Communication and Media

A Feminist Geopolitics of Technology

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Global Perspectives

This article proposes a *feminist geopolitics of technology* framework that analyzes the connections between global politics and techno-empires through the lens of feminist scholarship. This framework has three dimensions: (1) grounding in place, (2) attention to everyday surviving and thriving, and (3) community. We draw on two long-term, community-oriented ethnographic research engagements in Cambodia and Ghana to illustrate how this approach might be used. This framework provides a resource for scholars to make sense of the contrasts between dominant narratives and lived experiences, particularly encouraging more sensitive and generative approaches to analyzing the conditions and dimensions of a shifting geopolitics of technology. In writing stories of caring, thriving, and grounded alternatives, we hope to foster and support initiatives that encourage personal agency and living the full human experience amid inequality and structural violence.

I. INTRODUCTION

From the United States to China, from Facebook and Huawei, a rise in digitally mediated authoritarianism, nationalism, and populism around the world presents major obstacles for digital governance at scale. The torrent of techno-empires—forged by governments and corporate entities alike—presents a continuous assault on the freedom and security of users and citizens within and outside of traditional geographic boundaries. We define a techno-empire as a relation of power characterized by a single authority extending its reach by defining rules and capturing control in matters of the digital in formerly sovereign states. Drawing on intersectional feminist literature, this article proposes a *feminist geopolitics of technology* framework to analyze the connections between global politics and such techno-empires. Our goal in developing this framework is twofold. First, we aim to show how intersectional feminist scholarship elucidates the emerging conditions and dimensions of the geopolitics of techno-empires. Second, by applying the framework to our ethnographic work in Cambodia and Ghana, we provide a cross-disciplinary analytic lens for studies of technology and society relevant for researchers in human geography, Science and Technology Studies, human-computer interaction (HCI), and related fields. We hope this framework serves as a resource for scholars working to define the contours of and contrasts between dominant narratives of lived experiences with digital technology. In particular, we seek to encourage sensitive and generative tools for analyzing the geopolitics of digital technology.

The feminist geopolitics of technology framework is historically informed in that it considers histories of colonialism and racial capitalism in analyzing contemporary power relations. It draws on intersectional feminist literature (S. Ahmed 2010; Crenshaw 1989, 1993; Collins and Bilge 2016; hooks 2000; Rankin and Thomas 2019), as well as feminist technoscience (Barad 1999; Bardzell and Bardzell 2011; Benjamin 2019; Haraway 1988) and feminist geography (Elwood 2020; Elwood and Leszczynski 2018; Massey 2012, 2013; Hyndman 2001; Rodó-de-Zárate and Baylina 2018). Taking this intersectional and decolonized feminist approach, this framework encourages attention to the lived experiences of marginalized populations, including those in the Global South, ethnic and racial minorities, disabled people, and others who have been historically (and continue to be) marginalized economically and socially in imperial-capitalist regimes. Such attention helps in analyzing various lines of affinity and dis/empowerment within and beyond the unit of the nation-state.

Dominant articulations of the "margin" and the "center" speak to the ways technological power is imagined in the global economy, with particular sites (i.e., the West/Global North) seen as the center and the rest (i.e., the Global South) seen as the periphery (Chan 2013). In speaking of and from the margins, we do not amplify tales of deprivation. Instead, following hooks, we pay attention to the care that enables not just surviving but thriving within techno-empires. Here we locate sites "of radical possibility, a space of resistance" (hooks 2000, 206). Indeed, marginality is a site for producing counter-hegemonic discourse "not just found in words but in habits of being and the way one lives"

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(hooks 2000, 206). For example, our collaborators in Cambodia and Ghana are largely working- and middle-class urban dwellers who perceive themselves as marginalized in some aspects of their identities (e.g., in relation to participating in arts and technology work from a "peripheral" region). But these notions of marginalization sit alongside other aspects of their multiple, intersecting identities, some of which also reflect their relative class privilege and, for some, gender privilege. How they perceive their own sense of marginality, privilege, and inclusion is critical to how they live out the geopolitics of technology in the everyday.

Our first case draws on long-term research with a grassroots creative space in Phnom Penh, Cambodia. This space offers an "invisible infrastructure" of interpersonal support and trust within a tactile place, or home, of beauty. The cultivation of this space is a response to increasing authoritarian information controls that are being implemented in Southeast Asia in accordance with the ongoing American and Chinese rivalry in government advising and the corporate sphere. In the second case, we unpack the ways that young Ghanaian technologists are pursuing a vision of global STEM education. These technologists ventured to develop a science set to teach the basics of STEM to elementary/primary school children all over the world through principles of community care and persistent hope in the midst of major geopolitical shifts. We demonstrate how this group worked dynamically in relation to business interests from both China and the West. Though frustrated at times by the neocolonial dynamics of tech production in Ghana, these technologists were able to co-opt supply chains for their own entrepreneurial goals.

A feminist geopolitics of technology thus focuses on (1) personal stories grounded in particular places, (2) stories of survival and thriving, and (3) everyday matters of community. We focus on these three dimensions to establish the shared threads across our field sites and more broadly to explore the myriad ways in which the geopolitics of technology shape lives and showcase a kind of "collaborative survival in precarious times" (Tsing 2015, 2). This article is situated in what we consider classic geopolitics of technology. However, we adopt a feminist approach to intervene in and actively decenter the totalizing notion of state power prevalent in classic geopolitics. Specifically, we adopt feminist theorizations of affect and care to expound the everyday practices that enable surviving and thriving in the face and in the wake of techno-empires. We present the cases of two community groups who exemplify these feminist practices of care for surviving and thriving, and we conclude with some reflections on the implications of these practices.

II. GEOPOLITICS OF TECHNOLOGY

In geography and international relations, *geopolitics* is a set of realist approaches to foreign policy that focus on geographical aspects of the state (Mamadouh and Dijkink 2006). Digital technology and its modes of circulation act as both tools and catalysts for new geopolitical regimes (Aouragh and Chakravartty 2016; Hecht 2011).

Current geopolitical events emerging around digital technologies highlight the ongoing asymmetries of power between regions. Many of these relationships are patterned on and gain from existing colonial arrangements, while others are emerging around new regimes of domination. Within human-computer interaction (HCI), earlier conversations have positioned technopower rightfully in the *longue durée* of history, highlighting how present systems of production benefit from these earlier violent histories (Philip, Irani, and Dourish 2012; Dourish and Mainwaring 2012). Calls for historicizing and decolonizing the study of technology production and use have served as a foundation for important shifts in the field—indeed, the view that interventions are designed in one place (generally technoscientific hubs in the West) and unilaterally disseminated into new contexts (often in the "developing world") is questioned more in discerning HCI communities, including human-computer interaction for development (HCI4D). For example, we see Ames's critique of One Laptop Per Child—which shows how technology can gain utopian grandeur for social change and then fall dramatically short in practical intervention—as moving the conversation and the discipline forward in important ways (Ames 2019).

In related studies of artificial intelligence, critiques of algorithmic bias against Black people and women (for instance, Buolamwini and Tucker 2017; Buolamwini and Gebru 2018) showcase how techno-empires of today are rooted in the racial capitalism alluded to by the HCI critiques noted above. Capitalism's origins are entangled with the invention of race, the transatlantic slave trade, and European colonization (Robinson 2000). Racial capitalism is the maintenance and reproduction of capital-intensive wealth generation; at its heart is the "degradation of work and life, dependent on racialized and gendered difference" (Freshour 2018, 35). Naming this regime enables us to see continuities of technologically mediated oppression in seemingly diverse sites like abandoned rural areas in the United States, ethnic minority communities in the Global South, borderland slums, and anti-immigrant mobilizations in the European Union (Freshour 2018). It also allows us to see how there is a dominance of two models of digital governance in contemporary geopolitics.

One model is what we note above—specifically, the digital governance most visibly represented by American technocapitalism, in which monopolized technology companies accumulate consumer/citizen data as their own proprietary resources (Couldry and Mejias 2019; Zuboff 2019). This model is extractive and follows the colonial template by mining data and advertising revenue in the Global South for wealth accumulation in Silicon Valley and other Global North sites. Contemporary information and digital infrastructures also reflect colonial histories and unbalanced representation in decision-making (Rosa and Hauge 2020). Recent crises involving Western transnational corporations, like Facebook's influence on elections and political issues, underscore how embedded and dangerous these private corporations are for the global polity. There have been efforts to reign in these corporations and attempts to (re)capture liberal ideals of privacy and individual autonomy—for example, through the US state of California's Consumer Protection Act (CPA) or the European Union's General Data Protection Regulation (GDPR). There have also been attempts at improving the ethics of emerging technologies to try to eliminate bias from large data sets (Zook et al. 2017).

These efforts have their limits, however, and the fundamental effects of deregulation in late capitalistic expansion remain intact, allowing certain private corporations unprecedented and hegemonic global reach.

The other model is exemplified by the current Chinese government, which enacts communitarianism, nationalization of platforms, and strict state information control and censorship (DeLisle, Goldstein, and Yang 2016). This model encapsulates what has been labeled capitalism with Chinese characteristics (Lindtner 2020; Yang 2015) and effectively decouples capitalist expansion from liberal democratic ideals. Maintaining strict social control through the Communist Party, China's economic success in the last thirty years has provided a model of digital governance for other states in which democracy was already tenuous. The Chinese state's signature surveillance tactics have long been employed by many other ostensibly democratic nations, albeit less explicitly. Chinese-made technologies accompany the state's current "globalizing era," providing yet another avenue through which the Chinese model of digital governance gets taken up in different geographies (Mozur, Kessel, and Chan 2019). This model, embedded as it is in the same system that the other is, is also racialized, and we see this aspect in reports of Chinese-made facial recognition tools targeting ethnic minorities within China itself (Mozur, Kessel, and Chan 2019) and their uptake in particular sites in Africa—for instance, in Zimbabwe (Chutel 2018).

While these two models differ with regard to how far governments are allowed to intervene into private lives, widespread surveillance and value extraction act as tools of capitalist expansion and state control in both. Geography, international relations, and digital governance studies are attuned to emerging technological territories of power and how they function at the level of the nation-state. However, citizens often bear the brunt of government and corporate decision-making, so it is critical to understand how the geopolitics of technology is encountered in the everyday. We identify a robust approach to guide such attention in feminist scholarship, which elucidates how technocapitalism and digital government models are experienced and resisted "on the ground."

III. FEMINIST GEOPOLITICS OF TECHNOLOGY

Feminist geographers cite feminist theory as a way to critically examine "classic" geopolitics. This approach moves beyond the elite diplomatic level and shifts the geopolitical focus to the ways everyday people carry out their lives (hooks 2000; Hyndman 2001). Feminist theory intervenes in geopolitics at various scales aside from the nation-state to address unequal relationships and move toward a politics of recognition and distribution. Drawing in particular on feminist scholarship on collectivity and care (e.g., Benjamin 2019; de la Bellacasa 2011; Mol, Moser, and Pols 2015; Tsing 2015), we suggest that a *feminist geopolitics of technology* (henceforth FGoT) provides insight into how people thrive in spite of emerging technological regimes. We suggest that acts of care (de la Bellacasa 2011) and collective action (Tsing 2015; Benjamin 2019) allow people to survive and move toward a condition of everyday thriving. To suggest this, we decenter the nation-state as the primary unit of inquiry, focusing instead on the quotidian experiences of techno-empire. FGoT has three dimensions: grounding in place, everyday surviving and thriving, and community.

GROUNDING IN PLACE

Digital technologies work at multiple scales, from the embodied to the national. This question of competing scales is a classic feminist problem, and one that feminist geographers have approached in compelling ways (Hyndman 2001; Massey 2012). Attention to scale exposes questions of relationality, an orientation that foregrounds relationships rather than individuals and attracts attention to actors' positions in relation to power (Haraway 1988). Feminist scholars have paid attention to relationality within global/local infrastructures (Star 1999) as well as in technoscience (Haraway 1988). Attention to relationality works in concert with postcolonial and feminist technoscientific theory to underscore that the digital turn does not represent a revolution, a break or gap in history, but rather a continuation of structures of power and privilege (Eubanks 2018).

Rooting analysis in specific places exposes continuities in lines of power and scale (Elwood and Leszczynski 2018; Lindtner 2020; Tsing 2015). Feminist scholars have found that "a politics of becoming in place" is a way of being attendant to geographic, relational, and symbolic positionality of a specific place, person, or community, contributing to the recognition and autonomy of politically disenfranchised people (Gibson-Graham 2006). As Blunt and Rose (1994, 7) explain, "this elaboration of a subject position [or discrete location] marked by the histories and geographies of power relations denies the erasure of self enacted by the master subject."

To follow this line of theorization, we refocus the classic geopolitical scale of the national and the corporate to the personal and the embodied. Working within this politically oriented focus on specific geography, recent ethnographic work in global computing has shifted technology discourse away from questions of dissemination and access to questions of circulation and appropriation (S. I. Ahmed, Mim, and Jackson 2015; Avle et al. 2019). Jack, Chen, and Jackson (2017) show, for example, the integration of popular corporate platform Facebook into long-standing independent market culture in Phnom Penh, including older technologies like feature phones and motorcycles. This case shows that new power dynamics (rule setting by a transnational corporate entity) are integrated into older power dynamics (e.g., gender, class, and spatial) of the city.

Feminist scholars have further illuminated the ways that places are gendered, leading to unequal access and participation. Feminist theorizations of space note that private space (such as the domestic sphere) is often feminized and public space (such as the city) is masculinized (Rendell 2000; Blunt and Rose 1994), and that this difference has implications for who can participate in such spaces and then contribute to public/political discourse (Massey 2012). Rendell (2000), however, explains how feminist scholars disturb this binary by demonstrating the ways that women do occupy public space and reassert the societal importance of family and domestic life and work. Indeed, to quote Pratibha Parma, as hooks (2000, 209) does, "the appropriation

and use of space are political acts."

Access to space, and the broader question of gender equality within which it is embedded, moves beyond gender binaries, of course, and is a function of how "intersecting power relations of class, gender, race, and nation shape the institutionalization and organization of a range of institutions, policies, organizations, industries, and so on" (Rankin and Thomas 2019, 65). Intersectionality, as demonstrated primarily by Black feminists (e.g., Combahee River Collective 1983; Crenshaw 1989, 1993; Collins and Bilge 2016; hooks 2000), provides a critical lens and approach for understanding the complexities of power, identity, and lived experience. hooks (2000) adds to this broader set of positions by characterizing the spatial binary of center and margin to explain how being of and on the outskirts of systems can strengthen positions of resistance via personal history and storytelling.

While physical places may be how some are able to live and resist, others have to look to online places to create that life. Virtual spaces, like physical places, are socially conditioned and imbued with power differentials (Harrison and Dourish 1996). These conditions come to matter especially for those vulnerable to digital forms of power like surveillance (for instance, activists, journalists, or artists), those made to be dependent on social welfare (Eubanks 2018), and displaced or unhoused people who lack the privilege of claims to Western ideals of privacy (S. I. Ahmed, Mim, and Jackson 2015). The need for social distancing during the current global pandemic exacerbates existing inequalities for vulnerable populations and women reconfined to homes—for example, those without an internet connection who cannot participate in virtual schooling and economic activities.

In this article, we focus on physical places—homes, coworking spaces, offices—as a way to literally ground our analysis and to underscore the importance of place for our participants. Building on STS and HCI scholarship, we recognize the blurred lines between virtual and physical places and how their conditions bleed into each other or compel movement from one to the other. Our interest in place serves to illuminate the ways people actively carve out places as a way to live and survive amid the challenges of marginality (hooks 2000; Lorde 1982). Our cases show how our participants ground their lives in particular places as a response and counterpoint to the ways their lives are impacted by dominant national or corporate technological regimes.

EVERYDAY SURVIVING AND THRIVING

These days, technology often does not *feel* good. In the United States, we feel conscripted into a capitalist project when we code or use corporate platforms (Zuboff 2019). An abundance of empirical work has demonstrated that emerging communication technologies and their sociotechnical assemblages (such as the so-called smart city) are exacerbating inequalities (Eubanks 2018). With the tech industry strengthening ties to authoritarian and populist politics globally (Irani and Philip 2018), technology use can be accompanied by legitimate feelings of fear, anger, and a loss of agency.

There is room here for a realist *and* joyful vision, however (Wright 2011). We all live under conditions of structural violence, though some experience this violence more explicitly than others depending on one's relation to the margin. Even in the wake of violent and totalizing structures, people find ways to survive, and still others thrive. We perceive everyday surviving and thriving manifesting through acts of care (de la Bellacasa 2011) as well as in collectivity and community-rooted actions (Tsing 2015). Acknowledging joy and pleasure does not negate pain and oppression; indeed, attaining *pleasure* may even be an effective form of activism and a subtle subversion of the work that oppressive capitalist hegemonies do to rob people of their joy, comfort, and safety (Benjamin 2019; Brown 2019). As Gibson-Graham (2006) suggests, a theoretical commitment to a politics of possibility is an ethical act of enabling such politics to develop. Elwood's (2020) call to identify "glitch politics," or the alternative ways of surviving in conditions of impossibility, inspire us to pay attention to the ways that our participants "thrive otherwise" within structures of inequality.

Affect theory lends a useful framework for uncovering these moments of *everyday* surviving and thriving. Affect theory emphasizes quotidian life within regimes of structural power, both its material realities and its ephemera, and gives examples of bodies surviving and exceeding the norms of their context (Seigworth and Gregg 2010). The complementary strains of affect theory for feminists, queer and disability activists, and subaltern peoples (S. Ahmed 2010) highlight the affects of "alternative modes of being," "whose dynamics move along and make worlds, situations, and environments" (Berlant and Greenwald 2012, 88). Our attention to these affects leads to pragmatic possibility, or, as Berlant puts it, "representing, and standing for these alternative modes of being, ... provide new infrastructures for extending their potential" (Berlant and Greenwald 2012, 6).

In this article, we draw from these literatures to suggest that everyday thriving is a way to envision alternatives and to create otherwise. We do this without turning a blind eye to the practicalities and the challenges of bringing such a vision to life. Building on particular strains of affect theory (Seigworth and Gregg 2010; Berlant and Greenwald 2012) and anticapitalist politics (Brown 2019; Gibson-Graham 2006), we are intent on possibility, while at the same time recognizing long-standing histories of oppression or structural power differentials. A FGoT thus relates stories of people getting by and/or thriving despite oppressive geopolitics of technology as a feminist imperative (Elwood 2020; Gibson-Graham 2006). We include quotidian emotional states (including our own) in our accounts of so-called "macro" events, structures, and institutions to render people as fully human.

COMMUNITY

Part of our imperative to recognize everyday thriving is to move from chronicling and comparing differences into rich storytelling about collaboration and cohesiveness (S. Ahmed 2010; hooks 2000). Centering solidarity and the joys that emerge from it in our analysis encourages promising alternatives (Gibson-Graham 2006; Benjamin 2019). We take inspiration from Tsing (2018) and others' honoring of

interdependence between human and nonhuman worlds as well as the deliberate cultivation of community through the valuing of plurality and multiple ways of knowing (Tsing 2015; Escobar 2018). We also continue to build here on intersectional Black feminist scholarship, particularly from the radical tradition (Benjamin 2019; Nelson 2011; McKittrick 2006; Rankin and Thomas 2019; Robinson 2000), which has long demonstrated "how black communities tilt the balance of authority toward collective freedom and flourishing" (Nelson 2011, xii; cf. Benjamin 2019, 13).

Collective action is also an avenue toward mitigating some of the most dangerous geopolitical uses of technology. In 2017 Google workers acted in solidarity to oppose the company's support of the US Pentagon drone program Project Maven (Suchman, Irani, and Asaro 2018). This collective advocacy work led to greater public awareness about the connections between acts of war and big tech, as well as a commitment from Google to end the military drone contract, which had transnational and geopolitical ramifications. The continued need for this sort of solidarity remains critical, as the same Google in 2020 exacted retaliatory action against one of the few Black women in AI, Timnit Gebru, for speaking against the bias being built into its systems (Ajunwa et al. 2021).

We also observe community action in more subtle political arrangements, at the level of the discreet place, and the careful cultivation of home (metaphorically realized). One current example we are witnessing in the COVID-19 crisis and related political uprisings—specifically those against police murder of Black people in the United States and more generally racial inequalities—can be found in the coming together of neighborhoods and virtual communities to form smaller solidarity and mutual aid networks. In this article, we likewise speak to the ways in which community develops in and against the matrices of national, local, and corporate power and politics. We are interested in alternative forms of community and chosen kinship as they are fostered by affective relations in physical and virtual places. We show how people respond to and even supplant authoritarian modes of internet governance and neocolonial regimes of technology. Together, we hold that another world is possible, despite the seemingly immovable structures of capitalism, neocolonialism, and authoritarian power. Before we demonstrate the three analytic dimensions of FGoT through our cases, we discuss our methods and provide city-scale contextualization of our field sites.

IV. METHODS

This article draws from long-term ethnographic projects in Cambodia by the first author and in Ghana by the second author. The first author conducted research in Phnom Penh from 2014 to 2019. She began work in Phnom Penh as an analyst for a global NGO and has since held residency posts at three Cambodian-run arts and technology collectives. Part of her research training involved intensive Khmer language learning, both in the United States and in Cambodia. The core interest of her larger project is documenting the role of digital tools in post-conflict healing in Cambodia, and the ways that historical memories are tied into building new technologically mediated futures for young Cambodian

media creators. The project in Ghana that this article draws from is a long-term effort (2011 to 2020) to document and interrogate the lifestyles and motivations of young Ghanaians who are designing and producing new technologies. The project aims to make sense of emerging forms of technological labor, ideas about technofutures, and new spaces of collaboration in technology. Collectively, the data from the two countries include, as is standard for ethnographic work, observations and associated field notes, photographs and videos, reflective journaling, interviews (audio-recorded and transcribed), and public documents, including media coverage.

We (the two coauthors) have an ongoing collaborative relationship and frequently discussed the similarities and differences that we saw in our research sites when we met at conferences or online over the course of several years. In the summer of 2019, we systematically mapped our overlapping analytical themes using shared cloud-based documents. Specifically, each author named themes she found in her fieldwork, and where there were overlaps, those were noted with joint discussion about the nuances of those themes and what they signified. Data collection hinged on building relationships with our collaborators, and our primary challenges (and opportunities) revolved around developing and maintaining good relations with the communities in which we were working. These challenges included affective ones (we were responsible for bringing our full, vulnerable selves into research interactions) and embodied ones (our work required us to go to community events many evenings and weekends and stay present).

As a white Western woman who performed research in Cambodia, the first author acknowledges that her positionality played a role in ongoing, asymmetric power dynamics and ancestral oppressions, both in the fieldwork itself and in its outputs. Her research does not speak for her Cambodian colleagues and participants, but rather seeks to share her experience of the deep listening, observation, and collaboration that took place over the past six years. As a Black middle-class woman with African roots in a predominantly white American university, the second author experiences a liminal life that reflects the ways her intersectional identity is lived and perceived. To wit, this author contends with duality daily, as her identity garners racist microaggressions that impinge on her professional and personal life, while at the same time it affords socioeconomic privileges such as transnational mobility. These experiences are often received in solidarity in Ghana, where she has conducted research in the tech scene since 2011. Her shared experiences of growing up in similar conditions as many of the participants as well as the differences in current lived experiences across the Atlantic inflect her interactions during fieldwork research and are reflected in the research produced. Such a positionality shows how marginality and privilege can be entangled and experienced in the everyday.

Together, our lived, affective experiences impact our methods—from the questions we ask to what we see in our research sites—and our affect is conditioned by our positionalities (Haraway 1988; Dourish and Mainwaring 2012). Our anxieties and frustrations color the stories we tell. They shape what we pay attention to and reflect our own joys and discomforts, even as we attend to the stories of people we

encounter in this work. Indeed, the ethnographic accounts we share below are drawn from moments spent communing with our collaborators. Our analyses are shaped by many long, impassioned discussions about the history of Cambodia or Ghana, Western imperialism, decolonizing African and indigenous knowledge, and postcolonial economic relations with the people with whom we conduct research. These conversations make up a part of our process, while also helping us to confront the (at times impossibly) human work of ethnography. All of these aspects of ethnography require wrestling with complex emotions about poverty, wealth, identity, value, and life itself. Allowing space for the emotions to run, particularly when things happened outside of personal purview, became part of the research, part of how we worked out pragmatic responses, and part of how we and our collaborators learned to live and work together.

We acknowledge these positions not to be indulgent in our reflexivity but rather to demonstrate how allowing ourselves to feel and to *notice* those feelings, in addition to listening and telling stories (hooks 2000; Tsing 2015), is critical to building the kind of feminist solidarity that FGoT strives to bring to geopolitics of technology. It is to show how allowing space for new forms of solidarity—in this case, affective solidarity discovered in moments of collaboration, vulnerability, and care—might give voice to radically different ways of knowing (Escobar 2018).

V. THE CAMBODIA CASE

PHNOM PENH

Cambodian online spaces are among the media points emerging at the margins of competing epistemologies about global digitization amid empire shift. In 2019–20, Chinese influence grew in the domain of Cambodian digital media policy while government relations with the United States and the European Union chilled. Chinese corporate interests are dominant in new telecom infrastructures such as 5G (Parameswaran 2019), but the American corporate platform Facebook remains by far the most popular way for most Cambodians to use the internet. This dominance cannot be overstated: many public infrastructures—from mom-and-pop stores to rural government offices—now utilize Facebook as part of their core functioning (Vong and Hok 2018; Jack, Chen, and Jackson 2017; Jack, Sovannaroth, and Dell 2019; Jack et al. 2021; Vong and Sinpeng 2020).

The Cambodian government, in line with regional trends and based on the Chinese model, is moving toward technological "localization" (Basu 2020). As such, the government is trying to reign in American influence in technology and gain control over the "digital economy" and data flows. This move toward control and sovereignty, though sometimes couched in the language of decolonization, is also a pivot toward authoritarian politics. Human rights advocates have widely criticized the state political activities of 2017–18 as a rapid turn to illiberal democracy after twenty-five years of democratization efforts (Beech 2018). On November 16, 2017, the Cambodian Supreme Court dissolved the primary opposition party, the Cambodian National Rescue Party (CNRP) (Mech and Baliga 2017) in anticipation of the national election in July 2018.

A media transition preceded the political one when the government, with the help of Chinese advisors, implemented tighter information controls. A year before the election, at the end of August 2017, thirty-two independent (nonstate) radio stations were forced to close or stop broadcasts of Voice of America and Radio Free Asia, which were seen as oppositional (Reporters without Reporters without Borders 2017). After these events occurred in the traditional media sector of radio broadcasting, the internet came under more state scrutiny. Before the end of 2017, seven people were arrested for statements against the prime minister on Facebook (Cambodian Center for Independent Media 2017). In May 2018 the Ministry of Interior, the Ministry of Posts and Telecom, and the Ministry of Information declared that they could monitor and control the internet and make arrests based on online activity (Radio Free Asia 2018). The week before the July election, access to independent news websites was cut off entirely nationwide (*Reuters* 2018). Surveillance of the internet and arrests for online activity have increased during the pandemic, as COVID-19 has spurred heightened government tracking and control globally (Kennedy 2020).

These surveillance and control tactics move the country closer to a digital governance model like the Chinese model. They are also reestablishing a legacy of the ruling party, the Cambodian People's Party (CPP), which has tightly controlled broadcast media since it established power after the Khmer Rouge fell in 1979. During and just before the 2013 national election, traditionally politically disenfranchised people, including the rural and urban poor, could participate in politics through Facebook. Their form of participation was issue level, or "everyday" (Vong and Hok 2018), and represented forms of "quiet encroachment on real-world distributions of power" rather than the direct opposition it is being characterized as (Hughes and Eng 2019). Social media was a space of promise and possibility in Cambodian politics, typically controlled by elites. Since the new restrictions on social media imposed in 2017, many in Phnom Penh have become afraid of sharing on Facebook because of political sensitivities and the possibility of arrest. Others shrugged off this political shift as a return to a controlled status quo. Fear and frustration were tangible in and around the city during the 2018 election period.

Along with these major media and political transitions, Cambodia was also in its fifth year of 7 percent GDP growth in 2019 (United Nations Development Program 2019). The cityscape of Phnom Penh, the capital city, became a sea of cranes, construction sites, and demolition, frequently funded by Chinese investment. Poor people were left out of this rapid development as land and housing prices surged. In January 2020 two new buildings crashed down in the provincial cities of Kep and Sihanoukville, killing dozens (Thul 2020). These literal crashes foreshadowed events in the national economy, which halted to negative growth rates in early 2020. In February 2020 the European Union pulled back its preferential trade agreement Everything But Arms (EBA) due to concerns around democracy and human rights. The COVID-19 crisis eliminated Cambodia's tourism industry and disrupted trade with both China and the West.

These economic, architectural, and political events in Phnom Penh have motivated the first author's friends and

research participants to establish private and physical spaces. "We need places where people can talk confidentially and with trust," one participant said.

PTAYAH "HOME"[1]

In February 2017 Rotha founded Ptayah (meaning "house" in Khmer), an independent art space dedicated to giving students and recent graduates space to work on creative projects and meet new people. Ptayah has become a physical space and an in-person community, serving as a kind of "invisible infrastructure" for a new art sector driven by young Cambodian people. Rotha describes Ptayah as "a place for art students, independent artists, curators, and researchers looking for an inspiring space to network and work on their individual projects… We aim to connect, share ideas, and facilitate artistic knowledge between visiting artists, curators, and researchers." This place is an act of care on Rotha's part to create an alternative physical space for free expression. It is a response to a constellation of geopolitical conditions: that it feels less safe to speak freely on the internet due to state censorship and arrest, increased Chinese media advising, and the Facebook monopoly.

Rotha was born in 1987 in Phnom Penh during the socialist People's Republic of Kampuchea period, before national reconciliation through the May 1991 Paris Peace Accords. She started the space using her own money from independent arts management and administration positions, including her part-time job as the executive assistant for an internationally recognized Cambodian visual artist. In Ptayah, Rotha incubates creative groups and gives them free space to work, meet, and hang out; Rotha also gives me (the first author) space to work on my research.

Ptayah is located in a 1920s-era colonial-style townhouse that can be incredibly hard for the unacquainted to find. To get there, one must drive a bike or motorbike down one alley and turn right on another. The space is then obscured behind a metal gate. The entrance holds a few outdoor tables, protected from rain by an overhanging second floor. Upstairs are two small rooms with desks. The main room, downstairs, is an open space with cushions and short collapsible tables for computers, which can be rearranged depending on who is working in the space and where they want to work. Along the edges of the room are bookshelves with an eclectic library of books in Khmer and English about art, architecture, Cambodia, and Southeast Asia.

The back of the room has a small kitchen, from which Rotha serves guests Vietnamese, Cambodian, and Chinese teas. Rotha picks up street food from nearby stalls and brings it back to the space to eat lunch on the beautiful plates that she's collected, many from a Japanese secondhand store. Rotha often decorates the space with fresh flowers. She has students help with upkeep and maintenance, including painting and taking care of the plants. One day in October 2017, we painted the outside gate red together. We fell into discussion and began to analyze in more depth all of these acts of care in cultivating a space that provides a ground from which a community can arise in a changing political and techno regime.

When I asked Rotha why she built Ptayah, she said:

> I wanted to make an infrastructure. When I started Ptayah, that was my dream. It is for the future. It is about people who use the space… It is about a feeling that is difficult for me to describe. I want to create what I call an *invisible infrastructure*—you can know each other from this space… Here, there is no boss, you respect each other. In this invisible infrastructure, everyone is respecting each other, everyone is responsible for themselves, they know each other through the space, it allows people to have discussions, it allows people to be free without framing. You just feel like home.

Rotha has been successful at developing an "invisible infrastructure," which is a critical component of how Ptayah has become both an important space and a community for its members. Besides providing food and freedom to create, Rotha displays and showcases community ideas, art, and design in addition to the art she herself has collected over the years from major artists in the city of Phnom Penh. Ptayah hosts events about three evenings a month. These include presentations about research, arts, and student projects from a mix of Cambodian and international artists and researchers. Along with events at other creative hubs in Phnom Penh, these events serve as important times for researchers and artists to come together, meet, and discuss collaborations and get feedback on new projects.

Ptayah is, in some ways, a cosmopolitan space, and Rotha works regularly with international people. She hosts Westerners, from Cambodian American artists to European gallerists, and introduces them to the Ptayah community. Rotha has also started advertising her project in non-Western foreign countries. For example, she took a curation course in Ho Chi Minh City and traveled to New Delhi to present on her philosophy of grassroots creative spaces. However, Rotha has consciously demarcated this place as a Cambodian-run space. Since the 1991 Paris Peace Accords, foreign direct investment has had a disproportionately large impact on the gentrification of Phnom Penh. Though there are many foreign nationals of various ethnicities living and investing in the city, white, Western foreigners hold disproportionate access and wealth. As one of those white Westerners, I was encouraged by Rotha's commitment to granting preferential access to Cambodian young people even as she tries to build more responsible relationships between foreigners and Cambodians. In her words:

> [Cambodian] young people need inspiration… they don't have a lot of access to this sort of thing. It is okay to have someone to open the door for us, but now it is for us to stand on our own. They [international people] can be our board director, our mentor—to open the international door for us—but it is time for us to stand on our own.

Rotha is fluent not just in English but also in its elite us-

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1 The Cambodia case uses pseudonyms.

age in the kinds of transnational spaces where international researchers, artists, and curators converse and build solidarity. She earns money from her work with artists and her contracts with arts organizations, and she uses this income, as well as these connections and fluencies, to cultivate a space in which young Cambodians can do a variety of creative and intellectual work in their own language. Together the members of the Ptayah community root the space firmly in a Cambodian identity in order to demarcate the space from the transnational ones that indirectly provide funds for it through Rotha's personal income.

The Khmer language (like many so-called "minor" languages) has historically been marginalized on the internet for technological, sociocultural, and linguistic reasons (Vrana et al. 2020); it is often difficult or even impossible for people who only speak Khmer language to understand transnational tools that are not translated with enough attention (Jack, Sovannaroth, and Dell 2019). The inability to understand these tools takes on particularly high stakes with the changing digital governance model of the Cambodian state. The stereotypical "tech hubs" of Phnom Penh, like start-up spaces and boot camps, also use English as the primary language to make these spaces more accessible to international participants and investors, including foreign funders from Singapore, the United States, South Korea, and others. Having the freedom to practice collaboration and co-learning of intellectual pursuits in the mother tongue of students was how Rotha provided a foundation for an "invisible infrastructure":

> I want to be a leader—we don't have a lot of local curators. Here we can talk in Khmer language—some artists have an opportunity to engage [new ideas]. It is really about supporting each other. I want to develop an audience for the arts in Cambodia...

What does Ptayah have to do with the geopolitics of *technology*? This is not a stereotypical "place of technology"—the people inside are not in tech start-ups, nor are they coding. Yet digital technology is part of this creative work, and the students that Rotha hosts are using tech tools in a variety of ways. I will give one example from my field notes:

> One day, I accompanied Socheat and Jeny, two students that work at Ptayah, to a heritage movie theater for a surveying trip. They are architecture students voluntarily creating an archive of heritage cinemas in Phnom Penh. Socheat tells me that this is a complicated building—it isn't square. He says, "Now buildings have right angles, but in the 1960s they had strange angles." Socheat and Jeny take measurements of the length of each wall. Socheat has been able to borrow a laser measurement tool from a friend. He says, "I didn't learn the process of using a laser measurement when I was in school, I just picked it up after, and I borrowed it from a friend." The measuring tape is a little too short for one of the walls that Jeny is measuring in the back, and she has to mark the spot where it ends and start measuring again. She maps the walls on paper and decides the segments to measure, writing the measurements one by one on her paper map. She says, "I start with measuring the length of every wall, then I mirror the other side for symmetry." She and Socheat each enter their measure-

ments into the AutoCAD program, free for three years for students.
> This work takes a lot of patience and is very time-consuming. They are learning "proper" survey techniques through the project; they all know how to survey, but slightly differently, so they collaboratively learn and teach each other. Jeny at one point is confused when she tries to figure out how to measure the complicated angles by a doorway. She looks frustrated at first, but Socheat (who is a few years older and more experienced) helps her. After a few minutes working together, they realize there is an issue with the angle. Socheat draws the angle on paper. He uses the laser for more precise measurements. They enter the figures in AutoCAD. They later return to Ptayah to meet with the rest of their team, discuss plans, and build their archive website. They continue to tinker with the virtual models, and build tactile ones, which they then store at Ptayah.

Here, we see how Ptayah gives space to materiality, the work of technology, and collaboration. In the contemporary political and social context of Phnom Penh, the construction and maintenance of this space of trust, community, and artistic expression is an important form of self-protection during the gradual return to authoritarianism. Brick-and-mortar spaces of trust have become only more important as censorship and control intensifies.

FGoT requires us to think more expansively about technology, beyond transnational corporate portals like Facebook, Google, Alibaba, or WeChat, and beyond nation-states as the most powerful forces affecting lives. The combination of influence from the Chinese digital governance model and from American technocapitalism as epitomized by the Facebook monopoly has empowered the Cambodian state to monitor and arrest citizens for critical discourse on Facebook, effectively removing the internet as a public space for free expression. The changing economic conditions have also made high-rise and compartmentalized modern buildings replace traditional social arrangements in lower-rise homes. As the technology of the platform effectively closes down because of increased state censorship, the home becomes a more important space for its relative safety, just as it also becomes rarer and more expensive.

In Phnom Penh, many locals described fear of these new forms of surveillance and frustration regarding rapid urban development. But these negative feelings were mixed with the warmth, generosity, opportunity, and excitement that were present in spaces like Ptayah. Rotha's work refurbishes an old technology: a collective place, a home, which fosters creativity, culture, and independent thought. Increasingly restricted online, our participants retreat into brick-and-mortar places, seeking somewhere to "speak with trust." Here, we see how the values around virtual and physical spaces intersect with one another, sometimes blurring, other times needing to be separated for safety, comfort, and creativity. Rotha provided tea and street food for all who came into her space. She purchased local art and curated a beautiful space. She cultivated a "glitch politics" (Elwood

2020) of thriving in an unequal world, and her actions are deliberate actions of quotidian pleasure (Brown 2019) that foster a sense of care (de la Bellacasa 2011) not just for herself but also for those who come into the physical space as a place of refuge.

Ptayah is also where Rotha facilitates the collaboration between students Socheat and Jeny, who document the heritage spaces of a local cinemas. She not only gives them room to work together and to store their physical models but also advertises their work through her own social networks, including her social media channels. The politics are particular: preserving architectural models of yesteryear matters during a time of overdevelopment that threatens to dramatically change the physical landscape and the lives that are lived there. The students are fighting for heritage preservation of a public space that can withstand the force of capitalist expansion taking place. In so doing, they serve up their own alternatives to globalization and technocapitalism—one that is, literally, built into the ground. Telling grounded stories within a feminist geopolitics of technology means noticing how *a physical place* symbolizes survival and provides space for artistic, political, and personal expression, experimentation, and community expansion amid negative geopolitical shifts. From this, and working from Gibson-Graham (2006) and feminist analyses of space (Rendell 2000; Blunt and Rose 1994), we see *place as a creative technology* full of cultural potential.

VI. THE GHANA CASE

KUMASI

Ghana is often described as one of Africa's most economically and politically stable countries, a description that more accurately describes the global perception of Africa than it does Ghana. Still, this democratic stability and Ghana's history as the first sub-Saharan country to gain independence from British colonial rule, along with memories of the Pan-Africanist vision of the country's first president, Dr. Kwame Nkrumah, often make it a well-liked and respected country within the continent itself. Like many postcolonial states, Ghana's governance structure reflects the century-long administrative carving out of territories and resources to service the metropole (London). A 2018 referendum created six new administrative regions, adding to the ten that have existed since independence. Accra is where the central government resides and with it, most amenities; this arrangement attracts migrants from all over the country.

Kumasi is one of the few bustling metropolitan cities outside Accra that attracts similar patterns of mobility. The capital of present-day Ashanti Region and historically of the Asante Kingdom (dating from the 1600s), Kumasi is geographically located near the center of Ghana, thus acting as a key economic hub between the arid northern parts of the country and the southern coastal region. In colonial times, Kumasi and its environs were sites of struggle between the British and the Asante Kingdom. Post-independence, successive governments have treated Kumasi and the Ashanti Region as the second most important after Accra. Today, Kumasi hosts a number of specialized enclaves for technology endeavors, many of which revolve around Ghana's first and top STEM-focused university, the Kwame Nkrumah University of Science and Technology (KNUST). One of these hubs, Kumasi Hive, is focused on supporting entrepreneurs to build hardware and electronics. A cofounder of the Hive, who studied electrical engineering at KNUST because he "wanted to solve problems in the society," often pointed out that experience with hardware and machines was a key missing ingredient in Ghana's education and a factor that hampered industrialization.

The government of Ghana that came into power in 2016 has echoed this desire to industrialize the Ghanaian economy. It launched two flagship initiatives, "One District One Factory" and "Ghana Beyond Aid," aimed at boosting local production capacities in a primary export dependent economy. Despite the fact that Ghana has posted an average of 7 percent annual growth in the last few years, the percentage of the population living below the poverty line is still between 25 and 30 percent (United Nations 2020). The government has repeatedly outlined how these two policy initiatives would create long-term employment and wean the country off its dependence on external debt to finance the economy, although borrowing from long-standing lenders such as the World Bank continues. Increasingly, though, this dependence on external debt is stemming from trade relations with China. In April 2020 the Ghanaian government, along with other African ones, called for debt relief from China as a way to battle the economic effects of the COVID-19 pandemic.[2]

Before the pandemic, the Ghanaian government's deals with China required shrewd political calculation and image management given that Ghanaian citizens are used to being able to freely criticize and pressure their government. Ghanaian officials have used Chinese capital and technology as tools for advancing economic goals and election promises while fielding accusations of colonial exploitation through exchanges of natural resources for infrastructure and debt (Gbadamosi 2020). The narrative of China "recolonizing Africa" is a popular one that has characterized the relationship between China and African governments, despite officials of both parties countering that most of their dealings are "win-win" (Bodomo 2018). At the same time, public commentary in Ghana and elsewhere positions financial entanglements with the West as anchors weighing down Ghanaian and African interests, despite US and EU attempts to describe China's involvement in Africa as detrimental to Africans (Brautigam 2019). Both of these viewpoints come with commentary that is paternalistic at best, ascribing little agency to Africans and their governments. With the aspiration to industrialize through factories and foundries, the Ghanaian government can productively

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2 See "China Must Step Up on Africa Debt Relief, Ghana Finance Minister says," *Reuters*, April 7, 2020, https://www.reuters.com/article/us-health-coronavirus-africa-debt/china-must-step-up-on-africa-debt-relief-ghana-finance-minister-says-idUSKBN21P0Q0.

leverage Chinese investment to fulfill campaign promises and simultaneously move the hand of Western "partners" toward investments in areas they have avoided in the past. It is within these tricky relationships that the tech entrepreneurs in Kumasi Hive work out their own desires of individual and collective economic freedom. Couched in the terms of Ghana's industrialization, these desires are enacted through projects that require sourcing from both China and the West.

DEXT AND KUMASI HIVE

I (the second author) met Antipem and Michael, the cofounders of Dext, in April 2016, on my first day at Kumasi Hive. I had traveled to Kumasi to meet one of the cofounders, Jorge, and see about the "only hardware incubator in Ghana." Kumasi, also known as "the Garden City," is verdant and much more peaceful than Accra, where all the trees have been cut down to expose the reddish-brown sand. The houses in Kumasi are larger too. Kumasi Hive is located in a massive eleven-room house that a local businessman had built. For a fraction of the rent he would have paid in Accra, Jorge was elated that he could have offices, a makerspace, classrooms, and living accommodations for the scores of young people who came through the Hive's network to tinker with hardware and get their businesses off the ground. The landlord lived next door, and his elderly mother ran a small shop where Kumasi Hive residents and visitors could buy bottled water and snacks during the day.

Jorge was a key figure in Ghana's tech scene. He would later become the founder and first Executive Chairman of the Ghana Hubs Network, comprising all the tech hubs that operate in Ghana, all except one started by young, entrepreneurial Ghanaians across the country. Jorge, together with a British partner, turned a KNUST campus group (Creativity Group) into Kumasi Hive. The Hive has since cycled through a number of business models but has largely remained a mix of a coworking space, a makerspace, and a business incubator for young people interested in digital/electronics hardware.[3] Jorge told me in 2016:

> When you mention tech, people's minds go to software, and it saddens me. In our current situation, most of our challenges will or can be solved by hardware. If we embrace that tech is all about software, it leaves a lot of challenges that we don't solve. If you look at the [United] States [of America], they are at a stage of convenience, smart things and all that. That's where they are because most of the core challenges have been solved. They are no longer thinking about water, energy, and all that. They are looking at how to be faster and be more convenient, but we are not there yet. We have water challenges, malaria, health challenges, power, and all that. If we then focus on software, it leaves a gap that someone has to solve. No matter what, we can't develop software that solves energy: it can't

be. It will really be something superficial, but not solve the challenge.

Many of the inhabitants of Kumasi Hive, including the start-up Dext, reflected this mindset.

After touring the inside of the Hive that first day in 2016, including the offices that were converted into dorms for use when folks worked too late at night, Jorge and I walked around to the back, where he showed me a workstation with a wooden base covered in various cut-out shapes that were filled with resin from small buckets around the workstation. This is where Dext was making what they called "The Science Set" by hand.[4] Initially focused on electronics and robotics, the Science Set was meant to give practical opportunities that Michael and Antipem felt was missing in Ghanaian schools—specifically, a chance to experiment with basic science principles. Modeled after the geometry math sets found in Ghanaian schools, the Science Set is designed to fit in any child's schoolbag and is designed to be easy to use and workable with basic STEM curricula, with the first few iterations focusing on electronics. Having practical experience with theory in classrooms is perceived as essential to learning STEM subjects, and the absence of lab equipment meant that most primary schools in Ghana graduated students who had very little experience tinkering with the tools and concepts they had learned about. For the young people at Dext, and for Kumasi Hive more broadly, this was an essential gap in education that needed to be filled.

From when the two cofounders first cut and pieced together the Science Set by hand in their dorm room on campus at KNUST, through renting an office in Kumasi Hive after hiring their first employee, till moving into their own building circa 2018, the design, materials, and business operations behind the project have constantly evolved. In fact, from that first meeting in 2016 with Antipem and Michael, I would come to spend time with them at multiple sites across Ghana and the United States and witness this evolution. In June 2017 I joined the entire staff in late-night sessions in their cramped office to package orders for shipping. In November that same year, I joined Antipem and Michael in New York City as they competed with other African innovators to receive awards from the American Society of Mechanical Engineers (ASME). I met Antipem later in Michigan, my then campus, as he tried to court new partners for Dext, and I sat in on a conversation between him and a former Indian government minister who was giving a talk. By the end of that year, I would find myself walking around Huaqiangbei market in Shenzhen, China, with another Ghanaian start-up founder, looking for electronic parts for Michael as he tweaked the design of the Science Set. In 2018 I returned to Kumasi Hive and slept overnight in one of the offices turned dorms after working too late interviewing their part-time staff and interns. Through the years, we spoke frequently over WhatsApp or Skype or met up in Ac-

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3 See https://kumasihive.com.

4 See https://www.thescienceset.com.

cra whenever I was there to chat about what had happened since our last meeting.

Dext (or, more specifically, Antipem and Michael) had a specific shared vision for what the Science Set would look like and what it would do. The two disagreed on some things—for instance, which fundraising activities were worth pursuing. This subject came up in a heated argument during an Uber ride in New York City after their pitch at the ASME awards. Michael was not convinced these trips were worth it and thought his time would be better spent working on the hardware that needed upgrading. Antipem, an extrovert who felt at home pitching and selling, thought that even if the pitches didn't raise a lot of money, Dext was gaining visibility that could turn into later investments in the form of capital or new customers. It would become clear that they were pursuing grants and prize money because that was the only way to hold onto control of the company; investor money required ceding shares they were not yet ready to relinquish. This would change later, but, at the time, it was an important factor in decision-making.

The two agreed on almost every other aspect of the business, with key issues being (1) the set had to be made in Ghana—specifically, in Kumasi rather than the capital city, Accra, or elsewhere, and (2) it had to be affordable (less than USD 30). The original price, when they were hand-cutting the set, was GHS 45 (about USD 8). Today, the set retails for GHS 30 (about USD 5), a feat achieved due to investments in new 3D machines and laser cutters that enabled them to scale up in 2019.[5]

Being made in Ghana and being affordable were what one collaborator from the larger research project this story is drawn from called "sensitivity to local production." Throughout the four years that I followed Dext's progress, there was always the option to send the design to a manufacturing firm in China and simply put their label on the set, the way large product firms like Apple do. In the beginning, that option seemed out of reach because they couldn't afford to pay the Chinese, who often required cash payment up front. Antipem had initially been ambivalent about the Chinese option: he cared more about getting the sets at an affordable price into the hands of Ghanaian and African children.

Michael also cared about affordability but preferred to put everything together in Ghana. For him, manufacturing in Ghana was a reasonable outcome of what the sets would be doing: putting young Ghanaians on the path of scientific discovery, application, and innovation. This production model was a natural fit for the larger ambition of making Ghanaian children more skilled at science and technology. Later, when they had raised enough capital in 2019, the two decided instead to import industrial-size machines and hire local youth to work on them in their own building, still in Kumasi. The machines themselves did come from China; this is the case for much of the world's electronic production. Nevertheless, Michael still built probes and other devices to test locally, building smaller machines rather than buying larger ones online. In part he did this because he loved to tinker and build, but he also wanted to test the process of being able to build machines in-house later down the line. They imported the industrial machines to meet the high demand they already had. From the very beginning, each version of the Science Set they made sold out.

Being based in Kumasi rather than in Accra was a deliberate move to decenter Accra as the locus of globally legible technology activities. Like Jorge and Kumasi Hive, the cofounders of Dext felt an affinity to Kumasi—not just for the tech community built around the university, but also for other communities in the area, such as the Suame Magazine, in one of the oldest markets in Ghana. Described as a frugal manufacturing cluster (Yeebo 2016; Amedorme and Agbezudor 2013; Adeya 2008), Suame Magazine is home to generations of mechanics who have repaired and reengineered all things mechanical from anywhere in the world, particularly automobiles imported from the Global North. There is local respect for the technical expertise in Suame, but its scale is imagined to be limited due in part to the low formal education these mechanical experts have. The digital tech entrepreneurs in hubs like Kumasi Hive have over the years tried to foster closer relationships with the workers in the Magazine but have repeatedly failed to bring to life the kind of collaboration they imagined on any large scale.

Kumasi's arguably unfulfilled potential as a tech hub thus lies at the heart of why the startup Dext, against all odds, has chosen to stay there to build a globally legible company. In some ways, this attachment to Kumasi and its environs is also pragmatic—technologists can benefit from the expertise of communities like Suame Magazine and be proximate to other tech institutions in other regions (like Western and Brong Ahafo) given Kumasi's geographical location. There are other practical benefits, too, for startups like Dext: staying put where they started in the Kumasi area meant that teachers at the local primary schools knew and trusted them enough to order even the first rough versions of the sets.

Michael and Antipem saw, as I did, that it was an immense source of pride for the interns and staff they took on to have the sets made in Ghana and shipped to other countries, particularly countries in the West. When an American school ordered dozens of sets, the staff (and I) worked till dawn to get the sets packaged to be ready for shipment, all the while buzzing with excitement that the tides were turning in the company's favor. The staff were Kumasi-based young people who also felt giddy that something being done in their part of Ghana was gaining international attention. The founders of Dext, through multiple conversations, questioned the implication that Black Africans were only recipients of science and technology, receiving this kind of knowledge as only "inbound" to Africa (Mavhunga 2017). This narrative had long been in place, from the "civilizing" British colonizers to present-day academic narratives about Chinese investment activities in Ghana today. All these narratives elide context and histories of "making," invention, and innovation that existed before, during, and after en-

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5 See video at https://www.bbc.com/news/av/technology-50763356/a-ghanaian-kit-for-teaching-children-science.

counters with foreign others in Africa. Making the Science Sets in Kumasi, Ghana, was a symbolic move as much as it was a pragmatic one. "Achieving scale" in 2018 and 2019 through an upgrade of materials, moving out of Kumasi Hive and into their own makerspace and building, and installing factorylike production lines on which they worked on a purchase order from the Royal Academy of Engineering showcased what could be viewed as the setting of a new era in which former colonialists now received science and technological innovation from the former colony or "the periphery."

Our grounding within FGoT goes beyond a literal interpretation and appreciation of place as technology and metaphorically grounds our research philosophy. This may seem implicit in the kind of ethnographic research that we undertake, but adopting an explicitly feminist approach means truly noticing and attesting to acts of care and intentional labors that are often hidden by seemingly unrelated supranational-level events (Tsing 2015; Massey 2012).

That Kumasi Hive and Dext remain steadfast in their commitment to developing technology from Kumasi rather than relocating to Accra is a symbolic gesture and a desire to live out the particular attachment they hold to their part of Ghana. Choosing to "do hardware," even though "hardware is hard," aims to show how Africans, too, can produce technologies despite limited manufacturing infrastructure. Just as importantly for Dext, pushing through with the Science Set allows them to intervene in education, partly as a way to cement that goal of industrialization, partly to allow students to play and experiment with scientific ideas. Learning through physical play allows students to embody knowledge and teaches young children that science is something we not only think about but also touch and hold in our hand. The goal is to make abstractions tangible in a way that many students had hitherto not experienced. Doing the work in Kumasi rather than in Accra enables Michael and Antipem to bring transnational resources into the city that trained them, in their own act of resistance toward persistent administrative and bureaucratic centralization in the nation's capital. For Dext, "Made in Ghana" holds double valence for its creators because it also means "Made in Kumasi" and indicates their rootedness to the "Garden City."

Kumasi Hive, like Ptayah, also functions as a physical place of refuge. There, Antipem and Michael spent days and nights away from distractions, built friendships and collaborations, shared ideas, and cultivated mutual learning that would eventually lead to Dext. There were dramatic outbursts, impassioned speeches, impromptu dance parties, shared lunches, daily routines for those sleeping over that created an atmosphere in which particular affects were shared. When any one company in the incubator experienced a setback, others felt it and shared their frustrations. All felt continued annoyance at infrastructural failures and channeled that annoyance toward daily hacking and making. Every project that came out of Kumasi Hive (including Dext) was aimed at making life easier for other Ghanaians and Africans. Displaying emotions alongside pragmatic

work (a realist utopia of the sort described by Wright (2011)) demonstrated a depth of commitment to the particular projects at hand. Each pitch was heartfelt, and the emotional investments mirrored those of the second author, whose experiences growing up in Ghana were similar to but also different from those of the tech entrepreneurs gathered in Kumasi Hive. Being simultaneously an insider and an outsider required embracing the various affects perceived in others and experienced by the self.

At Kumasi Hive, one of the distinguishing features is how seamlessly everyone slips into Twi (as opposed to hubs in Accra that almost exclusively speak English). Kumasi culture is known for its tight coupling with Twi, a symbolic and practical outcome of its being the seat of the Asante Kingdom and a core node of resistance against British colonial powers pre-independence. In fact, most students at KNUST, regardless of where they come from in Ghana, learn to speak Twi and do so even in "formal" settings. Speaking English even in a professional business setting in Kumasi is perceived as doing "*nkratse sɛm*," which literally means "gentleman things" and can be loosely interpreted as putting on airs, or acting like the colonizers and their local agents. Particularly for the techies at the Hive who wanted more close collaboration with the older community of craftspeople at the Suame Magazine, it was inconceivable to speak English when trying to connect. Not that the locals did not speak or understand English (although many without formal education did not), but the practice is used to signal that together they formed one community even if they had different kinds of expertise or ethnicities, and the techies used that to respect the general ethos of the city that hosts them. Similar to Ptayah, then, language fosters community and works toward binding ties to a place that is simultaneously a center and a periphery in the imaginary of technological production.

VII. DISCUSSION

Global geopolitics of technology are shifting. In Cambodia, there appears to be a move toward authoritarian politics using reformulated tactics of surveillance and information control, adapting in part the Chinese model of governance to a digital economy dominated by American technocapitalism. In Ghana, China's appearance on the donor and bilateral economic cooperation scene revolves around infrastructure and industrialization needs and whether China's interest can be parlayed toward projects that the West was never interested in. "On the ground," these shifts between two models of governance translate into everyday headaches and opportunities for those being governed. Below, we further unpack the ways that the three dimensions highlighted at the beginning of this article work out in our cases.

GROUNDED

FGoT explicates geopolitics across varying scales, from the national to the personal. In Phnom Penh and Kumasi, our collaborators turned to physical places to find footing in a changing world. In sharing the joys and frustrations of making a life and a livelihood, they expressed particular af-

fects that are tied to specific notions of "home." None of these can be removed from the experience of geopolitics. Staying in Phnom Penh and Kumasi and doing the kind of work that Rotha, Antipem, and Michael undertake daily is an affective connection to place as much as it is a pragmatic response to life. As middle-class individuals who have the choice to relocate elsewhere, deliberately carving out spaces for others who may not have that option is an act of care through cultivating space for collective survival. They recognize that their particular urban geographies symbolize unequal global power based on geography and histories of exploitation in contemporary capitalism. Yet they work hard to carve out alternatives to foster opportunity for themselves and others despite the constraints.

EVERYDAY SURVIVING AND THRIVING

In the cases above, we remained attuned to full affective experience, specifically how people stay human amid both upheaval and everyday frustrations. We observe specific affects in the deliberate actions that intervene in global market politics and supply chain logics (Ghana) and the fears in Phnom Penh after witnessing an increase in state-sponsored oppressions and the removal of safe public spaces such as freedom of expression in online platforms (Cambodia). We point out the ways that attending to full affective experience brings out ambivalences and contradictions in any given person. For example, a key point of struggle for us was trying to reconcile the ways that participants seemed to vacillate between a decolonial sensibility and a reifying of colonial tropes about art, science, and technology. In seeking to provide students with the tools of "modern" science or architecture, decolonial desires produce friction with postcolonial pragmatism (Tsing 2015). Geopolitics in today's era of nationalistic rhetoric, alongside the height of globalized supply chains, can have the effect of creating cognitive dissonance for those of us situating our work in transnational networks. Watching with empathy as entrepreneurs and creatives wrestled with ongoing inequalities born of and embedded in racial capitalism and neocolonial expansion was one way of allowing their full affective experience to play out. Within violent structures, FGoT focuses attention to alternative modes of being and examples of surviving and thriving as an imperative. Working from Benjamin (2019), Elwood (2020), and Gibson-Graham (2006), we hope that telling such stories may encourage and facilitate the construction of more to come.

COMMUNITY

The word "community" denotes "togetherness." There are similar ways that Ptayah and Dext create community in their respective locations. In each case, our collaborators rallied around their chosen communities. For both, language is an important aspect of building and fostering community. Rotha gives priority to Cambodian young people, and one of her goals is to make space for Cambodian-led work that is affordable, as well as a place where they can speak Khmer. Kumasi Hive and Dext remain in Kumasi, speaking Twi, connecting across socioeconomic status with a city that is perhaps "doubly peripheral"— second to Accra,

and in Ghana—as a site of technological production. In both cases we see community as being undergirded by language ideologies (Irvine, Gal, and Kroskrity 2009), specifically that particular non-Western languages foster a sense of togetherness, marking boundaries within the geopolitics that impact the work that is being done. Language and linguistic differentiation are key aspects of identity and can signal positionality and power (e.g., fluency in English signals middle- to upper-class cosmopolitanism). Our global system of racial capitalism has fostered an environment in which dominant transnational platform corporations do not serve their users who speak minority languages, translating their products in ways that make them impossible to understand and increasing the risk that these users take in using them. English is associated with technology, highlighting the hegemony of that language within the broader geopolitics of technology. Prioritizing space for local languages, then, is also a response to long-standing exploitation by the colonialist entities that live on through neoliberal reform and the proliferation of NGO culture and foreign investment in both countries.

There are, of course, limitations to community, both for these specific spaces and for our FGoT framework. The "invisible infrastructures" created in Ptayah and in Kumasi Hive are nonhierarchical, but both are also inadvertently exclusive (open only to those who personally know the founders and can find their places). We were introduced to these spaces by specific individuals (Rotha, Michael, and Antipem) who have higher class standing and decision-making power in their communities. Though these individuals communicate feeling marginalized in relation to "global" arts and technology communities, they hold vast amounts of privilege in relation to the overall populations of Kumasi and Phnom Penh. Even though they built these places with accessibility in mind, people who lack a certain amount of cultural capital or confidence, or those without the interpersonal networks that give them an introduction or "in," are left out. Their work of inclusion is not perfect, even if it signals hopeful alternatives.

VIII. CONCLUSION

The intersectional feminist and feminist technoscience literature we began this article with gave us the tools to locate the three dimensions of grounding, surviving/thriving, and community. By asking ourselves how our collaborators locate, ground, and root themselves during periods of geopolitical change and challenge, we found various strategies for collectivity and care within the inequalities of the global world order. By consciously acknowledging the affects that accompany these labors, we are also able to perceive that while the work being done may be entangled in complex processes tied to the geopolitics of technology, the everyday practices are intimately concerned with collective surviving (Tsing 2015) *and* making space for others to thrive. Using this framework for analyses of technology, then, is a project of recentering geopolitics around the affective everyday practices of care on the ground, particularly where they allow people to negotiate and trouble, in however small or grand ways, state and technological power and privilege.

We hope these stories demonstrate the limits of the con-

trol of governments and technocapitalism, as much as they work to conscript us at all times. In writing these stories of alternatives, we hope to foster and support initiatives that emphasize personal agency and living the full human experience amid inequality and structural violence. Other scholars, technologists, and grassroots groups can also utilize this FGoT framework to illuminate and materially support community grounding and collective thriving within the global order of techno-empires.

COMPETING INTERESTS

The authors have no competing interests to declare.

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