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Postcolonial Computing: A Tactical Survey

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Abstract

The authors suggest that postcolonial science studies can do more than expand answers to questions already posed; it can generate different questions and different ways of looking at the world. To illustrate, the authors draw on existing histories and anthropologies and critical theories of colonial and postcolonial technoscience. To move forward together, rather than remaining mired in regretful contemplation of past biases, the authors offer some analytical and practical suggestions. In reading hegemonic forms of postcolonial computing, this article offers tactics for rereading, rewriting, or reimagining those scripts.

Keywords

postcolonial, computing, tactics, indigenous knowledge, HCI, ICT4D

Introduction

The One Laptop Per Child (OLPC) project, initiated by researchers at the Massachusetts Institute of Technology, has famously aimed to provide low

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Figure 1. OLPC ad asks donors to transform "developing" world lives with technology.

cost, rugged laptops as means of "creating educational opportunities for the world's poorest children" (The OLPC Wiki 2008) and to do so at a massive scale. Though OLPC's original distribution strategy was to sell laptops to national governments for distribution in schools, many countries ultimately pulled out of the project, citing the final laptop as too expensive or too risky. As a result, OLPC has appealed to tech-enthusiast donors in wealthier countries to "give one, get one"—purchasing a laptop for themselves as well as a child in a recipient country.

A recent video advertisement for the program depicts Asian and African children hunched in manual labor before cutting to an African boy dressed shooting an automatic firearm at glass bottles while the narrator tells us "Kids learn fast." The images suggest that third world children of color are currently learning two things quickly: manual labor and violence. The ad then cuts to African boys wearing collared shirts engrossed in the iconically green XO laptop as the narrator exhorts: "Let's give them the right tools" (Figure 1).[1]

The advertisement tells a fairly straightforward technologically determinist story—the laptop can turn the lives of these children around, perhaps, because it will open doors to different life paths, away from manual labor and violence to middle class knowledge work. At 30 seconds, some may argue that tropes of lack and aspiration expediently compel audiences to donate. How does the problem framing contribute to the ad's efficacy?

The video reduces child labor to a question of permission or prohibition, rather than a network of questions about how, why, in what political economy or which contexts. Other possible questions remain unheard: Could the shooting child be part of a conflict over water access as usable local rivers become scarce? What labor conditions enable the manufacture of such an inexpensive laptop? Do these children labor to get the cash that enables the supply of Monsanto seeds, tied into land ownership, irrigation strategies, and techniques? Complex and heterogeneous socioeconomic situations are universalized into a unitary category: the underdeveloped child. Understanding opportunity in these children's worlds would require an investigation of particular locations—drawing on history, political economy, and ethnography, and specific resource, community, and technology dynamics.

OLPC is one of many government, corporate, and nonprofit programs promoting Information and Communciation Technology for Development (ICT4D). The video calls our attention to popular narratives of computation and practices of information design. We suggest that this high-profile example of using computers for development is symptomatic of situations we call Postcolonial Computing.

Why Postcolonial?

Reading some common—one might call them hegemonic—forms of postcolonial computing, this article offers a few tactics for rereading, rewriting, or reimagining those scripts. Our reimagined model is also called Postcolonial Computing. That is, we see critique and rewriting as part of the same tactical process. We offer no absolute escape from ideology, no newly "appropriate" technologies or quick cultural fixes. Postcolonial Computing is a bag of tools that affords us contingent tactics for continual, careful, collective, and always partial reinscriptions of a cultural–technical situation in which we all find ourselves.

What is it about this cultural–technical situation in which we find ourselves that necessitates the deployment of such tactics? There is much about it that recalls the history of colonial technology transfers and of the assimilation of local knowledges. But we suggest that an important element of the novelty of our situation lies in recent developments in computational design. We will return to this point, developing our arguments and examples through computational design practices. But first, we explore why the analysis of this cultural–technical situation might call for the use the tools of postcolonial studies.

Why borrow from postcolonial theory?[2] Science and Technology Studies (STS) has over the past two decades refined a set of complex methodologies for the symmetrical study of truth and error that handily gets around the Enlightenment myths of abstract Reason and Western Rationality.[3] STS methods are widely used now, to understand technology and science, but parallel developments in humanities theory illuminate cultural dynamics understudied in STS. This postcolonial cultural–technical situation encompasses the entirety of the world we live in, shaped by the post–World War II atomic age, numerous mid-twentieth-century decolonizations, the Bretton Woods era, the 1970s oil crisis, post-Fordism, neoliberalism, new technologies and their attendant time-space compression, and new forms of global migration in which the flows of people, goods, and ideas took on formations different from those of previous eras of slavery, colonialism, and occupation.[4] All these and more led to the rewriting of practically every discipline in the humanities, giving voice to previously silenced framings of humanity and society. Science, technology, economics, and the "hard" disciplines, however, remained less susceptible to such rewritings and stood apart from the general ferment that became tagged as post-structuralism, postmodernism, postcolonialism, and so on. STS did take on the hard bastions of objectivity, transforming Euro-American sociology, history, and philosophy. However, much of the mythos of the Western origin stories of science and rationality, while being demolished in theory, manifested itself in practice, in a locational focus on Euro-American spaces of science. Even when scholars began to study other locations, there remained what Warwick Anderson characterized as a "semiotic formalism," in which "the 'local' can seem quite abstract, depleted of historical and social specificity." Studies implicitly assumed that the origins and practices of scientific truth could be fully articulated in Western contexts, and that an expansion to non-Western case studies would not significantly shift paradigmatic models. A version of the "mix and stir" method thus characterized many attempts to globalize the scope of STS. We suggest that postcolonial science studies can do more than expand answers to questions already posed; it can generate different questions and powerfully different ways of looking at the world.[5]To illustrate, we draw on the already rich histories and anthropologies of colonial and postcolonial technoscience. Below, we offer some analytical and practical tactics. Though drawn primarily from computing, these tactics invite translation and adaptation.

Why Computing?

As our opening example suggested, OLPC represents and reimagines the knowledge economy, offering computing as a tool for entering it.

Postcolonial computational sites such as these, as well as their associated forms of practice, organization, and design, offer opportunities for understanding postcolonial technoscience more generally.

Postcolonial Computing for Them; Plain Vanilla Computing for us?

Postcolonial Computing is not simply about the failure of good intentions via inadequate design, a liberal remedy for the illiberal error of prejudice, or an etiquette handbook for culturally "ignorant" designers. While the history of such errors and ignorance is certainly germane to any discussion of global technology, our main concern here is quite different.

First, Postcolonial Computing does not hold that design over "there" is fundamentally different from design "here." Researchers located in the West might appear to be the most productive innovators, while those in the developing world might appear at first glance to be simply adopting Western diffusions. However, on a closer look, both sides of this dichotomy are seen to be composed of contradictory stratifications, articulations, and meanings. There is no essential character or single "here" of Western knowledge and design. Nor is design "everywhere" converging inexorably to the shape of "here;" difference abounds. On one hand, we notice methodological innovations everywhere, suggesting commonalities across the West and the "Rest." On the other hand, incommensurability appears to mark relations not only across cultures but within them. As similarities and differences cross cultural boundaries, the boundaries themselves are called into question.

Postcolonial Computing advocates a focus not simply on the negative critique of constructions of cultural difference, but on the productive possibilities of "difference" itself. The seams among differences are not simply a source of undesirable unevenness and aberration, but also sites of creativity and possibility.

Second, Postcolonial Computing does not seek to transform design methods "there" by adapting supposedly culture-free Western design to supposedly culture-laden non-Western contexts. We approach design practice as a complex practice of translation. Translation has a dual meaning: the linguistic sense captures the transformation between different languages—culturally situated representational schemes; the geometric sense refers to the movement of a figure from place to place. Design methods as portable prescriptions of practice presume that translation preserves meaning. Instead, we draw attention to the purposeful, partial, and situated work that legitimately translates ways of life into technological needs and mandates.

Third, Postcolonial Computing does not merely advocate critical attention to computational design products (software packages, games, etc.) Human–Computer Interaction (HCI) research has already recognized the cultural specificity of design products, and this is an important step. However, the processes and methods of design are still considered universal. Methods of "user-centered" or "appropriate" design presume the logic of a God's eye view and an agentic designer. Taking a broader view, we argue that methods—the products of research communities, economic actors, and educational practices that span the globe—are always transnationally produced in situ. We view designers, planners, makers, the objects they shape, and a range of diverse users, as part of an assemblage. This assemblage includes not only the dreams of design but the messiness of manufacture as well. It links materials sourcing, the context of making, and legal regimes, with the historical fields of discourse that make computational design possible today. Just as STS has highlighted the need to examine the socially situated and contingent nature of scientific practice, so we want to draw attention to the dynamics and contingencies of design methods, in order better to understand how they might be subject to new forms of translation, transformation, and reconfiguration.

Our goal is to broaden the conversation about technology development by placing it in a theoretical and transnational context without relying on dualisms such as developed/developing, traditional/scientific, or colonial/postcolonial. Akhil Gupta illustrates the empirical inadequacy of such dualities in his account of entangled chemical and humoral Indian farming knowledges (1988). Hybrid communication is multidirectional in his stories, and technological encounters take place over years and decades. Attentiveness to the emergence of similar hybrid practices in information technology design can help render design more locally legible and contextually effective.

Our goal is not simply to bemoan the problems that arise when methods fail to move easily and stably from one setting to another but to understand design efforts as always already processes of hybridization. While many translational design problems arise primarily in "obvious" postcolonial contexts—in ICT4D projects, for example—our arguments are broader in scope. Hybridizing encounters happen not only across seams of national difference but also across other seams. For example, anthropologist Lucy Suchman (2002) framed the work that she and her colleagues conducted at Xerox as the staging of encounters among various stakeholders, including engineers and workers. This suggests the broader relevance of a focus on hybrid knowledge practice, via understandings of power, history, identity, and epistemology.

Recombinations of STS, Information Studies, and Postcolonial Studies have been productive before. In 1994, Suchman opened a paper on software systems design by quoting STS theorists Langdon Winner and Donna Haraway. Her paper's primary audience was in "Computer Supported Collaborative Work." Suchman invoked Winner's insights into the ways in which technological artifacts embody the politics of their design and development, and Haraway's demonstrations of how contingency, partiality, and heterogeneity capture something important about technoscientific practice, in order to make original claims about the future of ICT design. Extending Winner, she noted that "technology" suggests only objects but also their associated human/technical practices. Suchman also invoked Foucault, and cited the achievements of "postcolonial STS," showing that human subjectivity, like technology, is an outcome of historically specific practices. In this article, as in others since, she has implicitly held that humans and technological objects can be analyzed in a common rubric, rather than separated by disciplinary categories. Following her, we do not assume the unique application of Humanities for human analysis and Informatics for technological analysis.

Suchman's work illustrates how interdisciplinary borrowings lead not simply to the replication of an insight from one field in another but to reframings that produce new insights across both disciplines. Her analyses offer implications for how designers deal with computational categories, for how humanists might read Foucault, and for how programmers interpret Haraway's unruly universe. Postcolonial interdisciplinary practice can provoke alternate models of analysis and practice.

Non-Computable Complexities?

Most disciplines have built-in procedures to avoid problems of complexity that are too hard to handle within their methodological frameworks. Thus, it may seem counterproductive to render a seamless narrative seamful, to relativize a universal explanation, or to destabilize a sedimented claim. Does not this method produce a non-computable problem? For all its flaws, are not science and technology working for our betterment, and is not this quibbling simply another act of sabotage—the throwing of an intellectual *sabot* into the technical machine?

Information designers would be justified in asking for a road map through this deeply specific yet unremittingly abstract model of

Figure 2. Contrasting perspectives on the one laptop per child project.

Postcolonial Computing. Rather than offering Postcolonial Computing as a new ideal or a Novum Organum for the information age, we sketch out a pragmatic set of tactics, below.[6] What is at stake is the very practical, everyday practice of observing, analyzing, and working with natural, physical, informatic, and cultural systems.

> *Tactic 1:* When we see a technoscientific object, we investigate its contingency not only locally but in the infrastructures, assemblages, and political economies that are the conditions of its possibility (Figure 2)[7].

Tracing the long networks that enable technological formations is essential to a postcolonial account of technologies (Anderson 2002). When part of the assemblage seems to be taken for granted rather than seen as contingent, we ask why.

The first picture above depicts technological objects in use in a specific context. What are the conditions of possibility of this moment? The OLPC came to these two girls in part through the much publicized efforts of Nicholas Negroponte and open source coders, through the navigation of media and social networks, through sometimes antagonistic negotiations with software and hardware producers, and a dense assemblage of other forces and actors. In the second image, we see a rarer peek into the assembly lines of computing in a photo that stages the celebration of the XO's departure from design phases into manufacture and deployment. These paired images are a study in contrasting tropes—foreground/background, effect/infrastructure, authorship-use/execution, and ingenuity/routine. The photo on the right is the indication of the standing reserves of feminized Asian labor that manufactures the XO laptop, like many of the world's computers. The women's labors are part of the conditions of possibility of the girls' use of the XO. Such labors are hardly attended to in ICT4D or HCI. Infrastructured, the women's labor recedes into the background of consciousness to be taken for granted in use (Star 1999). Practically oriented engineers, designers, and STS practitioners can take them for granted because these women and their labors are held in an assemblage that is fixed, taken for granted, and consistently available, rather than visibly contested, contingent, and uneven.

Why do unstable, contingent relations appear as fixed and inevitable? Stories about the networked travels of technological objects reveal layers of information about the power relations that enable those networks. Often, the labor and natural resources needed to produce computers has gone unexamined. As Warwick Anderson has suggested, "Postcolonial studies of science and technology might offer opportunities to generate systemic understandings of political economies ... or at least they might offer us threads to follow through the labyrinth." (2002, 652). The labyrinth, or the network, is forged of connections made up of secretaries, semiconductor manufacturing workers, railroad systems, data centers, trade agreements, arms dealers, and other hybrids. These appear as background to the heroic actors (programmers, marketers, and users, in this XO story), because they are held as if on "stand by, to be immediately at hand, indeed to stand there just so that it may be on call for a further ordering" (Heidegger 1977). These standbys are not the character actors who have found their voices in numerous network narratives or laboratory ethnographies. The origin stories of the standing reserves of nature and labor are part of the narratives one must unravel in Postcolonial Computing.

Tactic 2: When we see a technoscientific regime coalescing, we look for work that is out of the bounds of this regime.

During the 1970s and 1980s, Brazil instituted special market protections for computer manufacturers, providing privileged market access to firms that designed computers within Brazil. Brazilian lawmakers had translated the consumption of artifacts designed outside of the country as an economic vulnerability and, additionally, a cause of poverty. A Brazilian company called Unitron responded to these incentives by reverse engineering and manufacturing a Macintosh computer clone they named "Mac de periferia." Though Apple had no intellectual property protection for the Macintosh in Brazil, the American corporation was able to pressure government and other economic actors within Brazil to reframe Unitron's activities, once seen as nationalist and anti-colonial, as immoral piracy. In exerting political pressure through its economic strength, Apple was able to reshape notions of authorship to exclude reverse engineering and modification, realigning Brazilian notions of intellectual authorship with American notions that privilege designated originators over maintainers and modifiers of code and hardware architecture (da Costa Marques 2005).

The story of Mac de Periferia foregrounds a question about invention: What counts as new? The assignment of novelty lies at the heart of how we value technological work. Novelty is far from obvious in some cases, contested in everyday talk (Suchman 2008) as well as in intellectual property trials. The answer to this question has implications for the transnational political economy of technoculture. We can trace the importance of legal and technical regimes by tracing the boundaries of what counts as innovative/imitative.

Unitron's work was not only an appropriation and translation of software knowledge produced in Cupertino. It was also a response to contemporary conditions surrounding intellectual property and the economics of software production.[8] International trade regimes often enforce alignments of regimes of control and ownership of knowledge. The diffusion of computational design practice is not a simple transfer of technology between cultural settings but a hybrid translation process enabled by the global circuits through which people, capital, and goods are already flowing. The economic benefits of these alignments and partnerships flow unevenly. Unitron's activities were simultaneously a technological design process, a form of political resistance, and a sociotechnical attempt to redress an economic unevenness, taking place in a field conditioned by political economic flows and active legal and cultural negotiations about innovation.

Unitron had performed intellectual and material labor in responding to local policy incentives, reverse engineering the Mac, and figuring out how to reliably manufacture it using local skills, materials, and infrastructures. This is the work—"integration, local configuration, customization, maintenance, and redesign"—that Suchman (2002) argues has been kept outside the legible boundaries of "professional design." The legal dismissal of articulation work by international forces in this case mirrors a broader cultural dismissal of articulation work, seen as a place where real innovation does not happen. In contrast, Suchman underscores the importance of local improvisation in technology production: "Local improvisation . . . is not just a matter of receiving something already made and incorporating it into a new site of use . . . . Rather, improvisational activities are the generative practices out of which new technologies are made" (Suchman 2002).

Questioning "innovation" and its invocations of originality opens up new spaces of inquiry into technocultural practices. How does something come to count as innovative or original? How do certain kinds of work, such as reverse engineering, call center technical support, or "rote" mathematics, come to be seen as the opposite of innovation? In what kinds of moral and legal economies do designations of innovation circulate?

What might we learn about innovation and the subtleties of technological embeddings by studying those technologies that are considered "copies" rather than the original? What are the political economic consequences of technojuridical or technocultural categories such as copy and original, innovation and derivation? What would we learn about political philosophy and the scripting of technological objects by studying those who crack software codes and violate their terms of service in different ecological and discursive milieus?

Apple is said to have derived its own innovations from the Star, developed by Xerox PARC. Xerox sued Apple for infringement in 1989 (Fisher). But that history is only known because there are voices familiar with PARC, who could circulate that story in powerful networks. In what ways are concepts of ownership and means of settling questions of ownership negligent of subaltern technologies and relations of property that were not noticed, archived, or defended when their derivatives were claimed as novel? Thus when we see legal, technological, and other systems coalescing to form a discrete regime of computational practice, we understand it via that which is drawn out of its boundaries. As the concept of innovation is elucidated by stories of copying, so other technoscientific regimes can be recast by investigating those negative spaces they exclude.

Tactic 3: When we see claims of inherent technological and cultural difference, we apply STS methods symmetrically to both the technology and the culture at hand. But we do not stop there; we proceed to deconstruct the binary between technology and culture and study the impure crossings between them.

Erin, a business analyst at a large Internet company in the United States, describes collaborating with teams in India to locate promising customers. The Indian employees had been tasked with identifying upgrade leads—existing customers with whose businesses might benefit from an increased level of service. After a few weeks of this collaboration, the U.S. team found that the businesses identified by Indian colleagues lacked what they considered good business models. The Web sites were not "well designed," their technologies were not "exciting," and their brands were unrecognizable to the Americans. Because they were in headquarters, the U.S. employees ultimately determined what counted as a legitimate lead but were unable to convey it to the Indian team in a way that helped them come up with more satisfactory leads. The U.S. team worked around these misunderstandings by asking the Indian employees to do highly formalized, quantitative analysis and computational tasks since such tasks left less room for ambiguity. "They are strong at math but less good at things that require some gut judgment," Erin explains of her Indian colleagues.

As technologies and collaborations around them have come to span national boundaries, cultural encounters such as Erin's have come into focus, recurring in our fieldwork. Erin understands the situation by recourse to a familiar story that understands Indians, like stereotyped Asians more broadly, as technically proficient but lacking business intuition. A larger assumption of national homogeneity and difference undergirds the account.

Technologists in ICT4D and HCI, as well as organizational scholars, have confronted thorny problems in intercultural collaboration and design that they have tried to resolve through a taxonomic model that sees culture as something that is inherently stable enough to be fixed as an invariant.[9] The stable differences claimed by taxonomic models of culture have their corollaries and echoes in some forms of user-centered design that strive to fit technologies to a stabilized notion of the user (Berg 1998). The focus on "cultural difference" as a topic for system design has sought to understand cultural characteristics so they may render culture as manageable in the software design process. Cultures have been taxonomized to fit managerial purposes since the early days of colonial anthropology (Goh 2006). Postcolonial Computing begins with the recognition that the categories on which taxonomic models are built, such as female, Asian, or human, do not exist independently of technology. Rather, what it means to be American, or Indian, is often deeply entangled with power, institutions, and technologies. Technologies such as language and radio emerged as technocultural productions and themselves have been instrumental in the imagination, creation, and maintenance of nation-states (Mrázek 1997; Siegel 1997). Media technologies in part constitute the very cultural categories by which some seek to explain them.

Understanding these categories' historical contingency blurs taxonomic borders and generates new kinds of questions. We see ways in which these categories are not inherent attributes of people or groups, but instead different positions in relation to multiple flows of people, capital, discourses, and media—flows and phenomena that can change over time. Postcolonial conditions underscore the cross-cultural encounters such as migration, media flows, extraction, and trade, which generate hybridities, conflicts, hidden resistances, and even cooperation and complicity (Gandhi 1998) at many different scales.

This methodological practice continues the process of tracking crossings between the narratives at hand and others in the shadows, between those in and out of the frame. It implies a generative, rather than taxonomic, view of culture—one where the cultural is produced and reproduced as people collectively encounter the world, a system of interpretive signification that renders the world intersubjectively meaningful and object-filled (Barad 2003). From this view, an individual may participate in many cultures—cultures of ethnicity, nationhood, profession, class, gender, kinship, and history—each of which, with its logics and narratives, frame the experience of everyday life. The goal, thus, is not to classify people and place them on a scale, but rather to understand how the technological objects and knowledge practices of everyday life arise as contingent, processual and dynamic materializations.

Tactic 3, Corollary: When we see an instance of indigenous science or "native" technology, we investigate it not as an instance of inherent difference or autochthonous authenticity but as a practice with the same epistemological status as putatively Western sciences. In other words, our categories, while always subject to grounded interrogation and theoretical critique, emerge from assumptions of diachronic imbrication rather than synchronic incommensurability.

> India is probably the only country in the world where you can send e-mail to a person who doesn't have access to the Internet, a computer, phone, or heck, even electricity. And, how? For Rs 10 and an A4 sheet, postmen will receive, print and hand deliver e-mail anywhere in India (or vice versa), typically within a day. How do you provide 'last mile connectivity' in a nation where only six percent of the people can access the Net and fewer still can read? India Posts' admirable reply would be: 'With our feet, and privacy be damned.' It's jugaad. (Ramachandran 2009)

Jugaad is what some Indians call an indigenous form of innovation. A word with many definitions, it often implies a problem worked around, a solution jury-rigged, and social connections and materials put to uses few could have imagined.

Some root jugaad in persistence and improvisational skill while others cite it as an approach honed in environments where scarcity and limited product choice characterize daily life. "Perhaps the *jugaad* gene is hardwired into Indians as an evolutionary adaptation for an environment in which things, more often than not, fail to work—if you want to get things done, you have to learn to reconnoitre your way around poorly designed and executed processes and systems," writes *The Hindu Business Line*.[10] In recent years, jugaad has become something of a banner for a post-1990s India establishing itself as a global innovator. Nasscom, India's IT business processing outsourcing (BPO) chamber of commerce, summarizes jugaad as an evolving business aesthetic rooted in scarcity, characterized by adaptability and relentless experimentation, and increasingly incorporating "analytical" and "strategic" approaches (Sharma 2007). The jury-rigged scooters and cell phones rescued from the precipice of obsolescence have drawn attention from bloggers, the *Wall Street Journal*, Indian businessmen-cum-authors, and designers seeking a form of innovation that they can designate as characteristically Indian.

What might it mean, then, to speak of indigenous or "native" knowledge? "Indigeneity," like "reason," can be a strategically invoked designation. Whether "indigenous" or "scientific," ways of knowing the world and practically encountering it also have symbolic resonances that are part of the performances of those knowledges. To act in a way others recognize as jugaad may be a matter of making the unlikely happen, but it can also be pleasurable or strategic essentialism. While it is tempting to assign instrumentality primary priority in considering technological practices in different cultural settings, the trafficking of jugaad suggests that performing knowledges can take on other resonances and circulate in other moral and symbolic economies. When Indians describe jugaad as *innovation*, in what ways is their assertion of sameness a mode of provisionally constructing commensurability, or as Helen Verran puts it "local, particular, and contingent symmetry" (2002, 731), so that difference can be asserted as well? When we consider alternate rationalities and epistemologies, what "complex and situated definition of rationality" does justice to their nuances in context (Philip 2001)? How is sharing knowledge a way of expressing identity, respect, sensibility, or trust? How are these very categories inadequate to convey the nuances of the many registers in which knowledge and technique are performed? Is jugaad evidence of incommensurably different design cultures? Is jugaad a manner of observing opportunity and taking action that represents an inherently different attitude to design, a hardwired indigenous skill? Even while provincializing rationality, how do we avoid reducing postcolonial knowledges to that which is fully commensurable with STS practitioners' expectations?

We argue against positing essential difference and caution against deploying one particular model of hybridity to represent a whole national or cultural design sensibility. All contexts are heterogeneous. Bricolage and articulation have always characterized technology design. We read ascriptions of hybridity and indigeneity as something other than originary and essential.

Incorporating hybridity into design practice requires a reconsideration of approaches that promise appropriate technologies or user-centered design as science that imply technology designers must develop objects appropriate to some stable, coherent, and knowable cultural space. Such models of cultural difference figure two locations, "here" and "there," where "there" is other, apart, and disconnected, stably distanced from "here." "There," the site of intervention must be knowable so that design interventions can be correct or effective. This spatialization of here and there is itself a legacy of colonial systems of difference, where the colonial power observes from a vantage point ahead of, or above, the colonized populations. We suggest that the design of objects is inextricable from a conversation about how these places are related to one another both by their uneven relations of power and the very presence of the observer marking the difference.

An alternative to Appropriate Technology (AT) practice can be found in a recent movement known as Critical Technical Practice (CTP; Agre 1997). Beginning through attempts to diagnose the limits of dominant AI paradigms, CTP coupled technical exercises with Derridean critical theory. CTP has been taken up in HCI as well as new media arts as a way of questioning assumptions of computational systems and motivating alternative technologies. As design theorist Warren Sack reminds us, "Even the technical details of the new media mechanisms we are discussing today are political. It's politics all the down" (Sengers 2009).

CTP suggests, then, that there is no escape from the political nature of technocultural practice. Instead, there are only located, always ambivalent engagements. This approach is one alternative to the sort of practice that claims correct answers, appropriate technologies, and user-centeredness for knowable sites of intervention. Instead of good conscience design interventions, CTP generates reflective and provocative engagements and more questions. Artist Simon Penny suggests that CTP catalyses expansive inventive thinking, and that "this approach tacitly recognizes that certain types of artistic problem solving compensate for the 'tunnel vision' characteristic of certain types of scientific and technical practice" (Penny 2000). If technical practices—whether robotics or jugaad—are enacted politically all the way down, then symmetry offers a tactic for analysis of the "modern" and "indigenous" alike.

Tactic 4: When technoscientific knowledge appears to diffuse from higher to lower concentrations, we look for signs of the opposite. What forms of technical practice seem to move against the flow, to develop unexpectedly, to pool in alternative spaces? What else (people, technological objects, laws, and capital?) moves with, or against, these knowledge practices?

The Warumungu people of Australia have been developing the Mukurtu Wumpurrarni-kari Archive (MWA), a repository organized into categories negotiated as significant to Warmungu people. The archive is built around Warumungu practices that organize appropriate seeing and speaking through kinship networks. Depending on one's kin, one is enabled to speak of and visit certain things but ought to avert their eyes around other things (Christen 2005). The system developed through negotiations and technological efforts among some Warumungu people, Christen, and software developers. The system now comes out of the stabilization of understandings of Warumungu information practice within an archival technology.

If the indigenous spaces are sites of contestation, cultural innovation, and connection just as those spaces called modern, we should expect to find new forms of technical practices emerging and moving from these spaces.

The archive is a tactic with a long history. In part, the MWA is a way of enabling storytelling for the education of younger generations who are now educated in town schools away from kin geographies.[11] The archive is also worldly; it has been designed by people conscious of and willing to circulate representations of aboriginal life as a way of engendering public awareness, interest, and alliances. "Culture" can be a product that sells coffee table books and gets grants. "Culture" is also a term through which Warumungu negotiate sovereignty and legitimacy with the Australian state (Christen 2005; Povinelli 2006). These indigenous information and technology practices call our attention to the politics of debates about legitimate use and access of information. Items in the MWA are neither public nor private but appropriate to see based on kin lines. This calls into question the public/private dichotomies that characterize many debates about intellectual property and digital commons. The MWA assigns ownership neither to a collective commons nor private individuals but instead grants access and use along negotiable lines of kinship.

The dynamics of movement are critical to understanding contemporary problems of ICT and globalization. The archive's technological reconfigurations underscore how contact, mobility, and circulation—worldliness—is as much a part of so-called indigenous technologies as it is of modern ones.

Historian David Arnold (2005) has argued that prevalent conceptions of technology diffusing from the West to the rest of the world have covered over the many innovative scientific, agricultural, and medical technologies that traveled to Europe and America from the supposed periphery. How do people, ideas, technologies, and methods move between different domains, and what sorts of problems attend those translations? How are these new technological mobilities situated within transnational migrations of people, capital, and other resources? How does history become consequential in contemporary technology use and meaning? What kinds of policy, infrastructures, and methods might support the development of new forms of partnership, and what kinds of transformations might we imagine and expect in commercial and technological practice as such transnational connections proliferate?

These alternative practices are not innocent, but worldly. We do not suggest, then, looking to these alternative practices as a nobler way of living or as inspiration for better solutions to be redistributed globally. "It worked for us, so let us transform it to work for them" is as problematic as "it worked for them, so let us transform it to work for us." As we have argued, the postcolonial computing calls the terms "work," "us," and "them" into question, while calling for reimagined, accountable, and provisional forms of transformation.

> *Tactic 5:* The universal model, the view from everywhere, and the voice of the center remain radically incomplete. But they cannot be completed by addition. Context and particulars are always already constitutive of a sociotechnical model, and therefore we begin with them, rather than adding them as "complex" supplements to a "simple" initial model.

Amazon Mechanical Turk (AMT) is a Web site where employers can put up large volumes of small tasks for pennies a task. People seeking to kill time or earn money can come to the site to perform the work. The many thousands of workers provide an around-the-clock workforce that provides «artificial artificial intelligence» to software developers. Cognitive pieceworkers label images, structure data, and rewrite sentences within form fields that make their output amenable to searching, filtering, and display on Web sites such as Amazon.com. Computation, here, is not only what happens in silicon and circuit boards but also in other wetware and fleshware brought into alignment in service of computation. The computational laborers are legally considered contractors in Amazon's Terms and Conditions and thus not entitled to minimum wage, though most workers make a few dollars an hour. In high-tech media, the low wages are explained as sensible because many people report doing it for fun and those who do not are presumed to live in a poorer country. However, one of the few surveys of workers found that 15 percent of workers always or sometimes rely on AMT to make basic ends meet and a larger proportion of such workers are in the United States (Ross et al. 2010).

Human labor is part of the processor power of computational networks. Who assembles materials so that chips can compute? These are not new questions nor do we invoke them here in order to assert the computer's materiality in the last instance. We wish to ask, instead, questions about the status, scope, and significance of the problem of materiality.

At one level, all computing is literally material; the representational and computational efficacy of the informational revolution is built on the practices of twentieth-century materials science and engineering. One cannot pose the question of matter without opening up a familiar political debate. When does the materiality of the computer emerge—in the conceptual advances in circuit design? In the assembly of ever-smaller circuits?

In 1985, The Cyborg Manifesto invoked the "nimble fingers of 'Oriental' women" and "women's enforced attention to the small," taking the postindustrial scientific revolution to task. Haraway (1985) predicted, "it might be the unnatural cyborg women making chips in Asia and spiral dancing in Santa Rita jail whose constructed unities will guide effective oppositional strategies" (p. 154). What do we know, a quarter-century after the Cyborg Manifesto, about the conditions of informatic production? We know of the toxics used in chip manufacture and some of their health effects on workers.[12] We know that in 1995, a 55-pound computer "generated 139 pounds of waste and used 7300 gallons of water and 2300 kilowatt-hours of energy, and will use many times that energy during its lifetime, will fill landfills with toxic waste after its lifetime" (Ryan and Durning 1997). Early twenty-first-century computer advertising comes with claims of green design and manufacture, which indicates the decrease of resource use and waste, but with no anticipation of a complete remediation of the problem. And green concerns have become safely detached from red ones—that is, ecological footprint stories and green design claims invariably appear separately from reporting on political economic footprints. Some forms of STS avoid the narratives of capital and the polemics of sustainability, in favor of the complexity of description.[13] It might seem to some of us that the problems of exploitation are now passé, obsolete. After all, has not labor been virtualized? Is not information clean, free of the soot of industrial era dirt? Has not the rise of knowledge work displaced the concerns about manual work?

From one perspective, computing and global markets conjure visions of clean development. From another, they evoke new inequities in a networked global division of labor. Postcolonial Computing offers a way of seeing from both perspectives, but in ways that destabilize each. Rather than adding one to the other as supplements, we begin by thinking both together. Politics and materiality function not as external context but as part of the ground for forging new modes of engaged description.

Postcolonial Computing In Action

As Lucy Suchman has argued, all forms of communications technologies impose regimes of action (Suchman 2007). Following her insight that "technology is not the design of physical things. It is the design of practices and possibilities," we see tactical Postcolonial Computing as an accessory to future practice not a nostalgic/guilty guide to colonial pasts.

Information and Communication Technology for Development is one context of postcolonial computational practice—a space of hoping, planning, intervening, and designing. ICT4D practitioners have encountered the cultural specificities of technological practices firsthand. Many well-intentioned efforts to "migrate" technologies from developed contexts to other nations or parts of the world have foundered on infrastructural differences (e.g., Verrips and Meyer 2001; Akrich 1992) or on flawed social, cultural, political, or economic assumptions. In the 1970s and 1980s, the problems and failings of technology transfer gave rise to the "Appropriate Technology" (AT) movement that argued for taking smaller engineering interventions that take local needs more centrally into account (Smith 2005). AT left an intellectual legacy in the recognition that user needs and contexts are of central importance and must be the place to start. This appreciation for local contexts has been expressed primarily as a focus on understanding the nature of the difference between "here" and "there," where "there" is the developing world, poor communities, or particular countries understood as separate from the point of observation.

This legacy has shaped recent ICT4D efforts, which often rely on taxonomic models of culture and teleological models of development, imagining "developed" nations as the modern terminus. Such models have come under critique in the last two decades (e.g., in Development Studies, Political Economy, and Postcolonial Studies) and circulated within the ICT4D community. Mark Warschauer notes that "well-intentioned programs often lead in unexpected directions, and the worst failures occur when people attempt to address complex social problems with a narrow focus on provision of equipment" (Warschauer 2003, 43).

"Global technology design" manifests another postcolonial computing site. As technology companies identify attractive markets in "emerging economies," technology designers try to understand and design for contexts unfamiliar to Euro-American design practice. In HCI and information systems practice, user-centered approaches involve an active engagement with users or their direct representatives through a variety of methods and staged encounters. As technology companies design for these different spaces, the methods and practices of technology design travel.

"Global design," however, seems unreliable—systems effective in the United States may fail utterly in Japan, and design aesthetics vary wildly from place to place (Marcus and Gould 2000). Even methods for participatory design and usability evaluation—genres of social practice with a history of reliability in Western design contexts—fail in new cultural contexts (Akrich 1992). Designers and marketers have taken up taxonomic models of culture to explain and design for difference. Such categories may suit particular agendas and projects (Goh 2006), can serve to "sort people out," or to strategically argue difference to one's own advantage (Mazzarella 2003).

Global distributions of computational labor, implicated in the knowledge economy, are a third postcolonial situation. Postcolonial geographies of interconnectivity, collaboration, labor, trade, and extraction have been enabled in part by the distributed connectivity and storage of the Internet (Aneesh 2006), the metrological practices of technoscience (Latour 1987; Turnbull 2000), and new systems of financial regulation (Ferguson 2006). While outsourcing has gained some visibility in Euro-American media, computer manufacturing is an often-hidden site in the social life of computing.

We see Postcolonial Studies and Postcolonial STS as offering long-term, flexible, and robust accounts of cross-cultural engagement and history—accounts that elucidate these longstanding, thorny problems in ICT, but also promise to enrich STS and HCI. Several STS scholars have recently elaborated aspects of engineering and design (Fortun 2004; Latour 2008) as embodying central aspects of STS concerns. In the spirit of this discussion, we have drawn from STS and postcolonial studies a set of issues relevant to information technology.

Rather than seeking to "reform" design, we call into question the separation of standard and fringe or mainstream and marginal notions of design. Marginal, frontier-like, or "culturally sensitive" participatory "fringes" of design have much to tell us about mainstream computing. Enlightenment science and reason, similarly, are not a disconnected, binary opposite to non-Western cultural practices. Such binaries were perhaps always fantasies of structuralist and culturalist simplification, and certainly cannot hold now, with the consequences of international traffic in design discourses, technologies, and people. It is in this sense that Postcolonial Computing is simultaneously the name of a phenomenon and an articulation of both its hegemonic and its resistant practices.

Postcolonial Computing proposes a rubric under which to examine this new global configuration of technology, cultural practices, economic relations, and narratives of development. This analytical rubric is interdisciplinary from the ground up, exploring how cultural contexts shape the design and use of ICT, as well as how ICT and ICT design function as a site of cultural encounter and technological translation.

Conclusion

Postcolonial computing is a way of asking questions, a mode of investigating and a form of conversation. It is not a theory of ends—it does not imply the historical end of colonialism, the end of exploitation, the end of history, nor is it a road map to egalitarianism, communitarianism, or democracy as philosophical ends. Postcolonial Computing is an approach to familiar areas of research that could too easily slip into simple, rigid patterns, achieving closure and canonicity at the expense of discovery and experimentation. It is more mode than method; more tactic than strategy; more a way of proceeding than a field object. It is a tactical epistemology, a need-to-know approach to reality that expands the scope of what one needs to know, and improves returns on our transdisciplinary reach.

Each tactic incorporates a vignette drawn from our larger research projects. Rather than tell each of those stories, we have used them anecdotally to demonstrate how particular modes of problematization draw questions out of our seemingly banal, daily observations in the field. We call our results tactics, rather than methodologies, strategies, or universal guarantors of truth. Tactics lead not to the true or final design solution but to the contingent and collaborative construction of other narratives. These other narratives remain partial and approximate, but they are irrevocably opened up to problematization. Such instability might earlier have been viewed as a problem (stability implying lack of truth, contingency showing lack of universality), but perhaps we can recognize, now, how instability can be a strength, not a weakness, of technoscientific practice and theory.

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Notes

1. The video was posted to http://www.youtube.com/watch?v=zPC2rbQG–U, by the OLPC Foundation on December 10, 2008 (accessed September 25, 2009). OLPC descriptions and images are reproduced here for educational purposes only. OLPC-related "Content is available under Creative Commons Attribution 2.5," see http://laptop.org/en/olpcorps/index.shtml, accessed December 9, 2009.
2. Critical theorists like Lyotard and Derrida have identified the unprecedented informational and transnational power of computational communication (databases and cybernetics for Lyotard and tele-techno-sciences for Derrida) as significant for the Humanities and for theorists of modernity and postcoloniality. The project of Postcolonial Computing is located in a space that has already been identified by postcolonial theory as a crucial area for investigation. We learn from those who have underscored the importance of this area but suggest that a closer attention to computational practice, information science, human–computer interface design, and other (seemingly banal) technological practices is still needed.
3. STS, of course, incorporates within it several competing discourses, from the Edinburgh school that elevated the principle of symmetry to an antinormative principle, to other trends that seek engagement with the world as modifiable technoscientific construct. Bruno Latour's early work (1987, 216) showed Western science as drawing from indigenous knowledge; "truth" was assigned to the former, and "custom" to the latter, via tactical deployments of historically specific forms of power. Whether self-described as postcolonial or not, much of STS has already incorporated a critique of truth that owes its legacy to the same intellectual, institutional, and disciplinary histories that produced the work of post-structuralist scholars. Yet, the groups have been separate in social and institutional settings.

4. These phenomena have been analyzed in different disciplinary domains by Frantz Fanon, Edward Said, Gayatri Spivak, David Harvey, Manuel Castells, Arjun Appadurai, and Roy Bhaskar, among others.
5. Warwick Anderson articulates the promise of postcolonial technoscience: "[It] might offer new, and more richly textured, answers to many of the questions posed in actor-network theory" by making apparent not only the network but "the relations and the politics engendered through it" (Anderson 2002, 649.) In Anderson's analysis, what is needed is "not so much an interrogation of the Western figure of the man of reason as an empirical study of the translocal co-production of technosciences and social orders" (2002, 647). Similarly, we argue that a conversation at the interstices of STS and humanities paradigms could open a space for new work that none of them alone can produce.
6. We take tactics to be piecemeal, opportunistic interventions in response to relations of dominance. In contrast to strategies, which Foucault (1980) characterizes as vast and coherent, tactics are improvisational and local (See also Critical Theory Institute, 2008).
7. Photos have been reproduced from Communications of the ACM v52(8) and flickr.com user inju http://www.flickr.com/photos/inju/1960432516/
8. Intellectual property has been a significant topic of debate in the encounter between indigenous knowledge systems and transnational corporate interest. See, for example, Gillespie (2006); Hayden (2003); Philip (2005).
9. These taxonomic models grew during a period of Cold War and globalization where intercultural encounters generated increased academic and governmental interest in understanding difference between cultures, particularly those defined by nation or region as relevant for work among the many nation-states of the twentieth century (Appadurai 1996,16-22).
10. Radhika Chadha, "Indiagenous Ingenuity," accessed May 14, 2009, http://www.thehindubusinessline.com/catalyst/2009/05/14/stories/2009051450080200.htm.
11. For discussions of indigenous knowledge archives focused on teaching within the community, also see Verran et al. 2007.
12. Arsenic, antimony, phosphorous, fuming nitric and sulfuric acid, and other compounds have caused severe bodily harm to workers who often earn a few dollars an hour mounting and assembling chips. Chip manufacturing processes use large quantities scarce water and gold and produce toxic tailings and large amounts of waste. The construction and disposal of lead and plastic chip housing add to the problems of resource use and waste.
13. See Joel Wainwright's (2005) "Politics of Nature: A Review of Three Recent Works by Bruno Latour."

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