Reimagining the Mobile Phone: Investigating Speculative Approaches to Design in Human-Computer Interaction for Development (HCI4D)

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Design has traditionally been used to solve problems in the field of Human-Computer Interaction for Development (HCI4D). Mobile phone applications intended to address health and education challenges in low and middle-income countries (LMICs) are prominent examples of these efforts. In this paper, I argue that design—especially, speculative approaches—can play a different role in HCI4D. Within HCI, speculative design has proven to be useful for raising critical questions. Here, I present a collection of nine speculative design concepts that are intended to raise questions about mobile phones; in particular, how they are designed and what they are used for. These concepts are inspired by my +10 years of studying mobile phone use in Kenya. In the discussion, I elaborate on how speculative design approaches can benefit HCI4D by prompting questions about whether the field is solving the right problems. I also discuss how speculative design is useful for drawing attention to other problems and topics of study.

CCS Concepts: • **Human-Centered Computing → Human computer interaction (HCI) → HCI design and evaluation methods**

Additional Key Words and Phrases: Design; Speculative Design; HCI4D; Kenya; Mobile Phones

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1 INTRODUCTION

Within HCI, and the growing subfield of Human-Computer Interaction for Development (HCI4D), technology is generally assumed to be capable of solving problems. Intervention efforts in this field, which are a form of design, have historically focused on developing novel mobile phone applications (henceforth apps); these efforts are largely driven by the rapid increase in access to these devices in low- and middle- income countries (LMICs) [81]. These mobile services are typically designed to address persistent socioeconomic problems, especially those related to health and education [15]. These design efforts draw attention to the benefits that accompany widespread mobile phone ownership. However, HCI4D scholars are increasingly raising questions about whether or not technology can be designed to effectively solve problems [38,78].

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Even some of the field's leading advocates admit that most of these mobile apps rarely solve the problems they are intended to [82]. Missing from these discussions are guidance on what role design *should* play in the field. In this paper, I argue that speculative approaches to design have an important role to play in HCI4D, especially by broadening the field's notion of design beyond primarily developing mobile phone apps.

Speculative design is generally defined as a critically-oriented approach to designing artifacts [20,88]. Within HCI, this method has been widely used to raise questions and provoke discussions about the dominant cultural values embedded in design and, more broadly, to challenge the status quo in design practice [90]. Speculative approaches also offer an alternative to others used in HCI4D (co-design, human-centered, and participatory). These approaches typically result in novel artifacts which are aimed at solving problems, and which are intended to be evaluated, and/or made commercially viable [20,24,88]. To date, speculative design has not been widely used in HCI4D. Here, I present a collection of nine speculative concepts that are guided by a desire to critically examine the mobile phone and apps designed for it. I developed these concepts, which are primarily inspired by my experiences from +10 years of studying people and technology use (mostly in Kenya), and by my training as an industrial designer. My concepts are intended to prompt questions about the usability and design of mobile phones, about what activities these devices should (and should not) support, and about why researchers and designers primarily focus on this technology at the expense of considering others.

I begin by reviewing prior mobile phone design efforts, followed by an overview of other scholars' critiques of design in HCI4D. Next, I discuss my positionality, and then briefly describe Kenya, the country where my research examining mobile phone use was conducted; I also present key observations from my studies. After that, I describe how these observations informed my design process, and then present my speculative concepts (Figures 1-9). Each concept includes a description of what inspired it, and a discussion of the question(s) the idea is intended to prompt. These concepts motivate a discussion on how speculative design can benefit HCI4D. I ask whether HCI4D scholars are solving the right problems, and suggest that speculative approaches can broaden the community's attention to include issues that are aligned with the traditional strengths and focus of HCI research, especially designing usable devices and interfaces. I also discuss how speculative approaches are useful for drawing attention to alternative technologies and interventions, and to unsolvable problems in LMICs. I conclude by noting my project's limitations and future research directions.

This paper's primary contribution is a collection of nine speculative design concepts. These concepts are designed artifacts that visually communicate key findings from my research investigating mobile phone use in Kenya. My concepts represent an important form of knowledge creation, and are a contribution in their own right [69]. Other contributions include a discussion about how speculative approaches to design can benefit HCI4D, and HCI more generally.

2 RELATED WORK

2.1 Design in HCI4D

Science and Technology Studies scholar Clapperton Mavhunga observed "that Africa appears on the technological map of the world as … an oceanful of problems—to be solved" [57]. Indeed, many HCI4D design efforts provide support for his observation. Historically, approaches to design within HCI4D have largely been guided by the premise that technology is capable of solving problems. This focus is perhaps most evident in the community's efforts to design mobile phone apps aimed at addressing longstanding problems in LMICs. These devices have become the

platform of choice in HCI4D, primarily because of the tremendous growth in mobile phone ownership in LMICs over the past +20 years. In their review of the field's literature, Dell and Kumar found that mobile phones are the primary focus of nearly 60% of research projects in HCI4D. They also found that these projects are frequently aimed at addressing longstanding socio-economic problems, primarily related to education and health [15]. Improving mobile internet access is another problem commonly investigated in the field. A significant number of HCI4D (e.g., [29]) and industry projects (e.g., Alphabet Inc.'s Project Loon and Facebook's Internet.org) focus on this problem.

Many HCI4D interventions have focused on education, particularly of children. Kumar et al. designed a mobile game called *Marakothi*, intended to improve English literacy among rural Indian schoolchildren [77]. Similarly, Madaio et al. developed *Allô Alphabet*, to provide rural Ivorian children with educational content about French speech sounds [54], and Poon et al. developed an SMS-based quiz tool to help Cameroonian students prepare for exams [71,72]. These studies generally report positive results after the deployment and evaluation of the intervention (e.g., increased learning [46]; improved exam pass rates [72]), as well as broader implications about using mobile phones to support learning (e.g., accounting for multilingualism [53]; the significance of trust [71]).

Health is another prominent area of design focus in HCI4D. Many of these projects focus on developing mobile services to solve problems, by providing various populations with pertinent health information. Early design efforts in the field include Ramachandran et al.'s deployment of short videos on mobile phones, intended to persuade expectant mothers in rural India to adopt better health practices [73]. This work inspired other researchers to use mobile phones to distribute video content aimed at addressing maternal health elsewhere in India [21,47] and in Lesotho [60]. Other projects rely on different mediums to provide women with information. Perrier et al. designed a "hybrid-computer-human SMS system", that enabled pregnant women in Nairobi, Kenya to communicate with nurses [68]. Such projects frequently involve community health workers (CHWs)[65]. DeRenzi et al. designed "ASTA", a self-tracking mobile application to support CHWs by providing them with data-driven feedback about their work [16]. As with the aforementioned education-focused projects, these studies typically note short-term positive impacts that accompany the introduction of a new mobile system.

To varying degrees, these projects focus on designing novel mobile phone apps to solve problems. Here I present another way to consider design in HCI4D: namely, one that results in design concepts which are *not* intended to address health and education problems. Instead, I designed nine speculative proposals which draw attention to other topics and technologies to consider in HCI4D.

2.2 Critiques of Design in HCI4D

My use of speculative design is also a response to scholars' critiques of design approaches used in HCI4D, especially human-centered methods (co-design, participatory design, and design workshops). These critiques are generally motivated by "postcolonial computing" discourse, especially its emphasis on understanding how design research and practice are "culturally located and power laden" [37]. Irani writes that human-centered approaches are legitimized in HCI4D because they are perceived as providing "poor people" with a "voice" in the design process and, more broadly, their future [38]. However, as multiple design scholars have observed [1,83], the marketable ideas are more likely to benefit Western-based designers, scholars, and technology companies, rather than the marginalized communities who created them. Harrington et al. also

critique the outcomes of participatory and co-design approaches, especially design workshops—a method used in HCI4D to develop novel mobile apps [7,59]. They contend that this approach prioritizes developing novel technological solutions to perceived problems, over deeply understanding the communities under study [33]. They conclude that there is an opportunity for HCI4D, and HCI more broadly, to expand conversations about what other practices and outcomes are considered good design.

Other notable critiques of design in HCI4D, have emerged from Sultana et al.'s study of low-income rural Bangladeshi women's technology use. Their findings draw attention to the practical limitations of traditional design processes; that is, although HCI and HCI4D design efforts are aimed at empowering rural women, they rarely achieve this [78]. They conclude that designers should adopt alternatives to viewing "the world through the lens of finding problems that we can solve." I agree with these scholars and build upon their work by presenting speculative concepts as design outcomes of my fieldwork. Further, the speculative concepts presented here are not to be made commercially available; nor are they intended to solve problems. This research demonstrates how design can be used in HCI4D to support the critique of technology, rather than to guide the development of novel mobile apps and services.

2.3 Speculative Design

Speculative approaches to design are related to design fiction, Afrofuturism and to other design practices that pose difficult questions about the relationship between design, technology, and culture [24,86,88]. Speculative design is generally traced to Dunne and Raby's coinage of the term "critical design." They describe critical design as emerging from their "concerns with the uncritical drive behind technological progress, when technology is always assumed to be good and capable of solving any problem." They define critical design as using "speculative design proposals to challenge narrow assumptions, preconceptions, and givens about the role products play in everyday life" [20]. The approach contrasts the largely uncritical approaches to design used in industry and academia; it also draws attention to other ways that design can contribute to knowledge about technology.

Speculative design enables designers use their skills to create artifacts that are not intended to be mass-produced (as is the traditional role of a designer). Instead, the approach lets designers use design to: provoke discussions about what the future might look like; consider the consequences of new technologies; reimagine contemporary technologies; explore new research areas; and think differently about how technology is used [5,51]. It is also an approach that relies heavily on the designer's accumulated knowledge and practical skills: that is, their individual "design judgement", rather than users' input or involvement [28]. It is generally accepted that speculative design concepts have these criteria: they incorporate contemporary technologies [5]; rely on satire, irony, and absurdism to communicate ideas [24]; and demonstrate an understanding of the interrelationship between information resources, technological infrastructures, and market forces [51]. Further, although all speculative concepts should seem real and be technically feasible, strictly speaking they are *not* intended to developed [5,26]. More broadly, speculative approaches deemphasize using design to solve problems, and demonstrate how design can be used to raise critical questions about design itself [24].

2.4 Speculative Design in HCI and Elsewhere

The HCI community's interest in speculative design emerged more than a decade ago and continues to grow. Within the community, speculative design efforts embody many of the

aforementioned characteristics, and its use has manifested in various ways. Some of these uses include discussions about the benefits of integrating speculative design approaches into HCI research [8,88]. Scholars have also explored how speculative approaches can raise questions about significant issues in HCI (e.g., infrastructures [89] and unequal power relations in international research [75]).

Other HCI efforts—that are similar to this paper—comment on the approach, and also provide collections of speculative design concepts (typically illustrations and/or prototypes). Gaver and Martin used the term "speculative design" to describe a collection of conceptual design proposals (e.g., The Worry Stone, Dream Communicator, and The (De)Tour Guide) that explored what future "information appliances" might look like [26]. Other scholars have developed speculative concepts to ask questions about the implications of future technologies. Taylor et al. present a collection of design proposals that were inspired by their study of "pottering" in British homes. Concepts such as the "growth detector"—a surveillance system that monitors shrub growth—are intended to raise questions about the ways technology interferes with serendipitous and unplanned activities [79]. Lawson et al. use a series of speculative concepts designed to monitor pets' behaviors to prompt questions about the "quantification of everything" [50]. Fox et al. also use speculative design to draw attention to the tendency to design technologies that measure and monitor aspects of daily life. They present a fictional product catalog that includes speculative menstrual tracking technologies [23]. These concepts are also intended to prompt discussions about data privacy. Wong et al. similarly use a speculative approach to explore issues related to technology development, privacy, and surveillance [90].

These projects demonstrate how speculative design can challenge status quo approaches to design; especially, by using design to raise questions about the implications of present and future technologies. However, important critiques of speculative design have accompanied its increased use. These critiques focus on the history of the practice, and how it influences the topics addressed—and presentation—of speculative work. Luiza Prado de O. Martins observes that speculative design has largely emerged from the "safe confines of developed, European countries" and that it is primarily practiced by a "white, male, middle class crowd" [55]. Elsewhere Prado de O. Martins and Oliveira add that speculative concepts are "devoid of people of color, who rarely (if ever) make an appearance in the (…) aseptic world imagined by these designers-researchers" [56]. Other scholars note the centering of Western people and settings in speculative design leads to future scenarios that rarely—if ever—account for how social class, cultural difference, gender, and race can influence alternative design visions [22,66,80].

In response to these critiques, there are a growing number of projects within, and outside of the HCI community, that center alternative perspectives in them. Harrington and Dillahunt ask who is allowed to speculate about the future, and whose visions are represented in design concepts [34]. In collaboration with a group of predominantly Black women they present a series of speculative concepts that, for example, depict a future where they have access to rights and benefits that they have been denied (e.g., desegregated cities) and where technologies support issues that are important to them (e.g., magnetic rings that fix environmental problems). Kotut and McCrickard, also ask questions about whose stories are (and are not) told in future speculative scenarios. They present a fictional research project that imagines well-intentioned HCI researchers—who are based at a Western university—travelling to a Kenyan community to help its members solve a crop loss problem [44]. Khan et al.'s research is another example of using a speculative approach in a LMIC; they present concepts that reimagine how technology supports education in Pakistan [40]. They emphasize that speculative approaches offer a "different framing" to the largely unsuccessful attempts to use technology to solve educational problems in

the country. These scholars conclude that speculative approaches to design, especially those that draw from marginalized populations' experiences, can lead to more inclusive and equitable design outcomes. I strongly agree with these scholars and extend their efforts to diversify perspectives in speculative design.

Lastly, this project builds upon important design projects from outside of HCI; these include speculative proposals created by designers who are from and based in LMICs. These projects include Butoliya's "homemade gas mask" made from discarded plastic water bottles. Her work demonstrates how jugaad (e.g., improvised solutions using scarce resources) can raise questions about future technology visions [10,11]. Other examples include AfriDesignX[1]—a network of African technologists and scholars—whose website showcases some speculative design projects [49]. Examples include Mukendi's "Yllux Electricity Meter"—a prototype of an electricity generator made from found materials.[2] Also using found materials, Kenyan designer Cyrus Kabira makes eyewear; his speculative designs are intended to reject notions that Africa is a "dumping ground" for other countries' waste [64]. As with these projects, my speculative concepts are grounded in present-day realities. This approach is aligned with Ansari's observations about speculative design; in particular, using the approach to investigate the "critical problems of now", rather than "dystopic futures", which are more frequently considered in speculative projects [3]. In his critique of speculative design, Ansari also asks that designers acknowledge how their positionality affects their work; I provide this information in the next section.

3 DESIGNER'S POSITIONALITY

My identity—a white, woman, middle-aged, middle-class university professor, who was born and socialized in the US—informed my design judgment and, subsequently, the concepts presented here. My design training is also relevant to this project because it equipped me with the skills to find inspiration in data, and then not only conceptualize ideas, but also develop and visually communicate them. Significantly, my +10 years of studying technology use in Kenya and elsewhere in Africa also informed the concepts presented here. Over the course of this fieldwork, I have tried to decenter my experiences, to understand technology use in Kenya; however, I acknowledge that this understanding is partial and incomplete.

This particular project was motivated by my doubts about using design to solve problems via developing mobile apps, as well as by a sense that design can play an important role in HCI4D—just not how it has traditionally been used. Notably, this work was informed by observations made over the course of my research, as well as by productive conversations with interlocutors who have witnessed first-hand the increased access to mobile phones in Kenya. These experiences have made me skeptical of mobile apps. There are multiple reasons for this skepticism, of which the most important is that after conducting hundreds of interviews with low-income mobile phone users in rural areas in multiple African countries, I have *never* met anyone who actually relies on a mobile app to access health information or improve their literacy.

4 RESEARCH CONTEXT/PRIOR RESEARCH

Here I provide additional information about the context and key observations from my prior research that inspired the concepts presented here. Kenya exemplifies the remarkable and swift mobile phone revolution experienced in many LMICs, making it a rich site of both information

[1] AfriDesignX: http://afridesignx.com/
[2] Yllux Electricity Meter: http://afridesignx.com/portfolio/items/yllux/

and design inspiration. Recent reports suggest that all Kenyan households own a mobile phone (typically a feature phone); this ownership rate is higher than most other LMICs [41]. Widespread handset ownership and local innovations, notably Safaricom's (Kenya's dominant mobile network operator) popular M-Pesa mobile money transfer system, play a prominent role in Nairobi's emergence as a leader in Africa's technology scene. The fervor surrounding technology and its potential to solve problems is present in Kenya's capital, at places like iHub—the city's popular tech innovation center—and on the campuses of the growing number of technology companies in Nairobi (e.g., Microsoft's Africa Research Institute (MARI)). However, my concepts were mostly inspired by fieldwork conducted at sites located about an 8-hour bus ride away from Nairobi. These sites are in Kenya's Western region, including villages located in Bungoma and Homa Bay Counties; these areas have a predominantly rural character.

Rural areas experience development differently from urban ones: for example, they typically lack access to running water, electricity, and paved roads. Most households in these areas rely on small-scale farming as a source of income. Mobile phones and the internet are present here and have been since at least 2011, when I first visited Western Kenya. Over this time, I have observed more and more people using smartphones. Internet connections have also become faster, and access more widespread. Although domestic internet access is becoming more common in Kenya's urban areas, it is still uncommon in rural households. In these areas smartphones are increasingly used to access the internet, as are cyber cafés, where the internet can be accessed via a desktop computer; a fee is charged for using the computer (typically a per-minute rate). Findings from my interviews with, and observations of, farmers, rural householders, and mobile phone repairers, draw attention to multiple barriers which limit mobile phone and internet use in Western Kenya. These barriers (including cost of airtime/credit[3], challenges with charging faulty and low-quality batteries, language, and literacy) have been observed by other scholars studying mobile phone use in Kenya [45,48,61] and have persisted over the course of my fieldwork.

Other findings from my research demonstrate that women tend to experience access to technology differently than men [13,95,99,104]. While women's access to mobile phones has grown, traditional gender roles have been slow to change, and—especially in rural areas—most women remain subordinate to men, socially, economically, and politically. These findings also informed and inspired my speculative concepts. More information about my prior studies, including data collection, analysis, and the findings which emerged from them, have been previously published [91-105]. Rather than looking for consistent themes, explaining phenomena, or constructing qualitatively derived theory (as I had done in these prior studies), I re-engaged with this data to find inspiration, and to stimulate my imagination.

5 DEVELOPING MY SPECULATIVE CONCEPTS

The concepts presented here were inspired by the findings from my fieldwork; however, I created them between January and May 2021. My approach was similar to the "artist-designer" one described in prior HCI research [27]. This is a highly subjective process, largely informed by the designer's judgment [88]. More specifically, I reused data from my fieldwork; that is, I re-listened to digital recordings of interviews and focus groups and re-read transcripts. I also drew inspiration from my fieldnotes, and observations at various spaces in Kenya, including people's homes, mobile phone repair shops, and retail stores. Over the course of my fieldwork, I have also

[3] The vast majority of mobile phone in Kenya are prepaid; that is, credit or airtime is purchased before use. As calls and texts are made and the internet is accessed—data is used—and deductions are made against the prepaid balance amount until no funds remain (at which point access is cut off).

taken thousands of photographs. Engaging with these also informed my design process; ten of these photographs are included in this paper (Figures 1-6). In addition to my prior research, other sources influenced my ideas: talking and listening to Kenyans, reading stories (in the popular press and in Kenyan newspapers), looking at commercially available products, observing conversations on Kenyan social media (Twitter and Facebook), and reviewing prior research.

I used graphic design software and collage techniques to make the illustrations; an approach others have used to create speculative concepts [27]. Specifically, I searched my collection of photographs, found some stock images, and then modified these pictures using Adobe Photoshop. Some concepts took longer to develop than others. I discarded some and revised all of them. I relied on my design judgement to determine when the images were complete—that is, when I thought they were interesting enough to elicit engagement, but also ambiguous enough to encourage questioning by people viewing them.

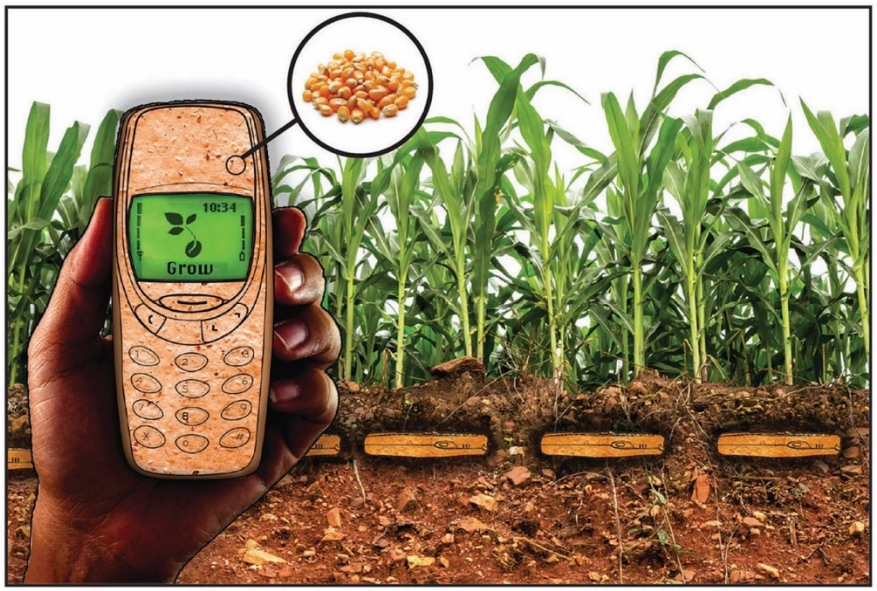
6 SPECULATIVE DESIGN CONCEPTS

Here I present nine speculative design concepts, and a description of what inspired each of them. Most of these descriptions also include the question(s) that the idea is intended to prompt. For many concepts, I also include the photograph(s) that inspired them. These photographs also provide readers with information about the context under study. In line with a speculative approach, these concepts are not aimed at solving problems. Instead, they are intended to motivate discussions about design and mobile phones within the HCI and HCI4D communities. These concepts also respond to the aforementioned criteria for speculative design. Although they are all technically feasible, my intentions are not to build, evaluate, or commercialize these concepts.

The concepts are diverse. However, they are all loosely guided by wanting to critique the mobile phone. Some concepts were motivated by a desire to rethink these devices' form factors. Others are intended to raise questions about what activities mobile phone apps should (and should not) support. The last group of concepts draw attention to other technology interventions (e.g., calendars and women's only cyber cafés). It should be emphasized that my goal here is to demonstrate how speculative design can be used in HCI4D, and *not* to advocate for the development or implementation of these ideas. Further, these concepts are intentionally incomplete (e.g., they lack details about how they would be implemented), because unfinished illustrations/concepts are widely understood as useful for eliciting critique [12].

6.1 Reimagining Mobile Phones' Form Factors

The first concept depicts a "Biodegradable Mobile Phone" (Concept 1). This speculative proposal is intended to raise questions about an overlooked aspect of the mobile phone revolution in LMICs; that is, how they contribute to the serious problem of electronic waste. Observations at multiple mobile phone repair shops, as well as conversations with "mafundi wa simu", or mobile phone repairers, who worked at them inspired this concept. At these shops, I consistently saw piles—and more piles—of discarded and broken mobile phone parts, gathering dust on the floors of shops across rural Kenya [97] (Figure 1). Frequently, these useless parts came from poor quality phones that are referred to as "China-makes"—a colloquial term denoting inexpensive, counterfeit, and/or substandard handsets (Figure 1) [101]. The quality of these phones varies, but the least expensive (that cost around $12-15), generally last just six months before they are



Concept 1: Biodegradable Mobile Phone

Figure 1: Inspirational Photographs

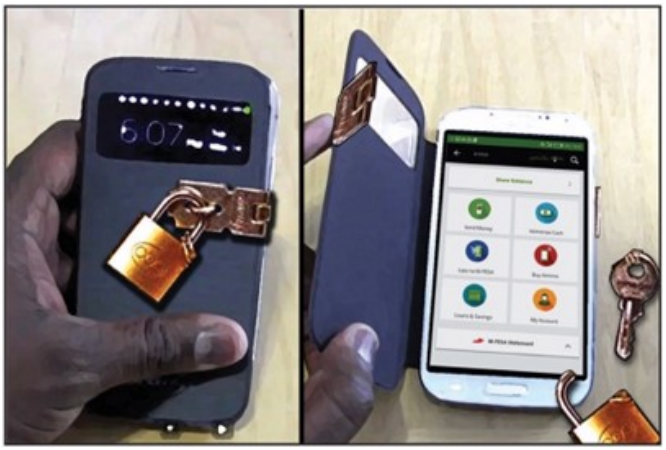
"spoiled" and become unusable, as well as irreparable. In addition to their poor quality, mobile phone repairers described other factors that contributed to high turnover of these phones, including customers dropping them. In rural Kenya, surfaces tend to be concrete or hardened dirt, and phone breakage occurs when the devices are dropped.

Here, I imagine a phone that, similar to a China-make, is *not* designed to last for a long period of time. However, rather than ending up as unusable junk, this phone's housing is biodegradable and can be planted. Imagining a mobile phone that is designed to decompose is not purely speculative; indeed, Huang and Truong developed similar "seed ideas" aimed at supporting the design or sustainable mobile devices for Western consumers [36]. Electronic companies have also produced a phone made of bioplastics, a renewable and easily degradable material [32]. Instead of bioplastic, **Concept 1** shows a device with a housing made from thick "plantable paper." This paper is made of residual organic waste and is embedded with seeds that will germinate and grow into plants [14]. In this concept, the paper has been molded into a mobile phones' housing, and maize seeds are embedded into it. After six months of use, the device's internal components

(circuit boards, liquid crystal display, speaker, battery, etc.) can be removed, then—after soaking the phone's housing in water and burying it in the soil—maize will grow. The discarded housing's components can then be placed inside a new housing made from plantable paper.

The "Lockable Mobile Phone Cover" in **Concept 2** is another attempt at reimagining the mobile phones' form factor. The speculative concept depicts a Samsung Galaxy S7 smartphone. Mobile phone cases and covers have become increasingly common, and a standard smartphone accessory. Unlike the cases I have observed, this speculative one is mounted with a hasp (a hinged metal fastener that includes a metal loop, which can be secured with a padlock). This illustration shows a small, brass, shackle-style padlock that can be used to close the hasp, and a key used to lock the cover in place. Padlocks and hasps are ubiquitous in rural Kenya (Figure 2). Various sizes of these locks are commonplace inside and outside of homes; they are used to prevent access to things. Here, I imagined integrating a padlock into mobile phone cases for similar reasons.

Concept 2 is also intended to raise questions about the usability challenges associated with digital authentication methods. Such methods are essential for protecting data on mobile devices.



Concept 2: Lockable Mobile Phone Cover

Figure 2: Inspirational Photograph

Concept 3: Community Pay Phone

Figure 3: Inspirational Photographs

However, over the course of my fieldwork, I have repeatedly observed people, especially older women, struggle to input the four- or six-digit Personal Identifier Number (PIN) code typically needed to unlock their devices [91,99,104]. Inputting the code into a mobile device can be confusing; some users do not understand why, that when they enter numbers—asterisks appear on the device's screen. A four-digit PIN must also be entered when withdrawing cash from an M-Pesa account. Just remembering these numbers is another significant challenge, especially for rural users who infrequently use the service [103]. Indeed, psychological theories tell us that users are likely to forget information that they do not use regularly [87]. My interactions with customer service employees working at Safaricom's retail shops provide more evidence for this observation. They have told me that helping phone owners retrieve their PIN numbers (a process that typically means assigning them a new PIN) is the leading reason people come into their stores seeking help. **Concept 2** imagines integrating a locking mechanism into a mobile phone's case. The concept offers an alternative to PIN-based authentication methods and builds upon users' existing practices (i.e., using padlocks).

The next speculative concept shows a "Community Pay Phone" (Concept 3). It is intended to raise questions about the benefits, and drawbacks, in communication practices that have accompanied greater access to mobile phones. I first travelled to Nairobi, Kenya in 2007, when

Concept 4: Domestic Alert System

mobile phone ownership was nowhere near as widespread as it is today. At that time, just a quarter of the country had a mobile cellular subscription [41]. Prior to widespread mobile phone access, there was "Simu Ya Jamii" (Kiswahili for "communal phones") (Figure, 3).

Mobile phones were too expensive for an ordinary person to afford, so many relied on these devices to make calls [31]. These were pay phones, typically housed in structures that were effectively phone booths. As mobile phone ownership became more widespread, it became less common to see Simu Ya Jamii, and they eventually disappeared. Here, I imagine reintroducing communal phones into rural communities. This illustration depicts a device that is attached to a building, so that it is easily accessible.

This concept was inspired by an appreciation for the benefits of non-mobile ("fixed-line") devices. Mobility, especially spatial mobility (e.g., moving across physically different locations) is a significant benefit of having a mobile phone [39]. However, travelling with a device also increases the likelihood of it being stolen, or dropped and broken [95].

Further, and unlike fixed-line devices, mobile devices have batteries that need to be charged. This can be a significant challenge in LMICs, where affordable and reliable electricity access cannot be taken for granted, especially by rural people [102].

Some rural users charge their phones' batteries at church, or at their places of employment, while others pay to use charging kiosks in the local marketplace. Other than greater access to household-level pay-as-you-go solar products, little has changed in regard to people's efforts to keep batteries charged (Figure 3). Solar products, such as M-Kopa, seem to be an effective way for some to charge mobile phone batteries; this explains why **Concept 3** features a solar panel.

6.2 Reimagining Use

The next series of speculative concepts were inspired by a desire to reimagine what activities mobile phone apps should—and should not—support. In particular, these concepts are intended

Concept 5: Daily Nation on a USB Flash Drive

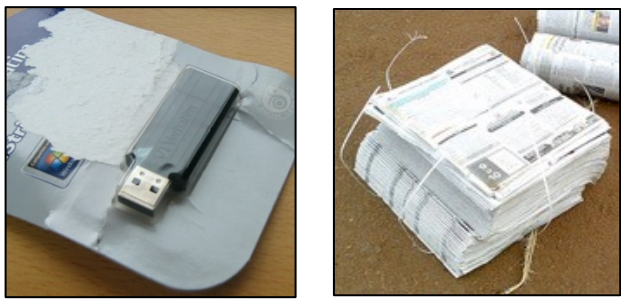


Figure 4: Inspirational Photographs

to prompt questions about relying on apps to deliver people information and/or to replace current communication practices. These concepts also draw attention to persistent problems (i.e., poor infrastructure) and existing practices in rural Kenya (e.g., related to accessing news information and taking photographs).

In rural Kenya, mobile phones are valued because they can be used to contact assistance during an emergency. People's emergencies vary; they can include complications during childbirth, strokes, motorcycle accidents, and natural disasters. However, sometimes when these emergencies happen, mobile phones are useless. As previously mentioned, the device's battery might be dead, or it might lack the credit/airtime needed to make a call [101]. Here, I imagined another system that could be used to call for help during an emergency. **Concept 4** shows a "Domestic Alert System" integrated into a rural home. Access to effective emergency services can save lives (e.g., 9-1-1 emergency service in North America) [42]; however, these services are rare—even nonexistent—in Kenya's rural areas [67,84]. The speculative system's components include a manual pull box. Pulling down the box's handle (on the left side of the house) completes a circuit; this sends a notification to the red rotating warning light and the security siren (both on the top of the house). In many cases rural street addresses do not exist in rural Kenya, and Global Positioning System (GPS) data tends to be unreliable. The siren paired with the light would conceivably make it easier for an ambulance, or another type of assistance, to locate a house

Concept 6: Facebook Camera Man

during an emergency event. As with the previous speculative concept, this one is also solar-powered (see panels on home's roof).

The next speculative "*Daily Nation* on a USB Flash Drive" (Concept 5) also draws attention to other technology possibilities. Here, I do not assume that news will be accessed via a mobile app or service, as has become the norm in some countries [85]. Inspiration for this idea can be traced to my initial fieldwork trip in 2007, when domestic internet access and smartphones were both virtually non-existent in Nairobi. To navigate limited internet access, people relied on USB sticks to exchange and store information (Figure 4) [94]. When browsing the internet at a cyber café, people would access a website, save it to a USB-flash drive, and then later view this content on an offline computer. The concept shows a vendor selling the *Daily Nation*; this is one of the oldest and most widely read newspapers in Kenya. Men wearing navy blue shirts emblazoned with the newspaper's logo and standing next to bundles of newspapers are a common feature on rural towns' street corners (Figure 5). The vendor in this speculative concept is selling both the paper version of the *Daily Nation*, and a USB-flash drive with the paper's contents saved on it. Speculative design concepts can prompt questions about the interrelationship between information resources, technological infrastructures, and market forces [51]; I do this in **Concept 5**. In particular, this concept demonstrates how selling newspapers provides some rural Kenyans with a livelihood; this would disappear if news articles were accessed via a smartphone application.

Similar to the previous concept, a "Facebook Camera Man" (Concept 6) was also inspired by the interrelationship between information sources, technological infrastructures, and people's livelihood strategies. Findings from my study of photography practices in rural Kenyan households suggest that similarities exist between those I observed, and those reported in prior HCI/CSCW research investigating domestic photography (e.g., the significance of printed photos in people's households and storing images in photo albums) [98]. However, other findings from this research differ from established ones in the HCI/CSCW literatures: notably, that greater

access to smartphones results in people taking significantly more snapshots and sharing them online [35]. Although access to smartphones has increased and most rural Kenyans have a mobile device with a camera, few use them to take pictures, and even fewer share images on social media. Various reasons explain this finding, including limited storage space on people's phones. The costs associated with using the mobile internet also likely limit sharing of digital photographs on social media sites.

Concept 7: Mobile Digital Assistant

Figure 5: Inspirational Photograph

Concept 7 depicts a "Mobile Digital Assistant"; it is also intended to encourage discussions about how technologies can support existing practices, especially Kenyans' knowledge and use of multiple languages. Kenya is a multilingual country. Swahili and English are both official languages. In addition to these languages, most Kenyans speak one of the country's vernacular languages as their mother tongue [30]. Prior HCI research details the cultural and linguistic biases towards English that are embedded in the community's research, as well as in the technologies researchers develop [2]. Most technology, including mobile voice assistants, are built with a mono-lingual—or, more specifically, an English-speaking—user in mind. These technologies use voice recognition, natural language processing, and speech synthesis to, for example, answer people's questions through phones (e.g., Apple's Siri). There are commercial efforts to design these systems for Kenyan users. Safaricom developed a voice biometric system called "Jitambulishe" (Swahili for "introduce yourself") that supports Swahili and English (Figure 5). However, over 30+ languages are spoken in Kenya, and to the best of my knowledge, Jitambulishe—like other commercially-available systems (e.g., Google Assistant)—does not support them. Code-switching (alternating between two or more languages during a conversation) is not supported either, despite being common in Kenya.

Concept 8: Informational Calendars

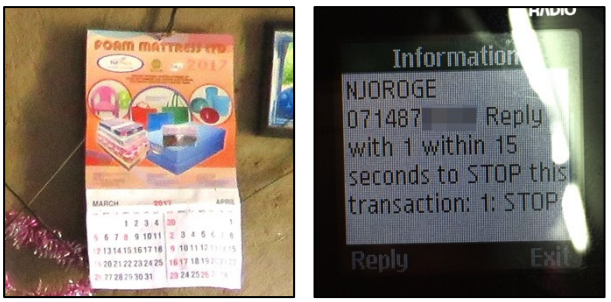


Figure 6: Inspirational Photographs

6.3 Alternative Technologies

The final series of concepts were inspired by issues related to mobile phone use (e.g., knowing how to use them). Similar to the previous concepts, findings from prior research inspired these ideas; they also draw attention to alternative technologies and interventions for designers to consider. "Informational Calendars" (Concept 8) was inspired by the paper calendars in homes' sitting rooms. There are typically multiple calendars from various years hanging on these rooms' walls. The calendars feature local imagery and/or advertisements (e.g., from banks or seed companies) (Figure 6). People like this imagery, which is one reason they keep the calendars even after they have expired [100].

As previously mentioned, in HCI4D mobile phones are widely perceived as effective platforms for communicating important information to people (e.g., via video or SMS). This concept was inspired by considering alternative ways to deliver information. I imagined using the calendars to respond to "device literacy"; that is, people's abilities to use mobile phones for purposes other

Concept 9: Google-sponsored Ladies Only Cyber café

than just making and receiving voice calls. Findings from my prior research detail the challenges some rural users encounter when attempting to use their phones to, for example, send an SMS message [92,105]. In this speculative concept, the calendars display step-by-step instructions on how to do this.

The larger calendar on the right (in Concept 8) features information about another important mobile phone operation—how to stop, or reverse, an M-Pesa transfer. I noticed this feature when making an M-Pesa transaction during fieldwork conducted in 2016: up until then I had not been given the option to "STOP" a transaction to the person receiving it (Figure 6). I immediately thought this was a positive development, because I had heard countless stories of people entering the wrong phone number into their mobile phones when sending a payment. On Kenyan Twitter, I have also observed people sharing pleas for assistance in reversing payments sent to the wrong number. Other than hoping that the recipient returns the money, senders had few options for getting their money back after making this mistake.

My final speculative concept (Concept 9) depicts a Google-sponsored ladies-only cyber café; multiple findings from prior research inspired this concept, especially the widespread presence of women's savings groups called *chama* (Kiswahili word for group) [13,43]. In rural Kenya, formal banks are scarce, so women rely on these rotational savings-and-credit associations to manage money. Chama groups typically meet in-person every week. In addition to providing women with a relatively safe way to save money, these groups are highly valued because they also provide women with an opportunity to gather, to enjoy one another's company, and to chat. In this concept, I imagine how other spaces can support women's gathering and socializing without the presence of men. Here women can also access the internet on one of the multiple desktop computers in the café— a reminder to designers that mobile internet represents an inferior form of access, for various reasons (speed, memory, and interface functionality, among others) [62]. Finally—and as indicated by the Google logo above the café's entrance—the American multinational technology company financially supports the café by providing women with free access to the space, the computers, and the internet. The company also employs the security guard to protect the café, and the equipment in it, when nobody is using it.

7 DISCUSSION: USING MOBILE PHONES TO SOLVE THE RIGHT PROBLEMS?

Here I return to the argument presented in the introduction. Speculative design has an important role to play in HCI4D, by broadening the field's notion of design beyond traditional intervention efforts that tend to focus on developing novel mobile phone apps to solve problems—especially those related to health and education. The work presented here also responds to scholars' critiques of design in HCI4D, and to their calls to expand conversations about what is considered good design (e.g., [34]). My project also builds upon nascent efforts to use speculative design in the field. I contribute a collection of nine speculative concepts that were primarily inspired by findings from my research examining mobile phone use in Kenya; my design judgment also guided the development of these ideas. Similar to prior projects [11,34], my concepts illustrate what speculative designs—inspired by experiences overlooked in prior projects—look like. They also demonstrate how design can be used for other purposes in HCI4D; that is, none of these concepts are intended to be prototyped, evaluated, or commercialized. Instead, my hope is that these concepts will prompt questions and provoke critical discussions in HCI4D, and in HCI more broadly, about techno solutionism, design, and mobile phone apps.

Throughout this paper I draw from my +10 years of fieldwork experience in Kenya. One observation that looms large is that although health and education are important, these topics do not define most people's day-to-day realities. As other scholars have observed, mobile phones are rarely used to access this so-called "useful information" [4]. Further, the sites where I have conducted fieldwork are not defined by their lack of mobile internet access. However, these topics persist as the ones HCI4D designers and researchers (and their funders) want to solve [15]. Underlying my speculative concepts are questions about whether or not this focus is misguided; that is, are HCI4D design efforts focused on solving the right problems? Here I discuss how the speculative concepts in this paper, and speculative approaches more broadly, can benefit the field. Practical implications of this work include drawing attention to different design issues for the community to consider, especially those related to developing useable devices and interfaces. I also discuss alternative technologies and interventions to consider, and the limitations of using design to solve problems.

7.1 Designing Useable Devices and Interfaces

Speculative approaches are useful for challenging the *status quo* in design [5,20,24]; the concepts in this paper achieve this by drawing attention to other topics for HCI4D researchers to examine. Most design efforts in HCI4D primarily focus on designing mobile phone apps to address longstanding problems in LMICs [15]. Less widely considered is whether or not the handsets' form factors are well-designed and their interfaces useable. Such analysis is important, because even the best designed applications are useless if the devices are not designed for the context in which they are used and if their interfaces do not support their users' capabilities. Improving design and usability have been essential goals in HCI, as well as significant topics of study in the field since its inception. However, there are few design efforts aimed at improving mobile phone design for users in HCI4D ([19,58] are exceptions).

Some of my speculative concepts demonstrate how existing handsets' form factors are poorly designed for rural Kenya, where deficient infrastructure, harsh environmental conditions, and persistent poverty affect mobile phone use. **Concept 1** (Biodegradable Mobile Phone) was inspired by an outcome of poor design: the glut of broken and irreparable phones that I observed in repair shops [97]. Other concepts (Solar-Powered Community Pay Phone) are intended to raise questions about a key assumption underlying mobile phone design, notably, whether or not

mobile is always preferable? **Concept 4** (Solar-Powered Domestic Alert System) demonstrates the consequences that can accompany relying on poorly designed mobile phones. That is, they might not work when they are most needed, because they are broken, or their batteries are dead. Some of these design issues have been considered in prior HCI research. Huang and Truong imagined what sustainable mobile phones might look like [36]. Pierce and Paulos developed prototype devices that demonstrate how technology can support mobile phone charging (using hand-cranked devices, harvesting body movements, and solar power) [70]. To date few HCI4D/HCI researchers have conducted similar studies in LMICs, where these topics—especially those related to maintaining a charged mobile phone battery—are urgent and continue to significantly hinder mobile phone use.

There are other opportunities for HCI4D researchers to study topics which have been of longstanding interest in HCI. These include investigating the interface navigation challenges LMICs users experience. More than +20 years ago—when feature phones were the dominant platform in the U.S. and in other Western countries—studies investigating how to improve people's interactions with these devices' 12-button keypads (e.g., improving text-entry) were widespread in HCI [52]. Other studies have focused on developing intuitive and secure digital authentication methods for users in Western countries [63]. However, there is no similar focus on understanding the interface navigation and security challenges faced by rural populations in Kenya (and, more broadly, throughout Africa), where feature phones are still widely used. The "Lockable Mobile Phone Cover" (Concept 2) and "Informational Calendars" (Concept 8) are intended to draw attention to these persistent usability challenges, especially those associated with digital authentication methods and sending SMS. Further, and as also demonstrated in **Concept 8**, my observations suggest that interventions which address these more immediate and prosaic problems (e.g., reversing M-Pesa payments) may be more beneficial than interventions aimed at addressing longer-term and consequential problems (e.g., improving health outcomes).

7.2 Appreciating Different Technologies and Interventions

Underlying some prior HCI4D efforts are assumptions that LMICs will follow technological trajectories which resemble those elsewhere (e.g., in the US), where using mobile phone apps to support activities is perceived as better and more desirable. Speculative concepts—like those presented here—draw attention to unexpected technologies, and to different interventions which do not recreate this technology trajectory. Within HCI4D, mobile phones are perceived as effective platforms for communicating important information to people, and various services have been designed to do this (e.g., [17,53,68,72]). The *Daily Nation* on a USB (Concept 5) and Informational Calendars (Concept 8) demonstrate different ways to provide rural householders with information—calendars and USB flash drives. These technologies have not been considered in prior HCI4D studies, even though people already use them to access and exchange information. Along with **Concept 5**, **Concept 6** (Facebook-sponsored Camera Man) is meant to prompt questions about whether mobile phones are the right technological intervention. These concepts demonstrate the "human infrastructure" underlying communication practices in rural Kenya [74], and which is not always considered when researchers design mobile phone apps. These concepts, as with **Concept 9** (Google-sponsored Ladies-Only Cyber Café) also draw attention to radically different interventions. These speculative concepts amplify—rather than replace—existing practices (e.g., by providing cameramen with sustainable employment opportunities and financially supporting women-only cyber cafés). These speculative concepts are a departure from the interventions that Alphabet Inc. and Facebook Inc. have developed for populations in rural

Kenya, and elsewhere in Africa. These efforts focus on using technology (e.g., giant balloons) to provide mobile internet access. These companies state that they are motivated by the desire to reduce poverty and increase economic and societal inclusion, and to more broadly "connect the unconnected" [25]. However, most of these projects (e.g., Alphabet Inc.'s Project Loon [76]) have failed. If economic development is the actual goal, these companies might consider other interventions.

Speculative approaches are intended to challenge the *status quo* in design practice. My concepts do this by drawing attention to other technologies and interventions for designers to consider. My hope is that, by broadening the community's design focus beyond mobile phones, I will encourage critical discussions about the greater effects of mobile phone apps on people's livelihoods, as well as about who actually benefits from US-based technology companies' presence in Africa.

7.3 Recognizing Unsolvable Problems

Speculative approaches to design offer an alternative to using design to solve problems; as such, the approach can support new narratives about technology use in Africa and can even draw attention to unsolvable problems. Mobile phones may not impact health and education in LMICs if favorable contextual factors concerning community and infrastructure are not present. The "Domestic Alert System" (Concept 4) demonstrates this challenge; that is, providing marginalized users with health information is not actually useful if the services and infrastructure needed to access medical care do not exist. Likewise with education: well-intentioned efforts to use mobile phones to improve children's literacy (i.e., [54]) may have short-term benefits, but they do not account for the longer term challenges students experience—in particular, finding jobs after they graduate. Youth unemployment remains a significant problem in Kenya, and in other LMICs [6]. This is one reason **Concepts 5, 6,** and **9** include references to providing people with employment opportunities.

The "Mobile Digital Assistant" (Concept 7) is a reminder that technology cannot—and should not—be used solve all problems. In addition to drawing attention to the linguistic biases that persist in design, this concept is intended to raise questions about the limitations of machine translation. African languages are numerous and complex; I speculate that even though a system similar to the one in **Concept 7** could be developed, it would never effectively support the complexities of language use in multilingual societies, especially code-switching. Building a system that could successfully do this exceeds the bounds of current machine translation and artificial intelligence techniques; it is a problem that cannot be solved. My hope is that this, and other speculative concepts, will demonstrate how Africa is not a place full of problems; instead, it is a place that reveals the limitations of what HCI design can do.

8 LIMITATIONS, FUTURE WORK AND CONCLUSION

Speculative design methods have their limitations (as do all design methods). I begin to address some of these limitations and explore previous critiques of the centering of Western experiences and people in speculative concepts [66,80]. My concepts work towards centering observations which are based on my long-term engagement with communities in rural Kenya. Their aesthetic also differs from the aseptic illustrations seen in prior HCI publications (e.g., [18,26,90]). Instead, my illustrations account for skin tones and settings mostly missing from prior speculative design efforts. However, they are still based on my design judgement, which is undeniably shaped by my privileged position as a white, US-based HCI professor. The concepts in this paper are also

primarily informed and inspired by research conducted at sites in Western Kenya. If I had conducted research in a different region, or in an urban area, my concepts would reflect the conditions observed in those contexts (e.g., infrastructural and linguistic). My hope is that this work will inspire other designers to use speculative and related practices (e.g., design fiction and Afrofuturism) in their work. The HCI/CSCW and HCI4D communities can only benefit from more examples of speculative design, especially those designed by people whose perspectives and experiences differ from mine.

Another limitation is that it is difficult to know if my speculative design concepts are done well; indeed, this is an established critique of the method [9]. How do you assess whether or not these concepts actually raise the questions, and prompt the discussions about mobile phones, that I intend? Publishing this research would provide some indication of its quality. Presenting my concepts at conferences would also give me a forum for sharing my ideas and discussing them with other researchers and designers. Such discussions—or critiques—can be instrumental in learning whether these concepts are too absurd to take seriously or saddled with the same problems that I critique. Prompting these discussions is a goal of speculative design, and another reason that greater use of the approach in HCI4D, and HCI more broadly, can be beneficial. Lastly, there is also value is sharing and discussing these concepts with the people who experiences inspired them. As I have previously done [96], I will develop a "design workbook" comprised of these concepts. The design workbook method supports conversations between designers and the people they are designing for [27]. I will integrate the workbook into my future fieldwork.

In this paper, I synthesized findings from +10 years of research investigating mobile phone use in rural Kenya, with other sources, and developed nine speculative design proposals. I demonstrate how design can be used for other purposes in HCI4D; that is, rather than using my design skills to develop novel mobile phone apps aimed at solving socioeconomic problems in LMICs, I reimagined the mobile phone, and more broadly how to use design in HCI4D. This project contributes an example of how, instead of being used for solving problems, design can be used to critique efforts to design mobile apps aimed at addressing longstanding challenges in LMICs. This work also expands the topics for consideration in design-oriented HCI4D studies beyond the relatively narrow focus of health, education, and internet access, and explores situations in which solutions would actually find users. Ultimately, HCI4D needs less attempts at problem-solving, and more speculation.

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