The Prototyping Mind: Rethinking Perception, Affordances, and the Mediation of Cultural Artifacts

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The Prototyping Mind: Rethinking Perception, Affordances, and the Mediation of Cultural Artifacts

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ABSTRACT

This article focuses on a prototyping session during which 6 Zimbabwean medical professionals design a prosthetic device. Prototyping helps the team determine which features must be built into the prosthetic, amplifies tensions between team members, and puts on display the kinds of futures they imagine. I use the state of disrepair of the team’s prototyping materials to tease out the distinct layers of perceptual reasoning that are instilled in cultural artifacts. An appreciation of the global flows of cultural artifacts lends complexity to the framework of “affordances” and “mediation” employed in the study and design of tools for learning.

Introduction

Let’s examine a scene that took place in Harare, Zimbabwe, in August 2011. In this scene, materials are playing a crucial role in how a collaborative team is learning to be creative. Six medical professionals—a psychiatry researcher (referred to as “Anesu”), a clinical physician (“Beatrice”), two physiotherapy students (“Clive” and “Danai”), a physician-researcher (“Esther”), and a biopharmacologist who specializes in indigenous plants (“Farai”)—have come together to construct a low-fidelity prototype, a rough physical representation of an idea they have been exploring all morning. The idea in question is a bottle-feeding prosthetic that could help an HIV-positive mother simulate breastfeeding her child when she is in conservative social company. Next to the team is a bin overflowing with scrap materials—egg cartons, chicken wire, old mesh ribbons, and polystyrene food containers—component materials that take on a new life as the six participants jointly construct the prosthetic.

This article takes the team’s prototyping as the unit of analysis. The prototype is a tool, a goal, and a motive for the team’s activity. As the object of activity, the prototype is “simultaneously given, socially constructed, contested, and emergent” (Blackler, 2009, p. 27). The activity of constructing a prototype helps the team to determine what concrete features must be built into the prosthetic. The prototyping provides insight into how people think about and with cultural artifacts, and it highlights the potential value of applying prototyping skills to nonconventional design scenarios. It presents an intersection of two different levels of cognitive activity: learning the skills entailed in prototyping as participants in a workshop and learning how to learn about a subject through prototyping, as a means of using design to radically alter the perception of constraints in the medical field. The prototype not only choreographs what the team members are doing, but also makes different future uses imaginable. The prototype amplifies tensions in the team and puts on display how an emergent tool, the bottle-feeding device, comes to be loaded with “previous patterns of reasoning” (Pea, 1953, p. 53).
The prototyping activity involves visualizing something hybrid out of old discarded materials that are in a state of disrepair. By focusing on the role that disrepair plays in the team’s activity, I tease out three distinct layers of perceptual reasoning that are instilled in the tool as it is constructed: (a) the computation and anticipation of scenarios for using the bottle-feeding prosthetic (typically understood as “mental”), (b) the social and cultural tensions that influence how the team approaches working together (mostly tensions over the topic of breastfeeding), and (c) the interweaving of material qualities with political perspectives that is unique to Zimbabwe as a setting for the prototyping activity.

The analysis culminates in a set of provocations for the framework of “affordances” and “mediation” used in scholarship on the design and use of tools for learning and problem solving. Throughout the article, gender and the informal activity, kukiya-kiya, serve as two useful analytical points for understanding how a cognitive tool (the prototype) is saturated with fluid sociocultural relations and contested perceptions of one’s placement in global power structures. Kukiya-kiya is a Shona umbrella word for clever work-arounds that arise in Zimbabwe’s economic crisis. It is an array of informal everyday practices and fluctuating terms of engagement that are designated as “informal,” or “invisible” economies. Of interest here are the points of overlap between the activities of rapid prototyping and kukiya-kiya. Kukiya-kiya exists in parallel with rapid prototyping and, I propose, influences how the team interprets its prototype. Understanding the prototyping mind has the benefit of shedding light on the cognitive activity behind this previously overlooked activity, kukiya-kiya. In the team’s purview, the unavailability of authentic industry materials and activities—what they continually attribute to the ongoing economic crisis in Zimbabwe—means that the activity of rapid prototyping is a process of seeing spaces of “strained resources” as sites for resourcefulness. Kukiya-kiya involves a similar search for resources in spaces of dysfunction and disrepair. I am interested in a framework that reconciles the notion of affordances being the functional properties of a tool that structure how people interact with objects, with an account of how people learn to use, think, and create with tools that have abnormal or dysfunctional properties.

Prototyping and kukiya-kiya—Zimbabwean problems and problem solving

Disrepair and dysfunction: seeing objects as a problem

In the purview of technology design, prototypes evolve from low-fidelity to high-resolution technologies by scaffolding how we think with them and by “fading into the background,” what Pea (1993) ascribed to “distributed intelligence.” Technologies are often portrayed as invisible, yet in a setting like Zimbabwe’s economic crisis, technology and infrastructure—the tools and artifacts that mediate activity—are conspicuously visible because they are in a critical state of dysfunction or disrepair. In Zimbabwe, objects are conspicuous for their breakdown, absence, impermanence, and disrepute. Things simply don’t look good anymore, they do not function, they are inaccessible, and they have all taken on a peculiar patina of abnormality, disrepair, and dysfunction. The economic crisis is articulated through this patina such that in everyday talk the appearance of materials has become analogous to “economic crisis” and is derided as a material display of the country’s political instability.

The crisis is described as a problem of objects: potholes, shortages, and queues. A growing body of literature on post-2000 Zimbabwe attempts to go beyond interpretations of the Zimbabwean environment as “failures” or “anomalies” in the political economy; in order to privilege, instead, how Zimbabweans “perform” the everyday (Hammar, McGregor, & Landau, 2010) via informal activity such as kukiya-kiya. Kukiya-kiya is always opportunistic, and it is constituted in both the limitations and freedoms that failing institutions, broken infrastructure, and distorted norms permit. Broken municipal buses are scrapped for metal, then repurposed
as new commodities; unreliable cheap products or “zhing-zhongs” are illicitly circulated from factories in China and sometimes embargoed on cargo ships in the Indian Ocean because of international sanctions on Zimbabwe. Scarce commodities are smuggled in by “hoarders” en route from neighboring Zambia and South Africa; and “nice” things are sent back to Zimbabwe as diaspora remittances and gifts. The “problem” with objects is constituted in circulation and alienation, two features of the postcolonial, neoliberal global order. For my informants, the Zimbabwean crisis has engendered a particular relationship to circulation and alienation that I call disinheritance—a perception of man-made things as “Other” or as inaccessible, impermanent, and unaffordable.

With the concept of disinheritance I point to the intersection of two ideas—alienation (Marx’s depiction of the consequences of commodity fetishism in a world of capitalist transactions) and cultural heritage (Vygotsky’s sociocultural notion of artifacts or tools inherited from society). In a world of global flow and friction, objects of disinheritance are the kinds of artifacts that make one feel excluded or alienated, and disconnected from a universal cultural heritage. Disinheritance captures how many Zimbabweans perceive objects as unintended, due to one’s economic circumstances, for use in their original “functional” form or design. I argue that disinheritance is an attention to materials—a way of looking at materials that allows the beholder to recognize transience, mutability, intermediateness—that allows Zimbabweans to employ novel and unexpected ways to act within and around the constraints of their material conditions. Disinheritance is a perceptual turning point after which ordinary tools begin to communicate alternative “affordances” (perceptions of properties and uses) that completely shift the realm of possible activity.

The activity of repair is often portrayed as an inherently human task, and even as a political act. For Hodder (2011), the constant need for repair is what binds people with their objects, what leads to a coevolution or entanglement of humans and things: “Things are always falling apart, transforming, growing, changing, dying, running out. . . . Humans are always busy . . . fixing things” (p. 164). Rosner (2013) called repair a politically mobilized and subversive way of reconfiguring the class disparities that are shaped by our different relationships to technology. In the fieldwork that supplemented my workshops (2011 and 2013), I visited two of Harare’s most marginalized urban districts—Gazaland (in Dzivarasekwa) and Siyaso (at Mbare Musika)—both of which have turned into spaces or centers of technological repurposing and fabrication. Here, via kukiya-kiya activities, the decayed materials of Zimbabwean everyday life are recycled and rejuvenated in a cycle of transients, rubbish and durables (Engeström & Blackler, 2005). In prototyping, as in the everyday kukiya-kiya activity of many Zimbabweans, disrepair entails not restoring something to its original state, but transforming it into something new.

A trove of “saved for later” things: the contents of the prototyping bin

Given this symmetry between prototyping and kukiya-kiya, a prototyping bin resplendent with objects of disinheritance would be a powerful way to see the confluence of mind, culture, and activity in action. The prototyping bin is an old plastic tub populated with a sensory explosion of forgotten, misplaced, or “saved for later” things. The intention is for the bin to provide materials that, despite their structural composition, could be perceived as malleable or destructible because they are easily pulled apart, cheap, or simply displaced. The materials share in common a sturdy or distinctive “form” such as molded styrofoam blocks (e.g., picture the factory packaging of an appliance) and empty plastic bottles. These staples are
supplemented with materials of unusual characteristics such as old or broken knickknacks and rectangular wooden tiles.\footnote{asked the other two coaches to bring materials for the prototyping bin, but I was solely responsible for curating the materials it held. In a design workshop in the United States, a bin might have contents such as construction paper, pipe cleaners (chicken wire served the same purpose), fuzzy balls, and aluminum foil, but these would not come across as “disposable” in Zimbabwe and would lend the prototyping an air of inaccessibility and costliness the workshops were trying to dispel. I wanted things that were familiar, that might be found in any home. For example, polystyrene “Kaylite” trays, used for packaging produce in supermarkets, is one sort of “thing” that many Zimbabweans might “save for later” in the home and repurpose for storage in the fridge or for feeding their pets and livestock. In keeping with this aesthetic of “saved for later” things, no materials, not even the unused ones, were removed from the bin for subsequent workshops. This had the effect of “growing” the bin, so that each new workshop group had more resources to choose from. At the beginning of all the prototyping sessions, we prompted the participants to go to the bin and collect as many materials as they found interesting. One of the coaches jokingly instructed the teams to “grab materials as though they were the last piece of meat to feed 16 people at a barbecue.” From the video recordings of this moment, it appears the team members perused the bin without making their individual strategies explicit. During the remainder of the prototyping, they were free to walk up to the bin to collect additional materials, or to trade materials with other teams.}

These choices on what makes a good prototyping material have been refined throughout the series of workshops. Materials, such as egg cartons, that were popular in the first workshop are replenished in subsequent workshops. Participants also use the furniture in the venue (a conventional conference room), and in one instance, a team once upended the prototyping bin, emptying it of its contents in order to use the tub itself. The teams regroup at designated workstations and pick from the materials members have scavenged, choosing what fits into the conversation as demonstrated in the example of our team’s discussion that follows. The physical attributes of the materials have some bearing on what prototypes are imaginable, but that each team may see different affordances of the same physical materials—in the extensive use of egg cartons in very different manifestations of a prototype, for example—corroborates the notion of \textit{perceptual agency} emerging or being brought into relief by the act of prototyping. I return to this notion of \textit{perceptual agency} after a brief overview of my methodological approach to shaping the prototyping sessions, which are part of a larger \textit{design thinking} curriculum, as the object of study.

\section*{Methodological choices}

\textbf{The challenges of framing design thinking}

Working with two collaborators, I set out to introduce \textit{design thinking} to Zimbabwean health practitioners.\footnote{Design thinking, and the approach to design as a means of framing problems, has a long history in design institutions around the world that have curricula building on both synthetic and analytic approaches to framing problems. Its methodology is applicable to, conceivably, any realm of problem solving, and it can be scaled from small collaborative teams to large organizations. \textit{“Design”} refers to the iterative process of drawing inspiration and scaling ideas from users in their real environments. It is framed as a kind of “thinking” because it involves reorienting one’s methods and attitudes toward collaboration, learning, and deriving rich principles from failure and productive experimentation.} Design thinking is an approach to problem solving that focuses on rapid idea generation, low-fidelity prototyping, and early integration of users into the development process, through developing empathy for users and articulating their observable needs or \textit{needfinding}. Prototyping entails learning through manipulating physical materials that is at the heart of popular pedagogical approaches such as constructionism (Kafai & Peppler, 2011; Papert, 1991), fabrication (Walter-Herrmann & Büching, 2013), and bifocal modeling (Blikstein, 2012). As an approach to research that transforms work for practitioners (what Davydov, 1999, called “learning activity”), this new kind intervention would ideally equip local professionals with a skill set to incubate research ideas, promote locally derived learning models, and generate innovative expertise that might improve healthcare service.

Pedagogically, the \textit{needfinding} and empathy at the heart of this approach fulfills the role of Freirean dialogue or culture circles by prompting participants to reflect on the social and political situations that limit everyday experience. For Freire (2000), literacy or \textit{conscientizaçao} (“coming to consciousness”) is a problem-solving education that reveals the world to be a dynamic process of
transformation, rather than a static reality. The objective of the workshops has been to provide a platform for practitioners to learn the principles of design thinking and apply them to the local practice of medicine. The workshops provide a “technology for participation” (Booker, 2008) that could help each new designer strategize how to acquire and sustain participation rights to innovation and transformation in their respective fields.

That said, the human “need” that design thinkers are in search of is paired with technological interventions and technical expertise that cannot easily be extricated from geopolitical distancing and the power structures inherent in the binaries “resource” and “need.” The workshops provoke “juicy” moments when informants problematize the assumptions about these binaries, and about the local and global “points of view” that design thinking rhetoric is laden with. This participatory critique and analysis creates a learning space where neoliberal agendas are directly confronted and workshop participants continue to “talk back” (hooks, 1989) and question the place of a design thinking curriculum in their professional development. This “talking back” is directed in multifaceted ways: at each other, at the researcher and coaches, at regimes of exporting technical expertise such as design thinking, at the status quo of medical education, and at the omnipresence of the state’s discourse on nationalist entrepreneurship to extricate Zimbabwe from its economic crisis.

The design of the workshops

The workshops mixed instructional lectures with breakout sessions that required participants to work hands-on with design thinking in their design teams, thus leveraging the needs-driven prototyping and early user testing that have made design thinking an effective methodology for problem solving elsewhere. The curriculum is adapted from the Stanford University (Hasso Plattner Institute of Design) d.school’s design leadership instructional material with several significant modifications: dual design challenges within a single design cycle, a preconfigured design challenge presented via video prompt, and changes to language and materials to reflect the specific Zimbabwean scenarios the workshops cover (further discussed in the following section). The video prompt allowed for shared experiences and comparable design insights across six teams in three design workshops. This approach builds on the use of video and text prompts to standardize the design challenge and allow comparisons of different teams’ classroom evaluation, as proposed by Carroll et al. (2010). In addition, the two video prompts allowed for the parallel use of the workshop as a design-based intervention and as a provocation for critical dialogue with informants about their experiences of the relationship between subjectivity and materiality in the crisis.

We solicited nurse matrons and general managers at hospitals, doctors and their assistants at private practices, students at a physiotherapy training program, and faculty physician-researchers at the University of Zimbabwe’s Faculty of Medicine; they, in turn, invited friends, employees, and colleagues to join the August 2011 workshop.3 Throughout the three workshops, I collected audio, video, and still photography from all the design teams as they worked, including their debates and debriefs in-between sessions, an inventory of the ideas generated, the prototypes as they were made and tested, and written responses to an exit survey.

The workshops ran for roughly 6 hours, with five sessions—on developing user empathy, defining user needs, ideating novel approaches, prototyping, and user-testing—attended by 33 participants and three design coaches. The six teams were formed to spread the medical and physiotherapy students (12 in total) across different groups while maintaining roughly equal sizes. Each team

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3Not only were the health professionals we solicited encouraged to think about how they could “exploit us,” we were all mutually preoccupied with fitting the workshops to the question of resources (their scarcity and their creation) in post-2000 Zimbabwe. As such, I also documented recruitment conversations as interviews. Other ethnographic resources included the journals, blogs, e-mail communication, and documentation of meetings with key stakeholders on the ground and among the workshop facilitators during the months of intense planning and rehearsing.
articulated its own perspective on the same design challenge presented at all the workshops (described in the following section), and each team elected an attribute they deemed most suitable for communicating and testing that perspective through a prototype. All the design perspectives and the scope of the corresponding prototypes are summarized in Table 1.

All teams were reviewed in the first round of analysis, but I focus on one team’s activity in order to present a detailed account of how participants arrive at new understandings of design thinking as a problem-solving approach. The general findings here are applicable to many of the teams in the workshop series because they exemplify the kinds of tensions and resolutions all the teams encountered and, in doing so, illustrate how the prototype, as an object, comes to be loaded with prior reasoning.

The team under focus (Team 6 in Table 1) was selected because of the range of resolutions (how the prototype feels, interacts, works, and looks) they scaled their prototype to explore, continually evolving it along these four dimensions. They picked a moment of sociocultural conflict between the user and the social world they live in as the focal point of their prototyping activity. They were vocal and animated in their disagreement and agreement. They had the widest diversity in profession and age—from 23 to 56 years old—and the team was atypical for having only two female members, Beatrice and Esther.

An enticing problem-solving scene

The “problem” or design challenge posed to the teams for the ideation, prototyping, and user-testing sessions was to help a young Zimbabwean mother provide maternal care to her infant. The topic was chosen to foster empathy from participants throughout the process by emphasizing the vulnerability of potential users of a prototype. All the teams were shown the same video prompt, which featured a young female doctor talking about a recent visit to her rural home during the national holiday weekend called Heroes’ Day. In the video, the conventions of good motherhood are put into question when a young mother must decide how to provide the best maternal care for her 2-month-old infant while navigating social expectations about and the appearance of being a good mother. This scenario pits, albeit rather formulaically, the cultural conservatism some urban

Table 1. Summary of Prototypes From Workshop Series, With (a), (b), (c), (d) Indicating Order Where One Team Had Multiple Prototypes.

<table>
<thead>
<tr>
<th>Team No. — Prototyping to</th>
<th>Feels like</th>
<th>Works like</th>
<th>Interacts like</th>
<th>Looks like</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Prevent of infection by transforming the health system</td>
<td>a. Surrogate mothers contribute to a milk bank</td>
<td>c. HIV immunization program with peer education support system</td>
<td>b. Breast “cloning” procedure that combines cultural and technological approaches</td>
<td></td>
</tr>
<tr>
<td>2 – Extract of HIV virus from milk</td>
<td>Solar-powered milk filtration device</td>
<td>Antiretroviral “chemo” therapy facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 – Create more synergy between healthcare service and child feeding routines</td>
<td></td>
<td>Combine milk treatment: expressing, filtration, and storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 – Combine all of a mother’s feeding needs in a single device/service</td>
<td>a. Video tutorial for using communal artificial milk bank</td>
<td>b. In-person group tutorial for using communal artificial milk bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 – Educate communities on alternative milk sources</td>
<td>a. Device that simulates feeding artificial milk as breastmilk</td>
<td>c. Feeding prosthetic for bus rides and visits with mother-in-law</td>
<td>b. Feeding prosthetic with imitation nipple as teat</td>
<td></td>
</tr>
<tr>
<td>6 – Mask bottle-feeding in conservative company</td>
<td>d. Feeding prosthetic with “milk-belt” reservoir</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
doctors associate with rural womenfolk against the medical rationale of preventing HIV infection in the infant.

During the workshop, the team spends some time brainstorming possible interventions to help the young mother. When the focus shifts to building a physical prototype to represent their favorite idea, all six members of the team contribute to the prototype by adding and removing materials from the prototyping bin. The team is elaborating on an initially vague idea of the prosthetic that would help the young mother pretend as though she is breastfeeding, whereas in reality she is giving her child prepared milk. As illustrated in the following snippet (Table 2) of the prototyping scene, a shared sense of what the prototype looks like and does emerges from a miscellany of materials selected by the participants. Alongside the dialogue excerpted next, I have sketched out the corresponding composite materials (1–7) referred to by the participants to show how the prototype is morphing into a hybrid of things. Figure 1, a photograph of the team’s design instructor modeling the prototype, illustrates the finished product of this morphing into a hybrid of things.

The challenge of reading this scene

The activity of aggregating rough materials into a physical representation of a refined idea helps the workshop participants understand how design could be useful, and even emancipatory, in their respective professionals fields. To the amusement and emphatic agreement of the other participants, Esther likens the lessons of design thinking to the rhetoric of Fourth Chimurenga (“Fourth Liberation Struggle”) that has become prevalent in the national discourse. Esther’s explanation, “We’re always being told we should be business people, we should come up with ideas . . .” calls attention to the participants’ cultural responses to how liberation struggle is portrayed as a state-of-emergency decree for business acumen and entrepreneurial spirit, neoliberal technical skills necessary to extricate Zimbabwe from its economic quandary. As Anesu puts it, “What I learnt today [in the prototyping session] is that if you haven’t got anything, you can actually design something to overcome.” The low-fidelity prototype the team is constructing inspires Anesu to imagine more refined industrial processes and elicits a sense of invention-in-the-making. Anesu’s excited contributions to the team discussion frame “industry” and “invention” as the legitimate and final culmination of assembling disparate objects from the prototyping bin. He sees this as an enfranchising and transformative experience, that is, prototyping and design thinking shift his positionality.

Later in the prototyping session he offers an assessment on the progress the team has made: “This looks really good. I can already see it 20 years from now . . .” to which Clive adds, “Wait until the businessman comes. Who is going to buy this thing?” The patina of the low-fidelity prototype, its rough and hacked-together appearance, leaves room for imaginative possibilities for Anesu, but tenaciously reminds Clive of the doubt he has in innovation coming out of these rough circumstances. For different members, prototyping becomes a means for articulating aspirations for what the prototype might prove: validation of the value in an idea or its nonviability. The different beholders of the prototype are coming from different social worlds, even within their shared experiences as Zimbabweans: the disparate visions of innovation, the different professions assert different takes on the solution to providing infant nutrition, and the designers and their users “see” a prototype’s affordances entirely differently. I find Monson’s (2008) term “perceptual agency” particularly useful for describing this stylized attention that emphasizes the processes of performing identity involved in selecting what is perceived. According to Bucholtz (1999), identity is produced in social interaction and through a process of contestation and collaboration.

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4This articulation of Chimurenga as business acumen trivializes revolution and confuses the state’s stance on capitalism, at once spurned and critical to a larger struggle against imperialism. This pairing of design thinking to the language of Chimurenga allows us to map the loci of innovation and entrepreneurship as they circuit the African imagination, confounded by the center-to-periphery hegemony that pervades models of entrepreneurship, and entangled in the self-marginalization extorted by state ideology.
Table 2. Snippet of Teams talk as they assemble several materials into their prototype.

<table>
<thead>
<tr>
<th>Team Member(s)</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esther (picking up an empty polystyrene box #1 from the prototyping bin)</td>
<td>The mother can wear those special bras where you open it (Esther demonstrates how the polystyrene-cum-bra will “open” with an imaginary flap)</td>
</tr>
<tr>
<td>Anesu (talking to Esther)</td>
<td>You should be in industry producing these things (Laughter)</td>
</tr>
<tr>
<td>Beatrice (to Anesu)</td>
<td>You have to design and innovate first before you can produce it in industry.</td>
</tr>
<tr>
<td>Esther (directing Clive, Danai, and Farai to adjust the polystyrene)</td>
<td>Okay let’s stick it there (indicating how to make “straps” out of old mesh ribbon #2).</td>
</tr>
<tr>
<td>Beatrice (to Anesu)</td>
<td>The idea is that people have got to be able to visualize what we are doing …</td>
</tr>
<tr>
<td>Esther (adjusting the “straps” #2 herself)</td>
<td>So the mother wears the bra which usually has a flap that opens like this… so this thing needs to look like the real thing (holding up a golf ball #3 that could be inserted inside the imaginary flap) so the gogo [grandmother of the baby] will just see the breast [of her daughter-in-law] she won’t see the artificial teat there because the bra is hiding it…</td>
</tr>
<tr>
<td>Esther:</td>
<td>So this thing goes in there … (sound of tape as golf ball is attached) … then you wear your bra which opens up a little bit. Has somebody got a pair of scissors … how do I break this? Oops (tears a piece from the egg carton to serve as a flap #4)</td>
</tr>
<tr>
<td>Danai:</td>
<td>Just make a hole then … (in the egg carton “flap”)</td>
</tr>
<tr>
<td>Esther:</td>
<td>Where is the [pair of] scissors?</td>
</tr>
<tr>
<td>Clive:</td>
<td>It’s being used by the other group</td>
</tr>
<tr>
<td>Esther (walking away from the huddled team)</td>
<td>I’m going to get some water. I’m thirsty</td>
</tr>
<tr>
<td>Anesu (rallying the team)</td>
<td>We’re close to inventing something!</td>
</tr>
<tr>
<td>Beatrice (laughing):</td>
<td>Heeee!</td>
</tr>
<tr>
<td>Farai (picking up a spool of thread #5):</td>
<td>So this thing here can act as a pipe of some sort … and then it comes out here … (indicating how the spool would connect to a “nipple”)</td>
</tr>
<tr>
<td>Beatrice:</td>
<td>Where’s the nipple?</td>
</tr>
<tr>
<td>Clive:</td>
<td>It’s on the bra (reminding B the golf ball is a “nipple”). We’ve attached it to the bra. We need a pipe that connects this…</td>
</tr>
<tr>
<td>Farai:</td>
<td>A straw that comes out from here</td>
</tr>
</tbody>
</table>

(Continued)
Table 2. (Continued).

Beatrice: So this thing (experimenting with how to connect the tube #6) needs to get in through there…

Esther (having returned with some water, she looks on): Can’t it suck like a tube? Anyway it is what it is. So we just have to work on … The idea is clear, they just have to decide what sort of materials (laughter) you’d use [in real life].

Beatrice: And remember we’ve got breasts (emphasizing plurality) … for both breasts.

Anesu (pointing to the golf ball): Okay, so we need another breast?

Clive: But I was thinking … when a woman is feeding she only uses one breast at a time

Danai: Yeah, one at a time

Esther: [Imagine] you’re on a five hour journey in a bus, are you going to continue feeding from the same breast?

(All four male members collectively say): Oh!

Danai (once second flap is added #7): So now we need to have a milk reservoir somewhere in there. [*The team later adds a rattle to serve as the milk reservoir]*

Figure 1. The team’s design instructor models their low-fidelity prototype—a bottle-feeding prosthetic that simulates breast-feeding.
Although working together on the same activity, team members “see” the prototype differently. For example, Esther points out, “The idea is clear, they just have to decide what sort of materials you’d use [in real life].” Esther’s comments suggest that the unavailability of authentic high-fidelity or high-resolution materials shouldn’t be an obstacle to engaging with or “seeing” an innovative idea. When Beatrice focuses on visualizing ideas and future possibilities as the goal of the prototype, she too is articulating one perception of innovation that draws on how the material form can mobilize networks by signaling ideas to future collaborators or users. When Anesu focuses on the authenticity of the prototype as a future “invention,” he articulates an entirely different idea of innovation, where the informal innovative practices of hacking things together prevalent in Zimbabwe, kukiya-kiya, might one day be legitimized through real industrial materials and business protocol.

Pedagogically, rapid prototyping builds on a perspective on learning that emphasizes how thinking is distributed across the people thinking together, and the objects they are thinking with, in a “cognitive ecology” (Hutchins, 2010). In this regard, the scene reveals some of the “affordances” of learning tools. In learning sciences research, “affordances” refer to “the perceived and actual properties of a thing, primarily those functional properties that determine how the thing could possibly be used” (Pea, 1993, p. 51). The low-fidelity prototype offers twofold affordances—it mediates how the team comes to understand the task at hand, and it allows the team to explore what the finalized device should allow their imagined user to do. The disrepair of the recycled materials embedded in the rough prototype is also crucial to the kinds of activity the prototype affords.

**Tracing the cognitive residue in a prototype under construction**

In this section, I focus on a second segment of the team’s prototyping session to briefly outline how team members jointly engage in constructing a physical form, D’Andrade’s notion of “reified ideas in solid medium” (as used in Cole & Engeström, 1993, p. 16). Bamberger and Schön (1983) described the ability of objects to “hold” meanings as a “reflective conversation with materials in the course of shaping meaning and coherence” (p. 69). In their early notes on knowledge-in-action, Bamberger and Schön (1983) documented how shifts in meaning happen only when previously tacit norms are liberated, and trigger the unexpected emergence of possible criteria for coherence. In their words, “uses slide into one another, new relations, new meanings emerge, and these, in turn, re-shape the makers’ [knowledge-in-action] with respect to the task” (Bamberger & Schön, 1983, p. 73). I refer to all this background thinking and talking and acting that is necessary for building the prototype as “cognitive residue” (Pea, 1993, p. 61). In the prototyping session, the emergent prototype is loaded with the “cognitive residue of prior actions [that are] crystallized in the object” (Pea, 1993, p. 14). That is, the intellectual labor of problem solving and jointly deciding what a possible bottle-feeding device does is carried along into the resulting physical prototype.

The excerpt thus illustrates how ideas come to be “reified” in “solid medium”:

Esther: The mother can pretend that she’s trying to keep up her modesty and cover up …

Clive: So the milk is coming from there (pointing to the inside of the bra) and she can hold the breast so that it looks like it’s coming from the breast

Beatrice: I have a problem with this … whatever it might be later. It will create a bulge (A quiet argument ensues)

Danaí: Inject the milk through there … so she doesn’t have to carry around the bottle

Farai (agreeing with Clive): I thought the milk would be somewhere in there within the confines of this thing (indicating the body of the bra)…

Beatrice: She’s got a small body, she’s worried about the bulge. She said she doesn’t want a bulge
Clive: I have to cut it in half and then staple it there or tie it behind . . .
(picking up a rattle from the prototyping bin to serve as a milk reservoir):

Anesu (pointing to the rattle): Are these the breasts or the milk containers?
Clive: Isn’t the milk container was [sic] the rattle?
Anesu: Because I was thinking this is the milk container but we might need to make it plastic or we might need to design it into this [the bra] . . . so the whole thing is . . . (gesturing a pliable plastic that lies flat)
Danai: Oh, it’s a milk belt
Beatrice: No, no, no, because then you need to get formula and the family will see
Clive: So it needs to be detachable
Esther: But remember the issue is not even when you go out. It’s what happens at home when the gogos [grandmothers] are seeing that you’re not breastfeeding, that’s where the issue is!
Anesu: At least the two of us, wife and husband, we’ve agreed that . . . “you do the shopping and I prepare the milk in the morning.”
Esther: Yeah but the gogo [grandmother of the baby] wants to see that muroora [her daughter-in-law] is breastfeeding
Beatrice: She wants to see the breast itself . . . (Sighs of shock followed by thoughtful murmurings)
Esther: And that’s why this has to be very
Farai: Artistic
Beatrice, Danai, and Farai (said in unison): Real
Esther: The nipple . . . (pointing to the golf ball)
Clive: So that’s the nipple?
Esther: If we glue it
Beatrice: No glue it onto there . . .
Anesu: This is glue right?
Danai: But what is this? Is it a breast?

The preceding excerpt follows the team as they weave back and forth from points of dissent (where members disagree on what shape the idea should take) to points of alignment (where members agree on how to implement their idea). In this weaving from dissent to alignment, the representational role of each object from the prototyping bin must constantly be checked to ensure the team’s vision of what the prototype should “afford” is jointly constructed. The team’s interaction alternates across four cognitive threads: bids, themes, contexts, and scaffolds.

There were three kinds of bids: references to new possibilities or the future potential of the prototype, jokes and laughter used to prompt critique or develop ideas, and questions or doubts used to check in about progress or to build on ideas. For example, when Beatrice says, “I have a problem with this . . . whatever it might be later. It will create a bulge,” she proposes a new bid that shifts the focus of the team’s activity toward appearance, privacy, and concealment.

The team focuses on three themes in their discussion: talk about the intimacy of breastfeeding, about the textural experience of using the prototype, and about physical or aesthetic aspects of the prototype. For example, Danai suggests, “Inject the milk through there . . . so she doesn’t have to carry around the bottle.” All three themes are references to the affordances of the prosthetic as a
technological tool. When Beatrice articulates the social context of breastfeeding—“She [the grandmother of the baby] wants to see the breast itself”—she makes a point about the level of intimacy forced by expectations of motherhood.

The context-related threads touch on the alienation of the mother, or of Zimbabweans more broadly. The abnormality of the Zimbabwean crisis means that unavailable commodities such as formula milk and disposable bags are nonviable as components of the prototype. The normative rules for behavior in public versus private spheres mean the device must help the young mother master the art of illusion seamlessly.

The last thread of activity, scaffolds, captures the strategies the team discusses and deploys as part of the prototype’s ability to address or mask social problems. This includes alternative engagements (new ways of gaining access to opportunities or resources); workarounds (such as making components detachable); and the use of hooded meanings, metaphors, pretenses, or masks that provide a cover for authentic behavior that might otherwise be perceived as unacceptable.

The graphs in Figures 2 and 3 show the distribution of these four threads in the excerpted segment and in the entire prototyping session, respectively. The graphs function as a record of the “cognitive residue” or cognitive threads loaded onto the prototype.

As the team adds and modifies the prototype’s different components (gluing and taping on “filters” and “milk belts” to the “bra”), the prototype begins to metamorphose from an amorphous assemblage of things and people thinking about these things into a relatively integral entity through which the team could jointly engage in imagining a world that didn’t already exist. Once the assemblage has taken form as a prototype, all of this cognitive residue (or previous patterns of reasoning) will underlie the features of the prototype that structure future thinking and perceptions of the problem as the group moves forward. For example, the “artistic” quality of the prototype, or indeed its artistry, is imbued with an understanding of how the husband and wife, a modern couple,

**Figure 2.** Distribution of activity in a segment and in the entire prototyping session. The graphs read clockwise from beginning (at “12 o’clock”) to end of the session. Each ring is the locus of one thread of activity: bids, themes, scaffolds or contexts. The density of the rays indicates the frequency of each thread.
will evade the insistent grandmothers. The prosthetic will be a tool for slight of hand, for mustering the illusion that traditions of child rearing are being upheld. Thus the “real” [looking] nipple is a crucial part of how the device will function. It is a specific affordance the team has elected to elaborate on, and an idea that comes to be reified as the prototype takes shape.

When Anesu asks the question, “Are these the breasts or the milk containers?” the process of realignment must be initiated and resolved. In this exchange (presented in the preceding excerpt), Clive picks up the rattle and talks about cutting it in half to make room for it in the “bra.” Anesu’s question appears to assert to Clive specifically, and all the other team members, that if the rattle is the reservoir and is to be imagined as a demi-sphere, then it is not how Anesu had pictured the concept of a reservoir manifesting: “Because I was thinking this is the milk container but we might need to make it plastic or we might need to design it into this [the bra] … so the whole thing is … [gesturing a pliable plastic that lies flat].” Danai picks up on this train of thought by proposing that the reservoir should be a flat belt instead of a rotund cup, assigning the metaphor of a belt to lock in the idea (“Oh, it’s a milk belt”). This is a moment of synergy in team collaboration, where members, although they may be alternatively aligned and dissenting on what the reservoir looks like, are all focused on the same task (Goldman et al., 2014). Kagawa and Moro (2009) described this synergy as a politico-affective interaction “which develops through the encountering of bodies and represents the gathering of people through the submissive process and the dynamics of affects” (p. 180).

The process of reifying ideas in the prototype is not only mental, but also a chain of social and highly contested engagements. Recall how the weaving of these cognitive threads involves periods of dissent and alignment (“politic-affective interaction”) in the team’s collaboration. That is to say, the prototype also becomes loaded with assumptions and understandings of patterns of social relations that are
echoes of and projections onto the sociocultural milieu. The prototype echoes how the team members are relating to each other, but also projects the team members’ understandings of social relations onto any future scenario where the prototype might be used. In the following two sections I expand on this idea by addressing gender as one of the most salient of those patterns of social relations.

**Gender, intimacy, and endangerment—seeing prototypes as social tools**

In the previous section, the team reaches a critical turning point when they realize the affordance of the prototype ought to be when it allows the young mother to mask how she provides care for her child. Initially the team imagines the prototype might be used on long bus trips, but the team also considers what happens in the home. In public spaces, it may allow a mother more discretion and flexibility to provide the kind of care she deems best, and in the privacy of the home it may even allow a father more intimacy in feeding if he uses the prosthetic too. For each imagined scenario, the prototype has different ways of fitting into or disrupting the social spaces it penetrates. Thus, the when is attributable to the intimacy and endangerment associated with breastfeeding. In this section, I look at the themes of intimacy and threat or endangerment as patterns of social relations suffusing the prosthetic at multiple points in the prototyping session. I focus on gender as one form of social and cultural relationships that affect how the team participants see the prototype as a social implement.

![Figure 4](image-url). Esther dresses the volunteer, Danai, in the prototype, as Clive watches and eagerly offers his assistance.
Gendered intimacy

The activity of prototyping new relationships through the bottle-feeding prosthetic opens up the possibility of disrupting the social structures that insist on maternal care (such as the absence of paternity leave and conservative social conventions). Recall the exchange between Anesu, Esther, and Beatrice:

Esther: But remember the issue is not even when you go out. It’s what happens at home when the gogos [grandmothers] are seeing that you’re not breastfeeding, that’s where the issue is! . . .
Beatrice: She wants to see the breast itself . . .

In this exchange, the gogo imposes the terms of breastfeeding intimacy through her surveillance of how mother and child interact. The team realizes that the prototype ought to structure how the young mother can resist this imposition. As the team begins to “see” the prototype acting in the future as a social mask, the team asks questions about artistry, believability, familiarity, and aesthetics. And when the team must “see” the prototype acting in the future as a wearable object, they ask questions about its bulges, symmetry, comfort, and weight. The fluidity of breasts must be accounted for in order for the team to design a breastlike prosthetic. For the design team, breasts function multiply as objects that are inappropriate for a design challenge, objects that sag, objects that are familiar in look and feel, and objects that might allow more paternal involvement in childcare. By the end of the prototyping session, the team can adeptly scale their way of seeing the prototype to fit the kinds of questions about breasts and breastfeeding they want to answer. The physical form of the emergent prototype signals to the team features of the prosthetic they have overlooked, but also possibilities for breasts and breastfeeding that they couldn’t previously see:

Esther (calling to Beatrice, the only other woman on the team): Come and see he’s getting excited about being a mother. (Laughter) So the father can actually breastfeed if you do this now. (Laughter)
Clive (failing to find a second golf ball for the second “nipple”): So we need another golf ball or . . . Do you need another one?
Beatrice (looking through the prototyping bin): Do you want a bigger one? Because now we don’t have a [second] golf ball . . . (Chatter and questions as mostly the men step in to adjust the prototype on its model. Esther, Beatrice, and Anesu watch from a short distance)
Esther: Look at all the guys getting in there. Weren’t these the guys saying, “I don’t know anything about breastfeeding”?
Beatrice: Now they can see how they can breastfeed [with the prosthetic] because they didn’t think a man could be breastfeeding.
Anesu: They don’t know how to breastfeed but they do know what a woman’s breast looks like (Laughter) . . . That’s where the inspiration is coming from . . .

Danai [who is wearing the prototype]: I think it should be a bit higher up . . .
Esther: That’s all right . . . She’s got two kids so the breasts are down there . . . (more chatter and laughter)
Beatrice: That’s what I call gender equality!
Anesu: Men can now breastfeed so paternity leave would now make sense . . .
Gendered endangerment

Some of the men on the design team were initially apprehensive about the role they could play in the design challenge, claiming they did not have much to contribute to the topic of breastfeeding. This discomfort was marked by profuse apologies for touching a female guest who had come to help the team test the prosthetic. “This isn’t sexual harassment, okay?” In veiled protest to the design topic, this male participant references decorum, unsolicited intimacy, and sexual harassment as a kind of gendered endangerment.

Another aspect of endangerment, which I return to later, is the contrast between urban and rural. In the video prompt for the design challenge, relatives of the young mother are cooking together during the Heroes’ Day holiday weekend. The weekend is a celebration of the country’s liberation war heroes and is marked by massive urban migration out of the cities back to rural homes (the tribal trust lands or “reserves” that black Zimbabweans were relocated to during colonial segregation). The reference to the holiday invokes Zimbabwe’s colonial past while also making the setting instantly recognizable as a confrontation between rural and urban ways of life. The dualisms “tradition” versus “modernization,” “rural” versus “urban,” and “colonized” versus “sovereign” function as an intricate backdrop for the theme of endangerment. In her history of colonial medicine in Zimbabwe, Vaughn (1991) attributed the contestation of rural wisdom by modern medical knowledge to these exact dualisms, and their purpose in the video prompt is to evoke that medical authority.

Because of the young mother’s HIV-positive status, the traditional approach to maternal care (breastfeeding) is endangering the young infant, yet the social and economic constraints of being a rural woman have endangered the young mother’s capacity to give good care. The team’s attempt to design possible interventions on endangerment means each member must consider carefully how men and women relate to their traditions, identity, and heritage (both cultural and postcolonial) differently as rural or as urban Zimbabweans. Through the lens of the prosthetic, the dualisms of rural/urban, colony/postcolony, modernized/traditional come to be seen as performances. For example, in the video prompt, medical knowledge is typecast as “modern,” through a performance of being modern that allows the team members to assert difference between the conflicting “truths” of the young modern parents and the traditional grandmother. Annemarie Mol (2003) described diverse sites of identification, knowledge, and treatment of an object as enactments of that object. Here I borrow Mol’s description of enactment as an assertion of authority, to make the case that the prototype is itself becoming a site of many enactments of authority. In the following section, I illustrate how dualisms are deployed in enactments of authority.

Materials as a display of difference

This section focuses on two examples of enacting difference. Both examples set up problems about difference and make assertions about what problem solving entails. Both enactments are examples of gendered talk and make reference to the political economy; both express a feeling of alienation and exclusion that is evoked by what materials display or signal. I invoke these two examples of gendered talk as though they are “paratexts” (Grey, 2010) or “patriarchal constellations” (Campbell Galman, 2014). Like “paratexts,” these gendered assertions or enactments are not directly related to the prototyping task, but are happening around and outside of the actual prototyping session. Furthermore—like the stars—“patriarchal constellations” are gendered discourses that exert, from afar, influence over the dynamics of the team. I use a temporal shift in my descriptions of the gendered talk to emphasize this performance of distancing and circumfluence.

Gendered talk case 1 or simply, “women who like nice things”

The first example of gendered talk came up when my colleagues and I tried to recruit one surgeon, Garikai, to participate in the workshop series. He explained the challenges of his work
to us: “See, the situation in Zimbabwe is an abnormal one. Patients here have to worry about where to buy the cheapest aspirin. If they are admitted into hospital they will be billed for each syringe before their treatment can continue.” These small technologies symbolized how his patients experienced the prevailing political and economic conditions as everyday materiality (of shortage, dysfunction, and structural collapse). When we suggested that design thinking could be an opportunity to solve some of these problems, he retorted, “You ladies are complicated. You’re too advanced for me! I’m a simple man.” He declared, “I can take you to meet some women like you who like nice things!” before marching us down the street to a nearby private hospital. This hospital had just received accolades for drastically transforming its service delivery and increasing its patient capacity. It was situated within the cluster of medical buildings that constituted the Baines Medical Centre and eventually sent several practitioners to participate in the workshop series. On the way to the hospital, Garikai explained that our enthusiasm for design thinking made us like “house-girls” who like “nice things.” He contrasted such house-girls to garden-boys who, in their tattered work coveralls and muddy gumboots, are recognizable for what they are, working class.

The garden-boy’s dress, coveralls, and gumboots is the attire typical of the men who kukiya-kiya in Harare’s most marginalized open spaces like Siyaso and Gazaland. These men strip abandoned cars and other dilapidated structures for metal, which is then refashioned, by hammering and welding, into 50 L water tanks, wagons, and window-frames that are sold to the city’s denizens who, in light of economic instability, prefer to invest their money in developing real estate. By lacing the self-presentation of the garden-boy and the house-girl onto the nature of their working-class labor in the private sphere, Garikai resurrects gendered class aspirations as modes of questioning legitimacy and access to participation in activities such as design thinking. The house-girl aspires to elevate herself, even if this is a frivolous pretense, whereas the garden-boy is true to his station. For Garikai, these dual positions are analogous to design thinking and kukiya-kiya as approaches to problem solving. His analogy delimits kukiya-kiya as a masculine space that is more tuned in—to borrow from Jameson, 1986—to which Zimbabweans are condemned. His delegation of masculine and feminine spaces mirrors Rosner’s (2013) findings in Makerspaces where gender differences can not be transcended as women’s repair work is cast as nontechnical, yet class disparities are overcome in the notion of men from all classes united by the activity of repairing broken household electronics.

**Gendered talk case 2 or simply, “I like your handbag-sha!”**

The second example is a similar assertion of gender difference. It is drawn from the workshop’s tea break, which was timed shortly before the prototyping session. I noticed one of the male doctors from the team standing on his own and asked him why he hadn’t joined the group of colleagues nearby. The group was, curiously, all female. He told me, somewhat conspiratorially, “They are probably talking about handbags, hair extensions, and nail polish and I wouldn’t know how to handle myself.” His playful enactment mimics Garikai’s analogy of “nice things” or frivolous materials as awkward. It turns out the women were talking women’s business. When I joined them I found them placing orders for chickens. Indeed, they had started out with questions about handbags. “I like your handbag-sha, where did you get it?” “My neighbor, she gets them from South Africa …” was the colored response. Through conversational twists and turns the discussion eventually led to chickens, cooking oil, soap, and other utility household goods that were hard to find in Harare and routinely smuggled from South Africa by mostly female traders referred to as “hoarders.”

The chatter about handbags was a marker for establishing collaborative networks of supplies and demands. The emphatic suffix, -sha, is a diminutive for shamwari (“friend”). One conversant had used the chatter to establish herself as a middle-woman, connecting a circle of female “friends”
(future clients, their families, and neighbors who might one day return the favor) with a reliable though temporary supply chain of fresh, home-reared chickens. By leveraging this mode of Maussian (2000) social debt, the women engaged in a kind of “women’s business” that benefitted everyone in the entire circle. Women were using “nice things” to display their access to unattainable resources and to find means to mitigate their own alienation in the economy. Although it was a “feminized” version of kukiya-kiya it was equally authentic and effective in the social context of women’s circles.

Kukiya-kiya entails “seeing,” whether one is female or not, the inherent dysfunction, failure, and transience of broken things and “envisioning” what these objects can be transformed into to make ends meet. Even though kukiya-kiya is often relegated as “male” and the literature on kukiya-kiya largely misses female perspectives, kukiya-kiya pervades all kinds of spaces. As Jones’s (2010) fieldwork shows, one kukiya-kiya practice called kujingiridza can mean “to make money, or you can jingiridza a broken stove … or apropos Zimbabwe’s 2008 presidential poll debacle, you can even jingiridza a democratic election” (p. 293). It is through this pervasive logic of kukiya-kiya, I argue, that the design team projects diverse kinds of political aspirations onto the activity of prototyping. For example, recall how Beatrice insists that the role of the prototype is to make ideas visible. In the two examples of gendered talk, the activity of repairing and reconfiguring objects becomes more than just an act of survival—it is one of reconstituting subjectivity as people come up with new ways of relating to the material to find economic, social, and sometimes political recourse.

**Perception and mediation of artifacts**

My objective in this final section is to use the logic of kukiya-kiya as a provocation of the theory on how artifacts are “perceived” and what they “mediate.” Gibson’s (1977) concept of affordances insists that

> the observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of an observer. (p. 78)

In this article we have tried to see how different threads of perceiving or attending to the prototype and its affordances are selectively picked up and abandoned. We looked at the intellectual labor (or cognitive residue) behind specifications for the physical components of the prototype—bids, scaffolds, themes, and contexts; we looked at the cultural moments of intimacy and endangerment that the prototype is supposed to remediate; we looked at the social tensions within the group creating the prototype and saw how they, as enactments of authority, become embedded in the prototype itself; and we’ve looked at the dynamics of disrepair and dysfunction and how they influence, from a distance, perceptions of prototyping activity. Our prototyping session illustrated how collective imagination, performing identities, and remembrance of everyday conditions are also integral to perception.

These different ways of “seeing” means that the affordances of the prototype are always framed and reframed within the context of the economic crisis and the kinds of subjectivities it produces. We looked at gender as one example of the different ways of seeing. Our prototyping team exercises a kind of seeing that is an assertion of difference, an enactment of authority, and an inherently political act. In the prototyping session, perception is full of agency; it is not only selective, it is related to tensions in identity and is always politically contingent. However, the kinds of “seeing” performed in our prototyping session are not quite captured in the three traditional characteristics of affordances “relationality, transparency and sociality” (Knappett, 2004). What is missing is an appreciation of global flows and how differences in the global order impact the way that objects scaffold thinking or fail to fade into the background.

I invoke dysfunction and disrepair as a crucial first step in acknowledging the role that global flows, especially circulation and alienation, play in the perception of affordances. On the matter of
disrepair or “dematerialization,” Ingold (2007) suggested that “the properties of materials are not attributes, but histories” (p. 15). He wrote, “Materials . . . continue to mingle and react as they have always done, forever threatening the things they comprise with dissolution or even ‘dematerialization’ . . . [changes which are] experienced as degradation, corrosion or wear and tear” (p. 10).

My point is that “dematerialization,” although it happens everywhere and is not particular to the Zimbabwean crisis, is selectively attended to by people who kukiya-kiya. I have called this attentiveness of the histories of materials (be they postcolonial, neoliberal, capitalist, racial) disinheritance. Disinheritance captures the histories that shape how objects come to be in Zimbabwe. I am speaking here of the role international development schemes and humanitarian aid efforts play in destabilizing African economies (Fassin & Pandolfi, 2010). In a setting like Zimbabwe, for example, objects are laden with the histories of international intervention that sustain their dysfunction.

How people think with objects, with culture, and with others has been the concern of scholarship on everyday cognition, distributed cognition, situated learning, and to some extent cultural-historical activity theory. Although they use different units of analysis, these perspectives share three general principles: (a) cognitive skills are situationally specific; (b) institutions and normative techniques socially orchestrate thinking or activity; and (c) everyday cognition is effective, practical, and opportunistic (as outlined by Rogoff & Lave, 1984). I refer to them interchangeably as “learning” not to collapse their differences, but to emphasize what they have in common with rapid prototyping and kukiya-kiya—understanding that thinking or activity is intricately interwoven with the social context of the problem to be solved. These conceptions of mind, culture, and activity, building primarily on Vygotsky, stress how a social context affects cognitive activity at two levels: by providing tools or cultural artifacts for cognitive activity and related practices that facilitate problem solving and by configuring, via social interactions, the activities of individuals.

Now, to make this concept of disinheritance (and its inherent acknowledgment of global flows) useful to the study of learning tools, I stress the question of mediation: Vygotsky’s cultural artifacts play the role of mediating activity. In cultural-historical activity theory Vygotsky’s model of stimulus, response, and “auxillary stimulus [cultural artifact] mediating between subject and object” (Rückreim, 2009, p. 100) is especially crucial. In disinheritance, some cultural artifacts (such as infrastructure in a state of disrepair) have come to be seen as a universal cultural heritage that is inherited, though unevenly, from a dispersed yet globally connected “society.” Such artifacts are laden with social meaning precisely because of the uneven relationships that bring about their disrepair or dysfunction.

The activity of kukiya-kiya, seen in our prototyping session, relies on perceptions of global and local unevenness such that, à la Vygotsky, the “stimulus” is dysfunction, the “response” is kukiya-kiya, and disinheritance—the perception of things as Other, transient, and exploitable—plays the role of “auxillary stimulus mediating between object and subject.” That is to say, kukiya-kiya becomes such a useful practice because it emphasizes seeing materials historically, and by doing so affords a kind of agency or acting on the very histories that exclude and marginalize.

Activities such as kukiya-kiya, collectively referred to as “informal activity,” have been documented across all kinds of economies—Uganda, Nigeria, Brazil, India, and even the Maker Movement in the United States. Informal activity is triumphantly framed as “disruptive innovation,” a term that has been appropriated from the original meaning of progress and change that defy skepticism or institutional inertia (Bowers & Christensen, 1995; Christensen, Johnson, & Horn, 2008) to narratives of technologies penetrating the remotest and poorest regions of the world; or exploiting untapped markets; or the overly triumphant rhetoric of “disruptive technologies” that collapse oppressive political and economic systems. Calling this process “disruptive” gives the impression of violent, radical upheaval and runs the risk of overlooking the stealthy, cunning, and opportunistic subversion that guides disherited people in reconstituting their understandings of the world. Although this celebratory language of “disruption” captures how
informal activity gives people the means to make possible livelihoods in the worst cases of poverty and exclusion, it opens few avenues for systemic disruption (Neuwirth, 2014). These narratives make it difficult to determine exactly how individual agency relates to social structures. In my reading, the language of “disruptive innovation” ratifies the continued marginalization of informal actors. It is my hope that, as done in this article, discourse moves away from seeing activity as economic toward seeing activity as learning. As we have seen with kukiya-kiya, informal activity is a kind of learning perspective—a pervasive logic that allows people to exercise agency and perform identity through their perceptions of technologies as systems of disinheritance.

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