

“If God Gives Me The Chance I Will Design my Own Phone”: Exploring Mobile Phone Repair and Postcolonial Approaches to Design in Rural Kenya

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ABSTRACT

This article focuses on “fundi wa simu,” (mobile phone repairers) in rural Kenya and their ideas about mobile phone design. Our study design and analysis were guided by ideas from postcolonial computing; we use our qualitative findings, and outcomes from a drawing exercise, to show existing flaws in mobile phone design, and to explore how repairers’ knowledge can lead to handsets that are better suited for rural Kenyans. Our argument is that, by engaging with repairers “[on] their own terms”, technologists can expand conversations around designing for the ‘developing’ world that go beyond building novel smartphone applications. In fact, such conversations can also include reimagining mobile phones, and supporting local repairers’ efforts to manufacture them. We conclude by discussing ways to improve upon postcolonial approaches to technology design.

Author Keywords

Mobile phones; Kenya; HCI; ICTD; repair; postcolonial computing; design

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

If God gives me the chance I will design my own phone.

“Esther,”¹ a mobile phone repairwoman working in Malaba, Kenya, told us she wanted to design a new mobile phone for her customers. She recognizes—as is

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confirmed by prior research [37,38]—that current handsets are poorly designed for rural Kenya, where poor infrastructures, harsh environmental conditions, and persistent poverty continue to affect mobile phone use and maintenance [10].

In this paper we use ideas from postcolonial computing [12,20,26] to investigate how local knowledge—or what one learns from living and working in a particular place [8]—can contribute to the design of mobile phones that are suitable for rural Kenya. Recent interest in repair cultures and critiques of needs-driven approaches to design also guided our analysis [19,21,22,27,33]. We contribute to this research by investigating repairers in rural areas, and by approaching them as innovative designers who are able to inform the design of mobile phones for local and global consumers.

To set the stage for our inquiry, we review research studies examining handset repair in developing countries and mobile phone user studies in sub-Saharan Africa. We then introduce postcolonial computing, and describe how it influenced our decision to use qualitative and participatory research methods. Next, we present our findings, demonstrate the technological failures which rural Kenyans encountered, and show how engaging with repairers “[on] their own term” can produce innovative solutions to local and global problems [12]. These ideas are captured in a collection of sketches made by the repairers. Then we discuss research problems for technologists in ICTD, HCI and ubicomp to solve, such as reimagining mobile phones and supporting local production of them by transforming repair shops into “maker spaces.” We conclude by reflecting on the limitations of our postcolonial approach, and offer ways to improve upon it.

¹ All participants’ real names have been replaced with pseudonyms to protect their anonymity.

RELATED WORK AND THEORETICAL FRAMEWORK

Mobile Phone Maintenance and Repair

Our study builds upon research examining how mobile phone repairers' practices can benefit global technology design. Houston's investigation of mobile phone repairers in Kampala, Uganda, describes their practices, focusing on the transnational connections that tie local repair practices to global networks of production exchange [19]. Jackson *et al.* discovered how repairers in rural Namibia alter or "hack" handsets' software to accommodate SIM card sharing [22]. Building on themes uncovered in this study, Jackson *et al.* then studied mobile phone repair shops in Dhaka, Bangladesh [21]. Their observations of 'bhagaris' revealed other innovative practices, such as the "creative repurposing" of parts, or using components from one handset to fix another. They argue that these workarounds "complete the material cycle of technology by reducing the amount of waste left to burden the environment," and can contribute to Western technology developers' efforts to design sustainable technologies. Also in South Asia, Rangaswamy and Nair observed mobile phone repairers in a Mumbai slum [24]; they concluded that there is an opportunity for technology researchers to view "the poor not as passive consumers but [as] agile agents and innovative producers of ICT products."

We agree with these scholars: repairers are local experts, and capable of producing innovative ICT products for local and global markets. We extend this work by observing repairers who work in rural areas, where the economic, social, and technical infrastructures are vastly different from those found in cities. We further explore this phenomenon by not just studying repairers' practices, but by asking them to imagine new phone designs optimized for their rural customer base.

User Studies in sub-Saharan Africa

These studies of mobile phones from the perspectives of local experts are a departure from earlier user studies in sub-Saharan Africa. Prior research has typically focused on uncovering novice users' needs, and offering design recommendations to accommodate them [16,25,38]. Examples include Gitau *et al.*'s study of how women with limited exposure to technology use the mobile Internet in Cape Town, South Africa [16]. Recommendations resulting from their research include asking software developers to design mobile phone Internet applications that do not require email addresses for authentication. Medhi *et al.* investigated usability barriers which hinder the adoption of mobile money systems [25]. They interviewed individuals from sub-Saharan African countries with "zero experience with personal computers," and suggested that mobile application have more "graphical cues" to accommodate them. In rural Kenya, Wyche and Murphy also focused on individuals who were less knowledgeable about

technology than the 'fundi' (Swahili for expert) in our study [38]. They describe how off-grid rural residents' inability to maintain charged handset batteries limits their use of the devices, and encourage researchers to "develop highly efficient software" that does not quickly deplete mobile phones' power. Guidelines from these studies are useful, and may result in improved computer interfaces for marginalized populations in sub-Saharan Africa; however, this needs-focused approach privileges researchers' perspectives over local experts' knowledge.

Rather than focusing on novice users in order to identify possible problems that technology can solve, as has been common in other studies, we focused on phone repairers in rural Kenya. These repairers are experts on the operation and maintenance of mobile phones and, we speculated, would be able to suggest improvements to their design.

Postcolonial Computing and Ubicomp's "Colonial Impulse"

We also situate this study in the broader context of postcolonial computing [12,20,26]. Irani *et al.* suggested that, once technologists began building computer systems outside of the industrialized world, they needed a different approach to design. When formulating this approach, Irani looked to development and postcolonial studies to remind us that development relates to broader issues of power, authority, and legitimacy—issues which shape the research communities' desire to develop novel ICTs aimed at creating a better quality of life for marginalized populations in developing regions. They propose "postcolonial computing" as an alternative to existing approaches to technology design that overlook the "colonial relationships that may have dissolved," but which still affect how "the global dynamics of power, wealth, economic strength, and political influence shape contemporary cultural encounters."

Dourish and Mainwaring build on this work when describing the "colonial impulse" embedded in ubicomp's research program [12]. Drawing from familiar debates within international development literature, including the shortcomings that result from describing countries as "developed" and "developing" [13], these scholars argue that Western software developers' approaches to technology design suggest that the technologies "people will want tomorrow are ones of which they cannot even conceive, and certainly ones that they cannot create themselves." They add that research aimed at identifying users' needs is disempowering to populations in "developing" regions—a critique also offered by ICTD researchers (e.g., [27,33]). Dourish and Mainwaring offer the ubicomp community strategies for overcoming this impulse, including "engage with people [on] their own terms."

To implement this strategy, we avoided framing repairers as merely ‘users’, and chose methods that gave them greater agency in the research process. We used interviewing and sketching techniques to understand repairers’ context, and to enable them to better envision the mobile phones they wanted. Repairers and their shops were analyzed not in terms of what they lacked or needed, but rather as sites of possibility, creativity, and local expertise.

THE STUDY

Site Selection

Kenya’s mobile phone penetration rate is 75%, a figure significantly higher than the African average of 65% [10]. This greater penetration is attributed to advancements in technical infrastructures, favorable government policies, and an active private sector. Mobile phone prices have also dropped, making them more affordable to the country’s low-income and rural residents. Increased phone ownership supports a growing informal economy that includes people selling airtime, charging mobile phone batteries, and repairing handsets [34].

We conducted our study in the rural parts of the country where nearly 70% of Kenya’s population resides [2]. Our choice of research areas was based on maximizing the diversity of experiences among rural repairers [3]. Sites ranged from agricultural market centers such as Chwele and Webuye, to the bustling border town of Malaba, to the emerging peri-urban areas of Bungoma and Kakamega. We identified repairers using convenience and snowball sampling techniques.

Methods

At the heart of our project was the desire to listen and to learn from voices typically absent from the technology design process; thus, we used qualitative and participatory methods—methods generally considered useful for allowing the voices of marginalized individuals to be foregrounded in the research process [30]. Reflexivity is a central part of a postcolonial stance [28]; in line with this approach, the authors self-disclose their positions. The primary author is a female, 39-year-old, English-speaking, American academic and former professional designer who has been studying mobile phones in rural Kenya since 2011. The second author is also a female, English-speaking, American academic with a background in computer engineering, who—like the first author—is interested in using participatory methods to learn about experiences of understudied communities so that their perspectives are represented in HCI and ubicomp fields.

The other members of the research team were our Kenyan assistants; both are fluent in Swahili and English, have experience moderating interviews, have collaborated with the primary author before, and were

from the areas where we conducted the study. Together we interviewed 34 individuals (33 men and 1 woman)² during a two-week period in June 2014.

A review of related literature and knowledge gained from an author’s prior fieldwork in rural Kenya guided the development of our interview protocol. To refine it, and to help our research assistants become familiar with the questions, we conducted a pilot interview. Our questions focused on repairer’s everyday experiences, their mobile phone knowledge, and the rural context where they lived and worked. Initial questions centered on how long participants had been fixing phones and how they had learned their trade. We then asked repairers to describe the last four phones they encountered, telling us about the customer, handset model repaired, and the cost and time to fix the device.

Although the majority of participants could speak some English (a vestige of British colonialism), they were often more comfortable responding to our questions in their first language. Our assistants moderated interviews and asked questions in the language repairers felt most comfortable speaking. For roughly half, this language was English; for the others, it was Swahili. Interviews were digitally recorded; we also digitally photographed repairers, their tools, and working environments.

Drawing Exercise

At the end of each interview, we asked respondents to draw a new mobile phone. This approach was informed and inspired by Jung and Chipchase’s Nokia-sponsored “Open Studio” project, in which they asked residents of urban ‘shantytowns’ in India, Brazil, and Ghana to draw their “dream phone” [23]. Sketching is also a fast and informal method that supports designers’ visualization process during the earliest stages of the design process—making it ideal for exploring what a mobile phone designed for rural Kenya might look like [7]. Finally, participatory approaches, like the drawing exercise we used, provided repairers with some ability to creatively communicate their own realities. Our tools were decidedly low-tech; we gave repairers an 11x17 piece of white paper, Crayola markers, and these instructions:

Imagine that you have been asked to design a new mobile phone. What would it look like?

Interviews ended after respondents had answered our questions; they were also given the opportunity to ask their own questions about the research. To show

² Efforts were made to locate women repairers for our study; we were only able to identify one. Women remain under-represented in the spheres of engineering and technology (even in affluent countries), and in studies of mobile phone repair.

appreciation, we gave repairers scratch-cards with 100 KES (about \$1) of mobile phone airtime.

Analysis

The research team began collaboratively analyzing data in Kenya to ensure that a sufficient quantity and quality of information was gathered. This initial analysis included writing field notes, and engaging in discussions (and debates) about common themes emerging from our data.

Analysis continued in the U.S., after our assistants completed the transcription and translation of the interviews. This phase of our analysis was guided by an inductive and iterative approach, using open coding [31]. Our process consisted of carefully reading and rereading transcripts, field notes, and prior research from HCI, ICTD, and development studies, while focusing on particular aspects relevant to mobile phone design. Data triangulation occurred between researchers and across media (i.e., digital photographs, transcribed interviews, and participants' sketches) to identify consistent themes in the data.

FINDINGS

Repairers have gained a vast amount of knowledge from fixing mobile phones; this provided them with ample inspiration for the design innovations and novel handsets featured in their drawings. Throughout our analysis, we draw attention to participants' deep understanding of mobile phones and of their rural customers, to how this influenced their design concepts, and to differences between our Kenyan repairers' practices and those reported in prior studies of mobile phone maintenance.

Repairers, their Shops and their Tools

Everyone interviewed was busy fixing mobile phones, as evidenced by the steady flows of customers dropping off broken devices, and stacks of handsets waiting to be fixed on repairers' work desks. Most reported servicing at least 5-12 phones a day (although some periods of the year were busier than others), with one of the most productive repairers telling us he fixed up to 40 phones a day. They fixed models spanning the latest smartphones to low-quality "China-makes." Participants reported working in the repair industry for four to seven years, although 12 told us they had been fixing phones for 10-12 years. These numbers correspond to the time period when mobile phones became increasingly visible in rural Kenya around 2005 [36].

Each repairer earned a living from fixing phones. Their daily incomes ranged from 300 to 500 KES (about \$3-5) a day, with some earning up to 2,000 KES a day—significantly more than the \$1.00 to \$1.50 most rural Kenyans earn in a day [15]. Working as a repairer provided other benefits, including the satisfaction that came with delivering a valuable service to rural

consumers. Tobias, a repairperson working in Chwele, articulated this sentiment:

People, they love their phones and if it becomes spoiled and they do not have money to buy a new one and they want to continue using that one, they need help from phone technicians like me.

Our observations of the shops where participants worked, and of the tools they owned, revealed a range of settings in which people engaged in making "spoiled," or broken, handsets function again. At one extreme, young men such as Willis and Michael worked in small structures typically built out of plywood or corrugated steel placed at a busy intersection in their towns. More common were the closet-sized cinderblock rooms housed within another retail shop.

Spacious cinderblock structures—representing roughly a quarter of the establishments where we conducted interviews—were another extreme. Repairers at these shops fixed miscellaneous electronic appliances, including mobile phones. The backs of their stores were typically filled with dust-covered machines waiting for their owners to collect them.

Standard to all shops were small freestanding wooden tables covered with clutter, including dusty mobile phone housings, motherboards, toothbrushes, bottles of cleaner, and plastic containers filled with gooey soldering paste. A soldering iron, multimeter, and screwdriver appeared to be the minimum equipment necessary for phone repair. Repairers working in larger places often had better tools and equipment, and more parts; they also typically had Internet access. Both those with their own access, and those who had to visit nearby cyber cafes for access, would frequently use Google to find solutions to new or unfamiliar problems. This quote describes the practice:

Something that you are not sure, you can just go to Google, you type the question and then they bring you the answer. You can easily get the information for Nokia and Samsung; they can even give you diagrams.

Repairers searched for diagrams depicting the phone's motherboard—necessary information for fixing a handset. They also told us that information found via Google or that was available on other online forums, such as JamiiForums and YouTube videos could be used to solve nearly any problem they encountered.

Prior user studies of mobile phone use in sub-Saharan Africa typically focus on making designs better for populations (e.g., design interfaces for low or illiterate individuals) [20], or on developing mobile applications that target longstanding development problems, including improving livelihoods (e.g., [17]). By engaging these repairers on their own terms, instead of focusing on what they lacked, we offer a counter-

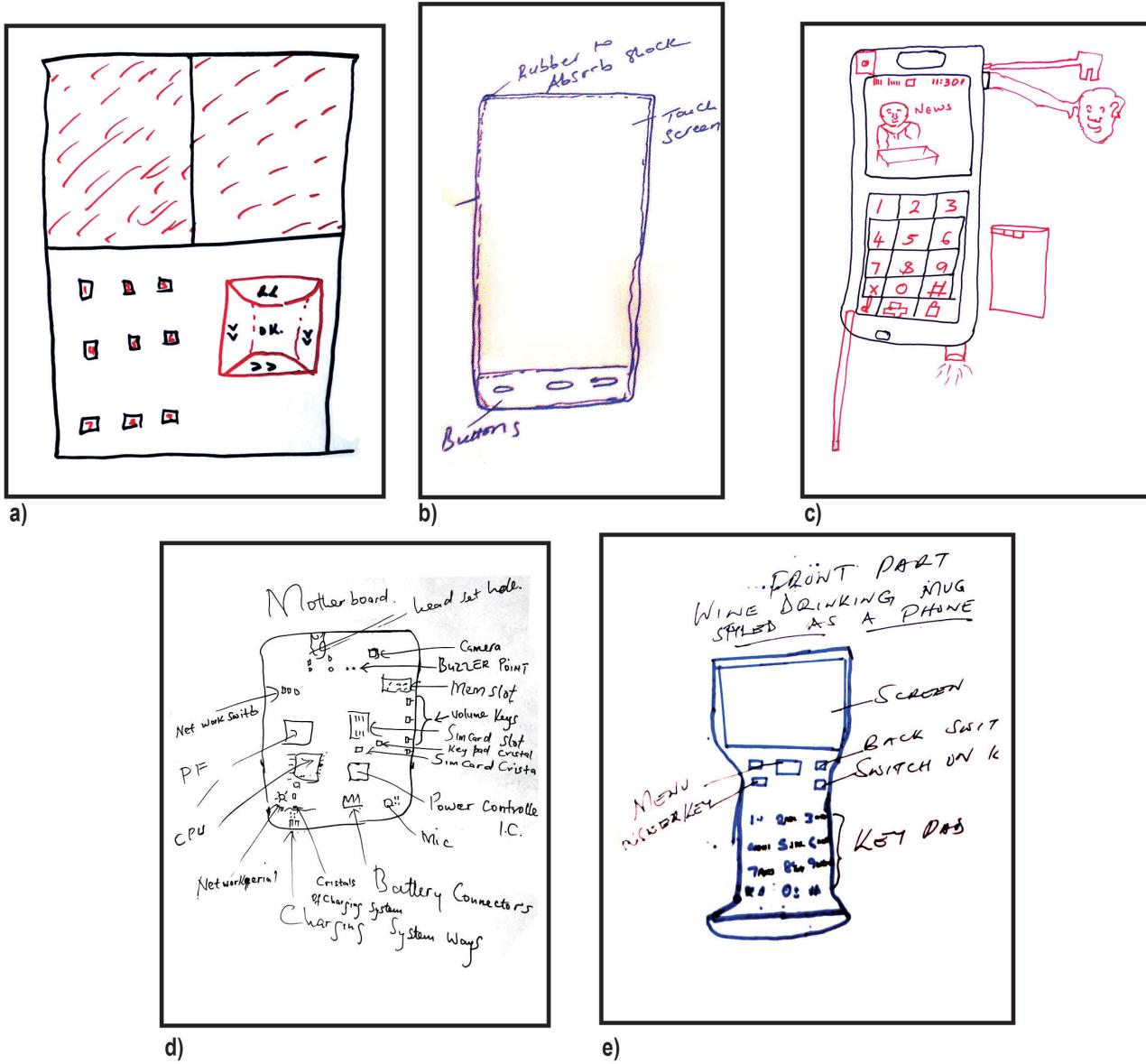


Figure 1: Repairers’ Drawings: a) two screens and two keypads; b) “rubber to absorb shock”; c) stronger antennae and lasting battery; d) redesigned motherboard and e) “wine-drinking mug phone”

narrative to these studies—one that reveals how rural Kenyans are already using technologies to earn a living.

Frequent and Consistent Problems

Despite the broad variations in where they worked, participants consistently worked on the same handset models, which typically were suffering from the same types of problem. These frequent breakdowns draw attention to the problems of maintaining a mobile phone in an environment for which it was not designed. Here we describe these problems, and relate them to the rural contexts where our study took place.

“Earpiece” and “mouthpiece” were regular replies to our inquiries about the most common repairs encountered. Rural Kenyans—like most living in rural Africa—predominantly use their mobile phones for voice calls

[9,38]. Dirt and/or sand gets inside a phone and damages the parts that receive and emit sound, resulting in a device that is useless for a population who rarely send SMS messages. “Broken screens” was another frequently mentioned problem, and was also the most expensive to fix. Depending on the make and model, replacing a cracked screen with a new one could cost up to 1,000 KES (about \$11). We asked what caused screens to break; respondents’ answers suggested a mismatch between touchscreen mobile phones and the rural context where they were used. A repairer explains:

We advise customers to avoid phones with touch screens, people fear them because the moment it falls down on the ground it is gone.

Homes and businesses in rural Kenya rarely have rugs or carpeting on their floors; instead, surfaces tend to be concrete or hardened dirt. Protective-but-expensive phone covers and cases, like those seen in industrialized countries, are uncommon there. Rural women rarely carry purses, and often wear skirts without pockets; consequently, they lack a secure place to store their phones. This, paired with traveling via “boda boda” (a popular bicycle-and motorcycle-based taxi service) on bumpy and unpaved roads, resulted in phones falling to the ground. Handsets were also vulnerable to torrential rainfalls; Seth, a repairman working in Malaba, told us.

During rainy season, I think it is the weather, sometimes phones have been rained on, or fell in water while someone was running away from rain so, in rainy season we fix a lot of phones.

Data collection took place during the rainy season (April-June), in which we experienced downpours every afternoon. We saw that people rarely carried umbrellas or wore raincoats, and observed how challenging it could be to protect a mobile phone in those circumstances.

Water damage also came from surprising sources: a repairman in Webuye described a malfunctioning mobile phone that had teeth marks in its plastic casing. He attributed this to customers holding their phones in their mouths so that they could use the “torch” (flashlight) feature while doing kitchen chores; possibly, he hypothesized, saliva enters the phone and damages the circuits.

“Originals” versus “China-makes”

Participants were keenly aware of the different handset brands they encountered, noting the strengths and weaknesses of various Samsung and Nokia models. Prior research indicates that smartphones are common in sub-Saharan Africa, and consequently technology developers are designing applications for them [5,25]. We asked about smartphones; all the repairers told us that they rarely see them, with the majority of their work being on simple, ‘dumb’ phones. David explains:

When you see someone having a smartphone here most probably someone sent it from abroad. You can’t get [Samsung] S4, S3 and HTC because they are too expensive.

Rather than discussing the differences between smart and dumb phones, participants compared “originals” to “China-makes.” They frequently, and consistently, used this term to differentiate the inexpensive and poor-quality phones, mostly manufactured in China, from their “original” Nokia and Samsung counterparts. Similar phones called “China-sets” have been reported in prior studies of mobile phone use in urban India [27], but the devices remain understudied in ubicomp and related communities’ literatures despite their growing presence in sub-Saharan Africa [19]. Indeed, a 2012

report from Kenya’s Communications Commission says that more than 10% of the country’s estimated 30.4 million handsets are sub-standard or counterfeit [1]—a percentage that appears to be much higher among Kenya’s rural residents.

Brand-name handsets (OKING, Itel, Forme) and knock-off Nokias were abundant because they were affordable to repairers’ frugal customers, and had features they desired. A counterfeit phone costs between 1,200 to 1,500 KES (\$13-\$15), compared to an original Nokia 1100 model that costs between 1,800 to 2,200 KES (\$21-\$25). Most of these substandard handsets have color screens, slots for two SIM cards and speakers, or features that basic original phones lack. Sampson’s comparison was similar to others’ remarks:

Originals are expensive, so they manufacture similar ones at a lower price. They are the worst, the worst in the market! There are so many, Chinese phones you can’t even know their names, but people buy them.

Rural consumers bought these handsets, but they were “the worst,” because they bore a fraction of an original model’s life expectancy and stopped working after four to five months. Repairers benefitted from these phones because their ubiquity, paired with their poor quality (and subsequent need for repair) supported their businesses; however, they were difficult (if not impossible) to fix. Participants attributed China-makes’ problems to their inferior hardware design, and told us these phones lacked the modular components that made original models easier to fix. For example, if a China-make’s “IC”, or integrated circuit, stopped working, all of the features it controlled—including sound, networking, and charging—also stopped functioning.

With China they have grouped on one IC, and is that IC that controls the phone. So if you were brought a phone that has unfunctional audio system, to repair it will be hard because when you tamper with that IC, it will die.

Compared to original models, finding replacement parts for China-makes was challenging, because of the hodgepodge of models and unavailability of parts. We asked repairers if they re-used parts from broken handsets, or engaged in the creative repurposing Jackson *et al.* observed in Bangladesh [21]. They did not, because the parts inside of China-makes were second-rate and could not be re-used. After one or maybe two repair attempts, the handsets became inoperable, and were a sunk cost for their low-income owners.

Seeing their customers lose money by repeatedly buying these low-quality handsets appeared to trouble some repairers. They speculated about interventions that might resolve the problem, such as asking their country’s leaders to limit the influx of these devices into Kenya. Others asked us to communicate their concerns

about China-makes to technology companies; for example:

It would help if you will take the report and share it with Nokia or Samsung company so that these manufacturers can find a way of stopping their phones to be duplicated or imitated.

These statements seem to indicate that repairers considered the authors to be intermediaries (actual or potential) between them and manufacturers. They also suggest that possible solutions to rural Kenyan's ICT problems might not be technical in nature (e.g., novel mobile applications), but rather policy-based (e.g., interventions that limit the influx of China-makes into the country) [14]. The frequency of these comments also suggested that respondents wanted phone manufacturers to understand the problems their rural customers faced.

Experts in Innovation for the Rural Context

Most repairers participated in the drawing exercise, perhaps because they had some technical training and experience sketching; six respondents chose to verbally describe their concepts for future phones. Here we present representative examples of the 28 drawings we collected. Concepts spanned from unsurprising handsets that featured functions available on new phone models, to innovative solutions to local problems, and wildly imaginative ideas.

Repairers typically began the exercise by drawing the outline of a mobile phone, and then adding various functions and features. The most common additions included buttons that could be pressed to access the Internet, or USB ports that would connect handsets to Internet-enabled computers. Repairers and their customers who did not have Internet-enabled phones wanted them, or, at least, wanted to be able to connect to and download from computers with access. Requests for "longer-lasting batteries" were also common, and featured in the drawings (see Figure 1c). This drawing also featured a long antenna, another item frequently included in sketches. Prior studies of mobile phone use in rural Kenya describe limited bandwidth, and the inability to maintain charged handset batteries, as rural consumers' most aggravating problems [38]. These were also prominent concerns among our participant repairers.

Repairers also sketched mobile phones with imaginative features that addressed problems they encountered. For instance, five separate sketches featured a mobile phone that had a back-up earpiece and mouthpiece. When explaining this concept a young man told us:

If one breaks there will be a replacement inside the phone.

In other words, the standby part would begin functioning as soon as the original part malfunctioned.

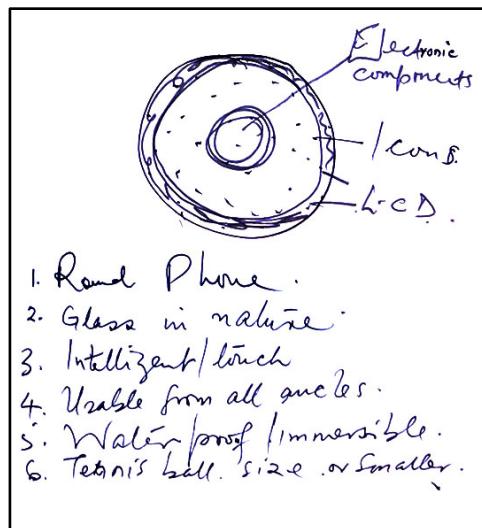


Figure 2: Round Mobile Phone

This idea was also offered as a solution to the issues of dead batteries and broken screens (Figure 1a, top, left, shows a phone with two screens). The repairperson who drew it explained:

I feel like having a phone that has two screens on both sides, because you may find that these smart phones, when this gets broken you can use this one on that side.

Perhaps because the problem was so frequent, other drawings featured ideas to decrease the likelihood that a handset's screen would break after a fall. Andrew described the need for a protective, "shock-absorbing lining" as he carefully drew the picture in Figure 1b.

If you could design so that there is a lining and when it falls down it hits this part—if the touchscreen is a little bit in[set], the screen won't touch the ground first, if it is rubber it will also absorb the shock.

Other solutions were phones with screens smaller than those seen on manufacturers' latest touchscreen devices. Rather than redesigning the screen, others drew handsets with entirely new form factors that would be less susceptible to dropping. Raymond drew a phone shaped like a "wine-drinking mug" (Figure 1e), that could be more securely gripped than the candy-bar-style phones he typically saw.

Concepts for durable handset features were depicted in other drawings; these ideas appeared to be motivated by repairers' frustration with the low-quality China-makes, and desires for phones that are easier to repair. Arnold told us, "I don't want plastic bodies because they do not last long." He added that future mobile phones should have iron screws, instead of aluminum ones that easily become stripped. Similar to other repairers, he envisioned handsets made of longer-lasting materials and with improved motherboards. Figure 1d shows one of six concepts for redesigning handsets' interior

components so that they could be easily removed and replaced, as is the case with modular components found in original models. Arnold concluded the interview by telling us, “Phones should last at least four to five years and consider village conditions.”

Requests for mobile phones designed for rural conditions were frequent. This not only meant designing phones that were more durable than existing handsets, but also included minor modifications such as repositioning the flashlight that is located at the top of most handsets.

Despite governments’ and donors’ efforts to provide modern energy to rural African populations, access remains woefully low [2]. The mobile phone’s “torch”, a highly valuable feature, addresses this need. However, our participants felt that current designs were inadequate, and their drawings featured ways for it to be improved. Figure 1c shows the flashlight placed on the bottom of the mobile phone; other drawings featured solar-powered flashlights, and still others showed phones that were redesigned so that they could more easily be held in the user’s mouth, thereby facilitating use of the flashlight while working.

Roughly a quarter of the repairers we interviewed completely reimagined mobile phones in their sketches, or drew concepts that did not resemble existing models. We thought some concepts were humorous, such as a heart-shaped phone that could be “given to the ladies” or the “flip-able fish-shaped phone,” with its keypad embedded in the back fin, while others struck us as more ingenious. For example, Simon devoted more time to completing his drawing than did other repairers, and applied much thought and imagination to his future handset. He explains his concept for a “round phone” shown in Figure 2:

This is my imaginary phone it is the size of a tennis ball or smaller, it is round, it is glass-like, it is intelligent, that is you don’t have the cover, but everywhere it is touchable from all of the side of that round shape.

He added that the benefits of this design included being waterproof, unbreakable, and glow-in-the-dark—all design features that are more suitable for rural Kenya than those included on current smartphones.

Our interviews and observations (and, especially, the concepts in the drawings) reveal how capable Kenyan repairers are at developing technical solutions to the problems they encounter—perhaps even more so than the Western designers who are geographically and culturally distant from the conditions our repairers work in.

DISCUSSION

Scholars ask researchers to avoid seeking an absence of technical solutions in “developing” nations, and to

instead engage with people on their own terms, so as to overcome the colonial impulse embedded in the design of computing systems [12]. We respond with a case study that illustrates what implementing their strategy looks like, discuss that strategy’s implications for research, and reflect on ways to improve upon it.

Findings from our study also provide evidence demonstrating how designing for “there” is not always different from design “here” [26]. Our repairers asked that mobile phone manufacturers use durable materials that last “four to five” years. Adding a “shock-absorbing lining” to the latest Apple iPhone may reduce broken screens—a problem that also plagues consumers in industrialized countries, and contributes to e-waste [29]. Embedding spare parts into jet planes has extended their lifecycle by reducing maintenance and the need to find spare parts [4]. To date, this innovative idea has not been applied to mobile phones.

Beyond Apps: Reimagining Mobile Phones

Technologists in ICTD, HCI and ubicomp are enthusiastic about the potential benefits that may come from widespread smartphone ownership throughout Africa, and they continue to develop mobile phone apps that target long-standing problems within the economic development domain (education, health, governance, livelihoods, etc.) (see [11] for an overview). Despite their developers’ best intentions, these applications often fail to achieve their intended benefit. Reasons for failure include employing a techno-centric rather than a human-centered approach and failure to account for lack of electricity, and Internet access in countries’ rural areas [18,37,38]. Our findings suggest that flawed handset designs may also explain why these applications are rarely adopted. After all, even the best-designed mobile applications are unusable if the handsets supporting them are not designed for the environment.

To date, smartphones have been designed for populations in Western markets who have access to the Internet and electricity, and who can typically afford to upgrade to a new device every other year. We hope researchers and practitioners will take seriously suggestions offered by our study participants, such as considering “village conditions,” and recognizing that smartphones are not designed for (and are mostly unaffordable to) rural consumers. Perhaps a glowing spherical handset is more suitable for rural Kenyans than a rectangular device with a fragile glass screen. Technologists must recognize that the currently-available phone designs are poorly suited for rural Kenyan environments. Every aspect of mobile phone design needs to be reconsidered: from their interfaces, to the materials used to produce them, to the ways they are charged and maintained, to the layout of their internal components, to the placement of the flashlight. Finally, we recognize that these recommendations invoke a

technologically deterministic perspective (i.e., perceiving technology as an autonomous, external force imposing societal change) that will likely never completely redress the inequalities that exist between developed and developing regions.

Supporting Local Design and Production of Mobile Phones

Philips *et al.* argue that postcolonial studies can prompt different questions among technologists. We agree, and believe that one benefit of a postcolonial approach to design is that it can change discussions from “designing *for* them” and to “designing *with* them” [26]. We encourage mobile phone manufacturers to recognize and work towards creatively engaging with repairers. Developing and implementing methods to increase intended consumers’ involvement in the design process is an established topic of inquiry within ubicomp [10]. However, studies using these methods rarely take place outside of Western settings, and typically include novice users, rather than experts. Repairers wanted mobile phone manufacturers to understand the problems their rural customers faced, and participatory methods may give them a voice in shaping future products. More broadly, creatively engaging with local experts in Kenya and other developing countries can open up ubicomp to a larger audience, and make room for a more diverse set of perspectives by which to shape future technology design.

Longer-term efforts to support African experts’ participation in the design process could include transforming repair shops into maker spaces—what Wanyiri calls “Foondi workshops” [35]. Lindtner *et al.* argue for taking repairers seriously because understanding their practices has the potential to drive economic and societal change [24]. Findings from their ethnographic study of maker-related events in China reveal that—with the right support and equipment—sites of DIY making can become sites of “industrial innovation.” Repairers in our study have the tools and the creative imaginations necessary for the transition from hacking to making. Supporting the local design and manufacture of mobile phones in rural Kenya may drive the longer-term economic growth that is necessary for improving their rural consumers’ well-being. These efforts are also useful for creating more meaningful connections between American researchers and local innovators in developing countries; as well, they are a necessary first step for incorporating local innovators’ expert knowledge into the technology design process.

Improving Upon Postcolonial Approaches to Design

We do not want our study to be another colonizing project, and yet recognize that we cannot entirely escape the political implications of our social location. Putting a postcolonial approach into practice is challenging; after all, this study was imagined, conceptualized, and carried

out within the theoretical and methodological frameworks of Anglo-European forms of research, reasoning, and interpreting. Two authors are faculty at major research universities; publishing this research is central to their career progression, but it remains less clear how it will advance the repairers’ careers. Finally, one cannot conduct research in the language of the colonizers without paying homage to them. Translating repairers’ words into English gives the English-speaking authors authority as translators and spokespersons; some perceive this authority as reinforcing patterns of domination [32]. We recognize these as limitations, but believe that there is value in continuing to improve upon postcolonial approaches to design, particularly since more and more technologists are studying and designing ICTs for populations outside of industrialized countries. Practically, this means re-examining participant compensation within the context of studies like ours, and discussing ownership of ideas.

Participant compensation—in particular, financial compensation—is a contentious issue within development fieldwork. Some argue that giving when there is a power differential between the giver and the receiver exacerbates power differences, and that therefore money should not be given [30]. For this reason, we chose not to give participants money; instead we gave them scratch cards, each of which was valued at about \$1 worth of mobile phone airtime. We subsequently realized that this was insufficient recompense, given that we are asking repairers not just to be interviewed, but to participate in a creative design activity that required them to use their skills and talents.

In an effort to establish a mutually beneficial relationship between the repairers and researchers, the first and third authors revisited those participants who were interested in engaging in the design process. During these visits, we updated them on the status of the project, and asked them to participate in other design exercises. We have provided them with copies of this paper, photographs taken during the fieldwork, and small sums of money to be used to purchase materials for their businesses. Indeed, such attempts at making relationships reciprocal are an important, yet neglected, aspect of design studies like this [6].

However, complicated questions remain regarding the intellectual property rights to the knowledge that participants shared with researchers. If mobile phone manufacturers implement and profit from novel ideas presented in these sketches, will the repairers benefit? Postcolonial approaches to design and participatory methods must acknowledge and account for these thorny ethical issues.

CONCLUSION

We have presented a case study of what a postcolonial approach to design might look like. We have argued that

by engaging with repairers “[on] their own terms,” technologists can expand conversations around designing for the “developing” world beyond building novel smartphone applications, to also include reimagining mobile phones and to supporting repairers’ efforts to manufacture them. By creatively engaging with repairers, we show that they have the imagination and agency to develop technological solutions to local and global problems. This study also contributes to technology repair research, by expanding the geographic range of prior studies to include rural Kenya.

Our conclusion is that when designing future technologies, technologists in ICTD, HCI and ubicomp must continue to learn from and engage with local experts. While we would never suggest that the issues mentioned in our paper could all be resolved by a single postcolonial approach, traditional needs-based approaches to design often lead to failed projects and a perpetuate the power imbalances we critique here. Alternatives are needed.

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