both as measures of success and as elements of the design process. To the extent that my considerations of legibility here are ones oriented towards a "user's" interaction with the people and institutional structures that also occupy everyday space, it is very much in line with these considerations.

The second broader concern is the relationship between technology design and social science, most particularly the theoretical and analytic considerations in social science research. HCI has a long history of drawing upon the empirical components of sociology, anthropology, and related areas through, for example, the adoption of ethnographic research methods as means for requirements analysis and capture. However, as argued elsewhere [6], a purely empirical perspective neglects many of the contributions to be gleaned from social science research, even that with an empirical basis. To reduce ethnography to data collection and summarization is to overlook the critical and analytic engagement that is the basis of its approach. In turn, I would argue that it is useful to turn to social science and related materials not merely for their empirical richness but for their analytic insight and for the ways in which they encourage us to ask a new set of questions as the basis of design experience.

The third concern is a recognition of the transformation of interactive systems as sites of inquiry. The discipline of HCI has evolved considerably over several decades, but so too have computer systems themselves. What I want to draw attention to here is not simply the fact that computers have become faster, smaller, and more powerful as technological artifacts, but that they have emerged as cultural objects in a radically different way than they did before. They are elements of the landscape of daily life in many different forms. Digital devices are embedded in our cultural and social imagination in very different ways than they were when HCI was emerging. To the extent that our discipline thinks not simply about user interface design but about interactions between humans and computers, these transformations suggest that we need to look more broadly for theoretical perspectives that help us understand how computation manifests itself as a cultural object [e.g. 17].

In this paper, I have attempted to draw on these positions in order to argue, first, that legibility is a critical issue for information technology in two ways – in the forms of ordering that digital representations support, and in the opportunities for making these visible in the course of interaction. I have argued, second, that mobile and ubiquitous computing is a particularly fruitful area for exploring these questions, because the movement "off the desktop" (and out of the office) inherently raises questions about the nature and orgnization of the spaces and settings into which computation has moved. As illustrated by Datascape and undersound, the ways in which ubicomp technologies are situated in space, in the "here and now," is a powerful element in building compelling reflective systems.

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