Deliberate Interactions: Characterizing Technology Use in Nairobi, Kenya

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ABSTRACT

We present results from a qualitative study examining how professionals living and working in Nairobi, Kenya regularly use ICT in their everyday lives. There are two contributions of this work for the HCI community. First, we provide empirical evidence demonstrating constraints our participants encountered when using technology in an infrastructure-poor setting. These constraints are limited bandwidth, high costs, differing perceptions of responsiveness, and threats to physical and virtual security. Second, we use our findings to critically evaluate the "access, anytime and anywhere" construct shaping the design of future technologies. We present an alternative vision called *deliberate interactions*—a planned and purposeful interaction style that involves offline preparation—and discuss ways ICT can support this online usage behavior.

Author Keywords

HCI4D, Kenya, urban computing, everyday technology

ACM Classification Keywords

K.4.2 Social Issues: Miscellaneous

General Terms

Design, Human Factors

INTRODUCTION

A growing body of research examines the mutual shaping of information and communications technology (ICT) use in everyday life and users' understanding of time and space [16,31,33]. The increasing availability of network access is a topic of interest in these studies because it allows mobile users to work in novel ways. Increased Internet access has also inspired new applications such as mobile video telephony and social networking on the go. This research challenges the trope of "access, anywhere and anytime" as a

guiding force that shapes the community's design of future ICT [31].

We have chosen to examine the relationship between online access, time, and space in a context receiving increased attention among HCI researchers—developing regions [36]. To date, the HCI community's understanding of this relationship is based on empirical studies conducted in infrastructure-rich settings in the global North [31,33], despite evidence suggesting patterns differ in other contexts [3]. To address this imbalance, we conducted a qualitative study examining ICT use among native Kenyans. Our study focused on desktop computer and mobile phone use in the home, the workplace and elsewhere. We chose to study professionals living and working in Nairobi who regularly use ICT, because understanding how they use technology highlights constraints some people encounter when using the Internet in infrastructure-poor settings.

In infrastructure-rich settings, designers expect widespread Internet connectivity in users' homes and workplaces. Even outside of these locations, there are growing expectations that users will have high-bandwidth connectivity on their mobile phones and laptops to access the Internet at locations such as coffee shops and university campuses. However, in Kenya, the equivalent facilities do not supply adequate bandwidth or the reliable service necessary for applications such as real-time computer mediated interactions and streaming video. Further, broadband Internet infrastructure is unevenly distributed throughout the country and often unreliable or slow [29]. Although, mobile phones hold the promise of making computer-mediated communication more widespread in Kenya than it currently is, recent developments highlight opportunities to understand users' experiences using the Internet on desktop computers. Specifically, the arrival of an undersea fiber-optic cable promises to usher in a "new Internet era" in Kenya and other sub-Saharan African countries [1,27].

During our fieldwork, we observed four factors that shaped our participants' perceptions of time as it relates to ICT use. First, limited network access availability made ICT use highly dependent on users' location. Second, once users

gained network access, the cost of Internet connectivity led to a hurried conception of Internet use and limited our participants' ability to "browse" online. Third, differences in social norms around email responsiveness created tensions between our participants and their coworkers in infrastructure-rich settings. Finally, concerns over physical and virtual security in Nairobi limited the widespread use of technology in public settings among our participants.

The main contribution of this paper is not these observations themselves, but their use in formulating an alternative design vision that we call *deliberate interactions*. Deliberate interactions are planned, purposeful, and often require offline preparation. As such, we use our observations to critically evaluate the "access, anytime and anywhere" construct and discuss ways the HCI community can support this online usage behavior. We intend for this critical discussion and ideation to inform future design efforts—efforts that will require new and longer-term contextual design fieldwork, but that will benefit from our initial work in this space.

This paper is organized as follows. We present related work analyzing the "access, anytime and anywhere" construct, investigating how ICT changes daily life rhythms and exploring ICT use and design in developing regions. Next, we describe our methods, participants, and analysis. We then present four issues that affected ICT use among native Kenyans living and working in Nairobi: limited bandwidth, high costs, different perceptions of responsiveness, and threats to physical and virtual security. These constraints characterize a new style of interaction that we call *deliberate interactions*. Finally, we outline design implications to accommodate this purposeful, and oftentimes offline style of interaction. These implications include: maximizing and extending Internet use, visualizing access constraints, and discreet computing.

RELATED WORK

"Access, anytime and anywhere" in HCI and CSCW
Numerous studies have examined the trope of "access, anytime and anywhere" and leveled varying critiques. In many cases, researchers observe that the particulars of a work environment shape workers' flexibility. For example, research by Perry *et al.* on British mobile workers on business travel [31] highlighted the unpredictability and uncertain nature of mobile work. Similarly, Wiberg and Ljunberg's study of Swedish mobile telecommunication engineers examined how the work tasks engineers performed were dependent on time and place, in some cases being highly location-dependent and constrained to occur within a certain period of time [41]. Another important finding from this study was that prior HCI/CSCW knowledge should not solely guide future ICT design. Instead, a careful understanding of the new social contexts where ICT is used should drive design because it is difficult to generalize findings about users' levels of access across different users groups. Indeed, prior studies indicate that context affects anywhere, anytime access for older persons

[24], Australian freelancers [35], and Japanese youth [21]. Constraints range from social factors such as wanting to avoid being accessible at certain times to having a dead mobile phone battery. Like these prior studies, we chose to qualitatively examine actual user activities as a means of better understanding their context. Further, we extend prior studies examining "access, anytime and anywhere" by exploring an understudied user group and context, professionals living and working in Nairobi, Kenya.

Despite this research, the transformative nature of anywhere, anytime connectivity remains prominent in marketing imagery for mobile technology and services [16]. Researchers also continue to investigate ways ICT can support "nomadic workers" or mobile workers who travel extensively and rely on constant connectivity as a part of their jobs [37]. This suggests that "access, anywhere and anytime" will continue to shape design and future HCI/CSCW research. However, it is unclear whether this vision accounts for people living and working in infrastructure-poor settings.

ICT Use and Daily Life Rhythms
We also situate our research in recent studies investigating how ICT change users' daily life rhythms. Much of this work focuses on "busyness" and has motivated studies investigating how ICT can help families schedule activities [5,6,28] and workers avoid interruptions in their offices [10,15]. These studies provide significant insight into how ICT can improve coordination and increase workers' productivity. Yet, like other researchers we believe this research takes too narrow a perspective on ICT use and daily life rhythms [33].

For example, Rattenbury *et al.,* write that treating busyness as a problem that technologies can solve limits HCI and related communities' understanding of time. Using data from a mixed-methods study of ultra-mobile PC use, they argue for a perspective on time based on the metaphor of plastic. "Plastic time" is the qualitative experience of time as related to mobile personal computer use. Characteristics of this type of time include, being opportunistic and "flying under the radar," or time users do not readily recall. Like these researchers, we wanted to provide the HCI/CSCW research communities with a more nuanced understanding of how ICT shapes users' daily life rhythms to highlight new design opportunities. We differentiate our research from all of these prior studies by studying users in an infrastructure-poor setting.

HCI4D
Finally, our work sits within the growing body of HCI for development (HCI4D) research or studies that focuses on understanding how to apply HCI principles to the design of technologies for developing regions[19, 35]. Recent examples of HCI4D research include Kam and his colleague's research on developing language-learning games for low-income children in India [22]. Parikh's work on developing a user interface toolkit that allows a camera-equipped mobile phone to interact with paper

documents for rural computing applications such as microfinance [30].

These studies have been instrumental in broadening HCI discourse to include users living in developing regions and in imagining innovative ways computing can address poverty reduction and illiteracy. However, this research focuses on particular user populations and on a particular ICT. A recent review of the HCI4D literature noted that articles concentrate on users living in rural areas, with low income and education levels, and design mobile phone applications based on their needs [19]. Our interest here is on users who interact with ICT in ways that are comparable to those in previous HCI4D studies, but whose actual styles of use are shaped by their different social, economical and technological contexts. Specifically, our participants lived in an urban area, were literate, and had access to a broader range of ICT than individuals examined in prior studies.

Like other HCI4D researchers, we recognize that mobile computing holds promise for countries in sub-Saharan Africa. We build-on prior research by providing evidence about desktop computing use in this region. This knowledge is necessary, particularly now that the arrival of an undersea fiber-optic cable to East Africa opens up new avenues for desktop computing [1,25]. In summary, our contributions are to critically evaluate the vision of "access, anywhere and anytime" as it applies in developing regions; to extend our understanding of how patterns of use differ in infrastructure-poor settings; and to extend the discourse of current HCI4D work by examining an understudied user group—native Kenyan professionals living and working in Nairobi.

METHODS

Site Selection
Located in East Africa, Kenya is an open society generally characterized by political stability[1] and economic prosperity relative to its neighbors (e.g., Somalia and Sudan). The country has experienced steady—though slow—economic growth during the last decade. This development has resulted in a well-established professional class that is largely concentrated in the country's capital, Nairobi [13].

Nairobi epitomizes the fast-paced technology adoption evident in other major African cities. The Internet was introduced in 1993 and access has slowly spread to the country's most rural areas [11]. As in most other countries in sub-Saharan Africa, mobile phone use is widespread in Kenya [20]. Moreover, mainstream African media reports indicate that technology use is on a significant upward trend in Kenya (e.g., [42]).

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[1] We conducted our research in July-August 2007, prior to the unrest that followed the disputed presidential election in December 2007 [13].

Despite rapid uptake of ICT within certain segments, Nairobi remains a city of extremes. As with many major cities in developing regions, middle and upper class housing developments are tightly intermixed with informal communities (slums). Ongoing rural to urban migration is one reason these extremes between wealth exist and the subsequent divide in ICT access [38].

Methods and Participants
We employed rapid ethnographic field methods throughout our study [26]. Interviewing key informants, having more than one researcher in the field, and asking focused questions about technology use allowed us to gain a reasonable understanding of our users and their context within a limited amount of time.

Most of our fieldwork took place in Nairobi; however, we began with a round of preparatory research conducted in Atlanta, U.S., where we asked five Kenyan immigrants to recall their daily lives and technology use in Nairobi. These interviews provided us with a foundation for thinking about ICT use in Kenya and helped us locate study participants. Those we interviewed in Atlanta had friends or family members living in Nairobi. From this base of contacts, we used snowball-sampling techniques to increase our sample size. This was appropriate because we wanted to locate participants in Kenya who were like the immigrants we initially interviewed. Like our participants in Atlanta, those in Nairobi had relatively high education levels and frequently used PCs and mobile phones.

In Nairobi, data collection took place over a six-week period. We interviewed twelve individuals employed in technology-related fields (11 men and 1 woman) in their offices. They worked as IT or media directors at churches and other non-profit organizations. Two participants were involved with Internet start-up companies. We also conducted a focus group with six individuals working for an organization that distributed audio Bibles to remote areas in Kenya. This helped us gain some insights into how an organization used ICT. We asked participants to describe a typical day at work and home. Then we asked questions about their access to technology, and their experiences
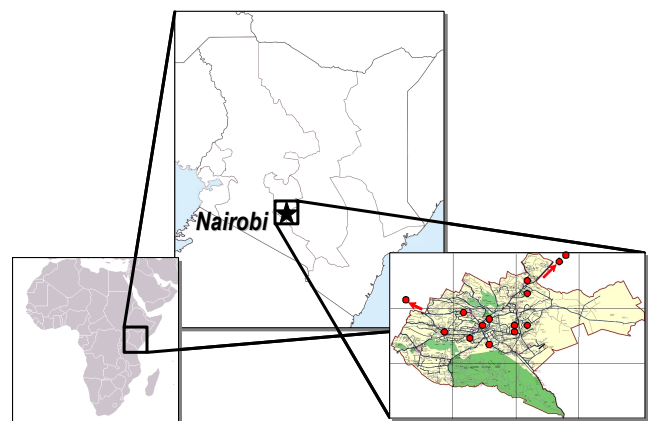

Figure 1. Kenya and field sites in greater Nairobi.

using the Internet, email, SMS, television, radio, and mobile phones. Interviews lasted 1½ to 2 hours and were digitally recorded.

Participants in Nairobi shared experiences and certain patterns of daily life. For example, those we interviewed had similar levels of education. They had undergraduate degrees (or were in the process of finishing a degree), had professional careers and lived in parts of Nairobi where middle class residents typically live. Many participants had traveled in the United States (U.S.) or the United Kingdom (U.K.) and appeared comfortable with interacting with individuals from different cultures. All participants indentified as Christian and regularly attended church. Indeed, this is common in Kenya where 90% of the population identifies as Christian and 80% describe attend church at least once a week [32]. Half of the homes we visited were located in and around the Buru Buru estate, the largest middle class residential community in Nairobi (Figure 1) [34]. All participants spoke English, Kiswahili, and in many cases spoke their "mother tongue," or local language (e.g., Kikuyu).

To complement this data and to understand how our participants used ICT in their domestic lives, we conducted ten in-home tours and interviews. These participants had a variety of occupations including teachers, ministers, a print shop owner, graphic designer, and stockbroker. Finally, we interviewed students studying computer science and design at two of Nairobi's major universities: the University of Nairobi and Jomo Kenyatta Agricultural and Technology University. We paired these interviews with observations at area shopping centers and stores (e.g., Nakumatt), coffee shops, churches, universities, and workplaces. In total, we formally and informally interviewed thirty-nine individuals (12 IT professionals, 15 other types of professionals and 12 students).

Analysis
Our findings are based on 27 transcribed interviews, approximately 150 photographs, and 50 pages of field notes. We supplemented this data with memos documenting our thoughts and reflections about the themes emerging in the data. The constant comparative method guided our data analysis in conjunction with reading literature from development, design, and HCI [14]. Further, we blended the perspectives of four HCI researchers with experience living and working in sub-Saharan Africa to find mutually agreed-upon themes in our data.

FINDINGS
Four themes arose repeatedly in participants' discussions of ICT use: limited bandwidth, high costs, differing notions of responsiveness and threats to physical and virtual security. While other studies have discussed some of these findings, we were struck by the degree to which our participants' network access remained tied to particular locations and their ICT use was planned and deliberate. In this section, we discuss these themes in turn, connecting each with this idea of deliberate interactions.

Limited Bandwidth
Our participants consistently told us how the scarcity of Internet bandwidth affected their ICT use. Even in environments where a given location (such as an office) had good local connectivity, available bandwidth to international websites (such as free webmail providers) is limited by undersea fiber capacity. Limited bandwidth frustrated many of our participants, particularly when they were communicating with coworkers in infrastructure-rich settings such as the U.S. and the U.K. For example, Kenyan professionals employed by western multi-national organizations noted how colleagues abroad were sometimes unaware that they lacked constant, high-speed Internet connectivity. This assumption upset many we interviewed:

> When we were doing our financial system . . .a lot of it was done by people with U.S. and U.K. backgrounds, like they did it in such a way that it would be using broadband every time and it will be available every time, so when they came to implement it in Africa, we told them this is not our scenario, we don't have it [the Internet] every time.

This participant continued to explain that she had to explain to coworkers with "U.S. and U.K. backgrounds," that Internet access not only varied between western countries and Nairobi, but also between Nairobi and the rest of Kenya.

> We told them you must provide us with a service that we can use when someone out in the countryside is not connected.

Frustration also resulted from coworkers sending large files that took a long time to download because of slow connection speeds. For example:

> In the U.S., you have broadband. You have high-speed data connection. We hardly have that here … That's a frustration for me because I know this technology exists but we're not there yet, so we're still traveling with slow speeds …

Exchanging information artifacts such as documents, spreadsheets, URLs, and presentations is an integral part of distributed collaboration and users with fast connections distribute such attachments effortlessly. However, downloading and uploading large files can take hours without high-speed broadband, crippling some email software that does not allow users to refuse or defer attachments. Our participants avoided sending large files via email; instead—when collaborating with people within Kenya—they saved documents to a CD and sent them via courier. Thus, for our participants attachments have not replaced physical objects, as they have done in other settings, because of limited bandwidth.

In some cases, participants talked about colleagues who travelled to the nearest Internet café to carry out their business, making it difficult to enjoy the speed and immediacy of electronic communications:

> Maybe a manager here needs a report and we will call the people in Mombasa, Kisumu, or Ebu, and tell them send me this kind of report, then the person will say I have to compile

it, I will then need to go to town where there is an Internet café to send it, so you see it wastes a lot of time.

Like sending information via a courier, waiting for a colleague to visit an Internet café "wasted time." Because of the increasing availability of cheap residential broadband access, institutional wireless access, and mobile data access in the U.S. and U.K., accessing information is often opportunistic, unplanned, and less tied to a fixed location [16,33]. Communication becomes immediate and digital correspondence replaces physical objects. Although, our participants said they enjoyed the benefits of email (without attachments), such as staying connected to friends, family, and coworkers, limited bandwidth meant that other benefits could not yet be enjoyed. These benefits were exchanging large files and accessing the Internet away from their office

There were other ways our participants negotiated working on computers with limited bandwidth in their offices. Some participants shared an Internet connection by physically passing an Ethernet cable back and forth—one user browsed the Internet or downloaded files while the other did work not requiring a connection. Others worked in environments where a single computer had Internet access. This quote illustrates why sharing access made lightweight browsing difficult:

> When you are at work using the computer, there is always somebody else who wants to use it and by that time, maybe you had something different you wanted to look up.

The multitude of opportunities to connect to the Internet gives workers in infrastructure-rich settings more freedom and flexibility in organizing their time [16]. The opposite appears to be true among our participants who told us that Internet access was hurried, interruptions were expected (and could not be avoided), and if participants did not plan their use appropriately, they would have to wait to access the Internet later. Thus, using the Internet did not fit seamlessly into the rhythms of their work life and browsing was not done to "kill time," as reported elsewhere [33]. Despite having access to the Internet low speed, limited bandwidth, and shared access meant that communication and exchanging resources required our participants to plan their online interactions. In turn, this made participants' Internet use deliberate.

High Costs
Like scarcity of high Internet bandwidth, participants consistently explained how the high costs of Internet access affected ICT use. Specifically, it meant that rather than being unplanned and opportunistic using the Internet required preparation and planning. High access costs made having Internet access at home unaffordable for all but two of our participants. Participants also told us paying for residential Internet access was unjustifiable, particularly for those who had access at work. If those with workplace access needed to use the Internet for personal reasons, they arrived at work early or stayed late. This statement echoed many we heard:

> If I wanted Internet access I could get it, but I go to work every morning and we have access. It cost about 12,000 Shilling [USD $157] for the whole year. I don't think I need to spend that much, especially when I can access it the next morning at work.

Additionally, many of our participants told us that visiting an Internet café was more economical than purchasing residential Internet access plans. Most participants lived within walking distance of a Internet café; even those with workplace access said they visited them when going to work was not an option for conducting online activities (e.g., on the weekend) and if they were "expecting" an important email. Examples of important messages included messages that required an immediate response and were often requests for money from friends and family living abroad or in other parts of Kenya. Frequently, a mobile phone call notified participants that these messages were coming. However, accessing the Internet at a café raised other concerns about high costs, for example:

> I do not waste time at the computer because I am paying for it by the hour, and the computers are slow, they say it is a 10 Shillings a minute but I tell them is it 30 Shillings a minute because your minutes is so long.

Although this particular participant pokes fun about the altered perception of minutes, the reality is that speeds available in such cafés, where a single dial-up connection is sometimes shared between multiple users, can be painfully slow [29]. As such, participants are forced to experience the Internet at a glacial pace and pay for each minute they spend waiting for pages to download. Unlike plastic time that flies under users' radars [33], for our participants, it was in their interest to carefully and actively monitor how much time they spent using the Internet, because they are paying on a time-usage basis.

Consequently, our participants made a point of using online time at Internet cafés as efficiently as possible. A common strategy for maximizing this time was to prepare as much of the necessary documents for online interaction at home prior to arriving at the Internet café. For example, participants told us they would compose an email message at home (on an offline computer), save it on a USB flash drive, and then visit an Internet café to email the message. This eliminated the need to pay for time spent composing an email. Other participants told us they quickly looked for websites at Internet cafés then saved them to a flash drive to view them later on their personal computers at home. This participant's quote was representative of others:

> I think the flash disk is one of the best things to come out, because before, I used to save my research on a floppy disk, the capacity was very small and by the time I saved one or two web pages it's full, so my flash disk helps me to download much of the info I want, then I go home to analyze them.

Given the high costs associated with using the Internet, participants commonly used PCs in their homes for activities that did not require them to be online. Within our

Figure 2. Participant's computer at home.

sample, there was high personal computer ownership. We toured ten homes and interviewed twelve IT professionals, and two told us they did not own personal computers. Parents described using their laptop and desktop computers so their children could watch DVDs, listen to music, play games, or do homework. CDs and children's toys surrounded the computers we saw, suggesting that they were actively used and valued despite being unconnected to the Internet (Figure 2). While domestic access to the Internet was desirable, not having it did not inhibit our participants from using their PCs. Instead, their computers complemented other ones they used that did have Internet access.

Our participants' attempts to reduce costs also affected how they used mobile phones. Five of those we interviewed owned two mobile phones that could work on different networks. An owner of a technology startup company explains the logic behind owning and using multiple phones:

> If you want to call guys on another network, you find that you better have a line on that network, because it is cheaper to call within your network . . .so I have two phones.

Participants had other strategies to help defray cell phone costs. For example, individuals described "beeping," or a person calling a mobile phone number and then hanging up before the mobile phone's owner can pick it up, a communication practice reported in other parts of sub-Saharan Africa [7]. For example:

> Some people will send you "please call me's," or beeps, because they are free, so I have to call them at my expense. It cost them nothing, but it cost me credits. But you don't know what problem they have so you feel obliged to call.

In this case, "please call me," is a free SMS sent to any subscriber on the same network. Participants planned when they would use their mobile phones as they did when using the Internet. Those we interviewed described how prior to making or receiving phone calls, they had to anticipate what network the recipient would be on and be conscious of how much time they spent talking to reduce the costs.

A major premise underlying "access, anytime and anywhere" is that time online is unplanned and opportunistic [16,31]. Like limited bandwidth, the high costs of access caused our participants to plan their online interactions and mobile technology use.

Responsiveness

Designers of collaborative work systems typically assume that communication occurs between individuals and groups with similar Internet speeds and connectivity [12]. Our participants who regularly received email from coworkers in countries with widely available and high-speed broadband connections told us their lack of constant Internet connectivity affected how quickly they could respond to messages these users sent. One employee of a multi-national NGO told this story:

> This week, I was working at home . . . and I missed email. I had 174 messages, 174 messages! From South Africa, from Washington D.C., and I have to reply and send things. I don't have Internet at home, I can not respond to emails as quickly as they can.

When our participant was not at work, he was unable to follow the ongoing email threads taking place among his coworkers because he did not have Internet access outside of the workplace. Consequently, he felt overloaded (a phenomenon also associated with email use in infrastructure-rich settings, though for somewhat different reasons). Some researchers have suggested that providing senders with information about receiver's availability might alleviate email overload (e.g., [2]), but the effectiveness of such solutions does not account for users whose location or limited access constrains their Internet use.

Mismatches between participants' ability to respond to emails and the expectations of their colleagues overseas about email responsiveness also frustrated those we interviewed. In particular, participants told us that their inconsistent Internet access caused their email response times to be longer than their coworkers who had constant and easily available Internet access. Sometimes to make up for dealing with slow connections or because participants realized they would not be able to respond when not at work, participants made alternative arrangements to keep their responses timely. One participant explained:

> If an email needs an immediate response I will call [the sender] after sending it.

Managing different expectations for responsiveness and alerting those in more connected environments about their colleagues' intermittent and (at best) slow Internet access was a constant struggle for our participants. Further, these individuals were concerned that their colleagues overseas would view their delayed email responses as an indication of a poor work ethic rather than a reflection of their constrained ability to connect to the Internet.

This finding also points to differences between how the spatial availability of network access shapes the perceived

connection between time, space and ICT use. Ubiquitous Internet access allows individuals to organize activities around flexible and convenient compartments of time [16]. In contrast, geographic location limited our participants' email use—they had to be at work or at an Internet café to communicate with coworkers abroad. Again, this meant that when our participants did go online they engaged in a deliberate style of interaction.

Finally, some participants told us they were uninterested in adopting a work culture that relied so heavily on fast-paced email exchanges, rather than face-to-face communication. Discussions about the "cultural bias" embedded in ICT have been presented elsewhere and reported when ICT were first appearing in Kenya [40]. This evidence suggests the need for longer-term fieldwork investigating how western professionals' attitudes about efficiency and ICT use may conflict with Kenyans' cultural values since the advent of greater Internet access. Such issues were outside the scope of our research.

Security

Mobile technologies can largely be used anywhere and anytime in most infrastructure-rich settings. However, concerns about security made using mobile devices and laptops anywhere and anytime in Nairobi difficult. Our participants accepted theft as a reality of living in an environment with wide disparities between the rich and poor and where high-end phones are commonly sold on the black market.

Anxieties about theft inhibited some of those we interviewed from purchasing phones they most desired because phones with features such as Internet access and color screens were more likely to be snatched. This motivated some of our participants to purchase low-end phones that lacked these features because they were less expensive to replace if stolen.

Participants took precautions to limit their visibility when using their mobile phones in public places. For example, a young man who worked as at IT director wore his mobile phone on a string around his neck:

> I was mugged some years back and found that wearing the phone around my neck was the best way of minimizing that from happening again. . . I feel more comfortable having it close to me, as opposed to having it in my pocket where others might snatch it.

Those we interviewed who owned high-end mobile phones with Internet access also took precautions such as limiting their use of these devices in certain areas. For example:

> I don't use my phone in the streets very often, so I only try to use it in safe places, in the part of town where I walk around a lot it is safe, it is a government facility, anywhere else I try to be very careful.

Concerns about theft restricted participants from freely using ICT in public settings. Like the high costs of network connectivity, the threat to physical security means that unrestricted Internet browsing in public settings is not necessarily as easily achieved in countries where disparities are high and the value of stolen technological goods make them an attractive target for thieves. We saw how fear of theft restricted ICT use during our observations at coffee houses and on university campuses. People did not use using laptops in these places because they did not want to advertise themselves as potential targets for theft. Our findings suggest that physical security concerns affect how ICT is incorporated into our users' daily lives, a concern the CHI community has not fully examined.

Cyber-security issues also affected our participants' Internet use. In regions where computer antivirus software is expensive or unavailable, public terminals in Internet, cafés are ridden with viruses [3]. This is a problem for users who use flash drives to shuttle data between computers at cafés and other computers, because this transfer process increases the likelihood of spreading software viruses. Employees who used Internet cafés for business communication were especially sensitive to cyber-security issues. For example:

> I would also say it is not so secure to go to a cyber café for real official office information.

It became clear that threats to physical and virtual security hindered our participants' technology use. Taking responsibility for one's physical safety, personal property, and data integrity implies thinking ahead before engaging in ICT use and highlight another opportunity for a deliberate style of interaction.

DESIGNING FOR DELIBERATE INTERACTIONS

While Kenya's internal and external connectivity is improving steadily, the issues discussed above are likely to persist. Increasing the availability and reducing the costs of network access requires expansion of network infrastructure. This expansion is costly. International bandwidth will remain an issue because it will take some time for bandwidth prices to come down and Internet services to improve [1]. Social norms such as expectations of responsiveness will likely resist change. Finally, physical security and economic prosperity are linked and as long as economic disparity exists, so too will concerns about theft.

While ICT has rendered time more "plastic", "flexible", and "opportunistic" in the global North, there is a sense that the opposite is true in Nairobi. One way that we see this difference is that high Internet costs force users to plan their computer use carefully. Another difference between our participants and those discussed in prior research is that they must visit their office or local Internet café to use the Internet. This eliminates the notion of filling small gaps in one's day with quick Internet surfing. Further collaborative technologies seem better suited to western norms of responsiveness, thus forcing some Kenyans to tie themselves more closely to somebody else's schedule. Finally, the high price and easy transferability of mobile phones and laptops makes them prime targets for theft in

Nairobi. Our participants told us this prevented them from enjoying ICT's time-altering affordances.

As previously suggested, these factors contribute to a deliberate style of interaction, that is focused, involves offline preparation, and that (rather than being an opportunistic and unplanned incident) is geared towards maximizing task efficiency to use the minimum amount of time (and hence cost) for the overall interaction. These differences in adoption patterns and associated socio-technical effects present an opportunity for HCI designers and researchers. In the remainder of this section, we discuss some ways in which designers might work to accommodate this deliberate style. These suggestions, while informed and broadly illustrated by our design fieldwork, are intended as starting point for ideation. In Nairobi, as elsewhere, actual product and service designs would need to be refined and adapted to the sociocultural and material contexts in which they would be deployed.

Maximizing and Extending Internet Use
As noted, scarce Internet access has deprived some Kenyans of the time-transformative effects of the information revolution. We suggest three routes that may allow individuals like the ones we interviewed to incorporate Internet access into their day more easily than they currently do.

One route to this goal is to *maximize the usefulness of users' limited time online*. Systems researchers have proposed technologies for coping with slow or intermittent connections using techniques such as pre-fetching and caching [9], delay-tolerant store-and-forward networking [8] and proxying [39], and the use of unconventional network transport methods such as USB flash drives and data "ferry" computers [17]. These technologies operate at the systems level, seeking to preserve existing application software intact while modifying the plumbing underneath it. However, it may be more productive to modify the user interface. For example, one might give the user interactive control over how limited bandwidth is used. Current browsers download content indiscriminately, offering a few coarse controls (such as downloading all images versus downloading none, or stopping page loading versus allowing loading to continue). Given how long pages take to load, users might appreciate the ability to choose which parts of a page are downloaded (or downloaded next), much as green printing tools such as GreenPrint (printgreener.com) allow interactive control over which parts of a page will be printed.

Another route is to *smooth the transition between online and offline use*. A prominent phenomenon in our data is the offline computer—a computer that is technically capable of being connected to the Internet but is not connected due to cost constraints or lack of network availability. We suggest that user interface innovations could support better use of these offline computers by simplifying the shuttling of application data between online and offline computers.

Interactive tools for creating offline Web browsing caches (e.g., HTTrack, httrack.com) or offline email stores (e.g., VTrack [17]) are a start in that direction, as are asynchronous Web toolkits (such as Google Gears, gears.google.com). However, recent experience with online/offline versions of Web search [4] and other collaborative Web applications [25] indicates that they will often need to be split into a fully interactive front end and an asynchronous back end, thus requiring changes to both interaction design and underlying application semantics. This suggests the need for user interface toolkits to ease development of applications with this kind of split interaction.

A third route is to design to *exploit the different access and cost structures of the networks available*. For example, given that access to network bandwidth is limited and tied to specific locations, we suggest placing "media kiosks" in suitable locations where users can download content onto flash drives for use on computers at home.[2] Rather than having the user sit in the café waiting for a live download the process could be started in advance through a "SIM Application Toolkit" application running on a mobile phone and communicating by SMS. The access cost would likely be the same, but the waiting time would be minimized and the risk of viruses could be as well (if the kiosk is run as a dedicated "appliance").

Responsiveness and Visualizing Access
Given that Kenyans will likely continue to have inconsistent access to the Internet, those working in transnational organizations will continue to feel frustrated by the mismatch in responsiveness between coworkers in different locations. Collaborative tools and email clients can be augmented to help reconcile differences in response times to alert those with higher connectivity speeds and easier access to the Internet about those with deliberate interaction styles. However, additional contextual factors beyond those considered in existing "responsiveness" tools (e.g., [2]) may be required. A simple idea along these lines is illustrated by the Google Mail feature that exposes the "sender's time zone." More generally, email clients could maintain data on indicators such how promptly users respond to their email, the time distribution that a computer has network connectivity, or the quality of the Internet connection over which email has been recently downloaded. Such data could be shared with users in other locations in various ways, whether directly (e.g., through visualizations such as graph of response times or schedule information) or—more usefully—indirectly (e.g., through user interface notifications, such as a tooltip for the "send" button that appears before a message is sent and informs the

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2 In many countries, mobile phone shops often serve this role for the larger mobile phone market, with shopkeepers maintaining a stock of selected (and typically pirated) content such as videos and music for users to copy.

sender that a reply would be unlikely for two days). Such tools have obvious privacy concerns but users may well decide that benefits make the privacy cost worthwhile.

Security and Discreet Computing
As we have seen, physical security is an ever-present consideration in mobile ICT use (an observation that is anecdotally true of many places, not just Nairobi). An area of research with potential relevance in this domain is that of mobile HCI. In particular, one can consider applying the large body of research on eyes-free interfaces, hands-free interfaces, haptic/tactile I/O, and so on [23]to produce a sub-type of deliberate interaction, one that focuses on making interaction in public environments *minimal* and *discreet*. The trivial example of this is setting one's phone to vibrate mode, but the inclusion of novel forms of tactile feedback (e.g., [18]), more complex vibration patterns, etc. may also be a fruitful direction. Further, analogous to current accessories such as Bluetooth audio headsets, there is the possibility of personal-area-networked accessories that enable minimal I/O without exposing the presence of the more expensive laptop or mobile phone.

FUTURE WORK AND CONCLUSIONS
We presented the results from an empirical study of professionals living in Nairobi, Kenya to highlight four constraints that shape how they use technologies in their everyday lives. Specifically, we highlighted four factors that should be considered when developing ICT for infrastructure-poor settings: limited bandwidth, high access costs, different perceptions of responsiveness, and threats to physical and virtual security.

These factors are well understood separately, but considered together motivate an interaction style based on our users' deliberate use of ICT. Deliberate interactions are focused, involve offline preparation, and are geared towards maximizing task efficiency to use the minimum amount of time for the overall interaction. We provided implications for design of technologies to accommodate this style of interaction, specifically ones that maximize and extend Internet use, help users manage different expectations of responsiveness through visualizations and that allow discreet use of technologies in public settings. Our study has set out to characterize technology use in an infrastructure-poor setting and challenged the trope of "access, anywhere anytime" as a guiding design principle for less well-resourced settings.

This research is an entry point to a rich and complex design conversation. The characterizations here are based on our design fieldwork using rapid methods; it is understood that richer and deeper ethnographic research can be used to inform specific designs. Future work could further examine how well other tropes related to interaction styles such as "busyness" apply to these settings. Finally, in addition to contributing to the HCI communities' understanding of users in new contexts, our research suggest there is much to be learned from studying professionals living and working in developing countries, which remains understudied in HCI4D.

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