Air in Unexpected Places

Metabolism, Design, and the Making of an 'African' Aircrete

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Abstract

Aircrete is a lightweight building material with a number of remarkable qualities, including high compression strength, buoyancy and thermal insulation. Perhaps most strikingly, its lack of sand aggregate makes it energy efficient compared to concrete. While aircrete is regularly sold by various construction companies, DIY enthusiasts and technicians around the world are cultivating more home-brew, open-source methods. This article follows James, an American ex-security contractor and mining engineer, as he attempts to convert his own embodied legacies of imperial extraction into a pro-social business venture by designing aircrete machines and mixes for urban Africa. His adventures in aircrete typify an energy future in which an array of intriguing experiments and technologies intersect with a broader entrepreneurial effort to capture Africa's growing consumer markets.

Keywords: Africa, aircrete, Anthropocene, architecture, design, energy, infrastructure, materials

In a recent article, Gabrielle Hecht (2018) pushes us to place Africa at the centre of the Anthropocene, the age when industrial capitalism has deformed planetary-scale biophysical systems, and the human worlds that rely upon them.

Confronting the Anthropocene, in Africa and elsewhere, requires fresh sources of imagination. And these sources must be found at the frontlines of planetary transformation ... Africa is the continent where population growth is projected to be the highest. It contains 60 per cent of the world's uncultivated arable land. Some pockets of Africa lie at the forefront of decentralized energy systems (such as solar power) that promise to mitigate climate change. And that's only for starters.

This article offers an ethnographic narrative of what, for me, has emerged as a 'fresh source of imagination' at a key 'frontline of planetary transformation': an

unconventional and environmentally friendly building material known as aircrete. Aircrete (sometimes called cellular foam concrete) is composed of cement and a foamy mixture of soap and water. As a slurry it can be poured into moulds and cured, allowing for expansive forms such as panels or domes. It boasts a number of remarkable qualities, including high compression strength, buoyancy, thermal and acoustic insulation. Perhaps most intriguingly of all, its lack of aggregate makes it lightweight and environmentally friendly to produce and transport compared to concrete.

I became interested in aircrete after a chance meeting with an American named James on the outskirts of Dar es Salaam, in the peri-urban neighbourhood of Hewa where I have been living and conducting research off and on since 2010. A former private military contractor and mining engineer who has lived and worked across Africa for decades, James is just one of an international assortment of DIY technicians and tinkerers who have been exploring the possibilities of aircrete, and who was convinced that it might find a market in Africa. As I followed his attempts to get the mechanics, chemistry and even economics of aircrete right, I came to consider it a material that was both good to think with *and* good to build with, emerging from and perhaps remediating African histories of imperialism, colonial extraction and ecological violence.

Infrastructure as metabolism

At first glance, an ethnographic case study on a building material might seem at odds with a volume devoted to energy frontiers. Built structures, after all, are important backdrops for the generation of light, heat or movement, but are not themselves those processes. And yet materials and energy are two sides of the same coin: just as any energy process needs a material to fuel it, materials objectify energetic processes and potentials. Architects, for example, are increasingly considering not just the 'operational energy' of buildings – the energy it takes to light and heat them – but the energy 'embodied' in their materials' geophysical formation, technological extraction, infrastructural transport and socially organized construction (Benjamin 2017). As I will show, concrete buildings embody what Julie Livingston (2019) has called a politics of 'self-devouring growth', predicated on the capture and limitless extraction of a non-renewable energy source – namely sand and gravel aggregate. A critical analysis of construction materials is thus perforce one concerned with energy, and resonates with a central concern of this volume: development always comes from somewhere, and has hidden costs that are borne by particular social and ecological systems. African worlds tend to make these costs especially visible.

In an article that draws on ecological readings of Marx, and in particular his exploration of 'metabolic rift' (Foster 1999), Dominic Boyer observes that our now planetary 'gridworld' – buildings, roads, ports and pipelines – can be considered a kind of objectified energy: an automated and metastasized extension of capitalism's 'appropriation of quite literally fleshy power' (2018: 228), a gelatinized precipitate of various extractive and exploitative processes. The astonishing speed and efficiency of Amazon delivery, the climate-controlled office, the undimming electric light: all

depend on a vast 'congealment' of materials, knowledge and labour that ultimately amounts to a one-way capture and transfer of energy circulating in other circuits and across other time-scales. This puts an ecological spin on Walter Benjamin's insight that every document of civilization is simultaneously a document of its own barbarism (2012: 256).

I would venture that many people I've known and spoken with in Tanzania would find this reading intuitive, given that the continent has historically served as a reservoir from which to extract raw materials and leave waste in the service value realization elsewhere. The 'development' that does trickle back down to this periphery, whether as foreign investment or high-end commodities such as solar panels or mobile phones, is always somehow less than the collective endowments – the potential energy, we might say – of the continent. Anyone who has spent time in Africa will have surely heard the mixture of bewilderment and grim knowingness in people's attempt to balance the equation: 'We have so many natural resources, we are the wealthiest continent, why are we so poor?'

But of course not all are. As Jean Francois Bayart (1993) famously argued, many elites actively leaned into dependence as an extraverted 'mode of action', supervising the flow of value moving out into the World System. Many African states and elites are not shy about disregarding environmental concerns in the name of development, which tends to mean, alongside their Western counterparts and collaborators, supervising lucrative contracts for oil, infrastructures, dams or mining concessions. The irony, as both Omolade Adunbi and Kristin Doughty show in this volume, is that whatever promises they hold, the result is usually high social and ecological costs and meagre rewards for all but a few, sustained by an infernal circuit of selling extracted energy on the cheap to buy back development (sustainable or otherwise) at expense. In the meantime, alongside continuously deferred expectations of modernity, African populations must absorb all manner of violence, slow and fast: from outright warfare and displacement, to the general strains and stresses of poverty, to the hazards of under-regulated global markets and industries that leach toxins into metabolic circuits of eating, drinking and breathing.

As the social and ecological consequences of the capitalist extraction of surplus value mount, the possibility of renewable energy adds an interesting twist to Africa's subordinate position in the global system. On one hand the possibility of decentralized distribution has all sorts of interesting affordances. Solar power, for example, promises a certain freedom and autonomy for populations unconnected to centralized grids. Yet as Erin Dean shows (this volume), such dreams are themselves reliant on materials and technologies that are produced abroad and then supplied and installed by USAID funded contracts, creating new dependencies on an international supply chain. Moreover, while solar power is itself sustainable and renewable, its embodied energy is far from carbon neutral since its panels require rare earth minerals mined in often socially and ecologically destructive ways (Riofrancos 2019). Clean energy is thus a misnomer if the environmental cost is simply displaced up the chain to the very materials of its construction. The Anthropocene in this sense is a lesson in something like the reality principle: whatever

we may wish or imagine, the world will always register and respond to our actions – ultimately there is no ‘elsewhere’ to relegate or ignore the consequences. Rather, we must think metabolically, across the entire circuit of a given energetic process: its production, use and decomposition. From this vantage, it may be that solar power offers neither autonomy nor sustainability, but rather its appearance.

The tendency to fetishize free-standing technologies/energy sources as inherently empowering has a marked family resemblance to what Peter Redfield (2015) calls ‘humanitarian design’, the production and dissemination of little devices such as the ‘flying toilet’, a disposal poo bag, or the LifeStraw, a consumer point-of-use water filtration technology. Redfield registers a sensitive ambivalence about this ascendant mode of intervening in Africa and other global poverty hot-spots. In some ways there is much to admire in the design half, which entails a certain pragmatic engagement with the facts on the ground, situating ‘entanglement and care’ in place of earlier high modernist revolution that reached for totalizing ‘emancipation and mastery’ (Redfield 2015: 164). But these impulses are often woven into a market logic that presumes one can ‘do well while doing good’ (ibid.: 159) – in which finished products are sold back to the poor, thereby keeping the basic coordinates of structural dependence in place. As Jamie Cross and Declan Murray (2018) have shown, humanitarian design has taken alternative energy as one of its fields of intervention, selling lamps and solar panels while leaving a massive trail of e-waste in its wake. A narrow promotion of technologies in and of themselves, divorced from their political-economic circuits, often ends up reproducing both ecological damage and structural poverty.

Is there a way out of such industrialized logics? What might it look like? In his reflection on ‘revolutionary’ struggle in the Anthropocene, Boyer speculates that ‘to contemporary optics and epistemics, the idea of revolutionary infrastructure seems preposterous, utopian, fantastic. Over time though, through the work of proliferating decentralized small-scale action, the carbon gridworld will find itself incrementally disabled by the tapping and redistribution of its materials and energies’ (2018: 240). Boyer cites German politician Hermann Scheer’s call for a decentralized solar economy that would, in obviating the long supply chains of fossil fuel sources, be more ‘susceptible to democratic political control’ (ibid.: 236). Leaving aside the extractivist pitfalls in supplying the panels, we can take Boyer’s point. Rather than vanguard control in the high modernist vein, ‘revolution’ entails a web of experiments that actualize elective affinities between renewable energy and local autonomy, a splintering and reweaving of the ‘gridworld’ congenial to what he and Timothy Morton (2016) call hyposubjects. The contrast is with hypersubjects: ‘typically, but not exclusively white, male, northern, well-nourished, and modern in all senses of the term ... They command and control; they seek transcendence’. But hyposubjects ‘are less than the sum of their parts ... *subscendent* rather than transcendent. They do not pursue or pretend to absolute knowledge or language, let alone power ... They inhabit the cracks and hollows. They turn things inside out and work miracles with scraps and remains’.

In recent ethnography, notable hyposubjects might include matsutake mushroom pickers in the American northwest sensitively chronicled by Anna Tsing

(2015), learning to live in the aftermath of American war in Southeast Asia, economic fallout and ecological ruin. Likewise the women in Stacey Langwick's (2018) wonderful portrait of an NGO based in Northern Tanzania that promotes and distributes *dawa lishe*, fortifying medicinal herbs that remediate the generalized toxicity of African life. While not directly a politics of decarbonization per se, foraging and community gardens cut transversally across capitalist energetics. Matsutake, as Tsing points out, do not easily lend themselves to private property regimes, nor can the independence of their pickers be easily broken or disciplined. Similarly, while many species that comprise *dawa lishe* are resistant to plantation agriculture, they have flourished across a network of regional gardens, with their cuttings, seedlings and saplings regularly shared and planted in circuits of gift exchange. This is not to over-estimate such minor, precarious activities, nor to ignore the ways in which they might eventually feed – and feed upon – market demand. However, it is to recognize that they cannot easily scale, and hence cannot be easily drawn into the spiral of self-devouring growth.

In other words, from a certain perspective, these economies of capture are relatively regenerative and autonomous, situated within the metabolic interchange of a particular milieu, rather than reduced to a standing reserve, their energies extracted to exhaustion.¹ We can also recognize the related sense in which these economies, in all their sensuous particularity, are *captivating*, capable of coaxing a certain hyposubjective otherwise. 'What first struck me', Langwick reports of her initial visit to the NGO, 'was the lushness' (2018: 415). Aircrete too has certain political possibilities that can be sensed in its qualities and affordances. What first struck me, holding a prototype we had ourselves produced, was the *lightness*. It gestured to a politics of treading lightly, a way of building in which aggregate remains in the ground, uncaptured, and thus remains our existential grounds, qua planetary infrastructure.

At first glance, James is an improbable hyposubject. He is white, an American, and a former private military contractor who has spent much of his life securing the outposts of the American imperium. This biography suffuses his casually noxious attitudes on race, Africa and postcolonial politics in general. Yet he is also an inveterate autodidact and tinkerer who, after a decade of building mining machines in rural areas, pays close attention to the ways chemical and material processes affect daily African life. Unlike the slick professionalism of humanitarian design, the technology he envisioned is not a would-be silver bullet, targeted at some specific problem. It is not just designed to be sold to relatively poor consumers – the proverbial 'bottom of the pyramid' – but to be made there, and to recursively transform it. Thus, as we will see, it is in important respects non-proprietary and open-source; it combines the sophisticated chemistries of industrial engineering with the often-inspired amateurishness of locally produced 'Afrigadgets'.² Ultimately, it is nothing more and nothing less than a material – one that, by capturing bubbles of air instead of mounds of earth, might tap into and redistribute the inequalities bound up in contemporary modes of building and dwelling, both in Africa and beyond. That is, it might redistribute the inequalities bound up in the weight of concrete.

Of houses and graves

Since the 2000s, Africa has been a veritable construction site. The combination of strong primary commodity exports, consistent population growth, Chinese demand for raw materials, and resource for infrastructure swaps has rendered the continent a place to build. A central medium for this explosive construction is concrete, the material of new roads, runways, ports, dams and of course residential buildings. Against this backdrop of 'Africa Rising', anthropologists have begun to explore how concrete becomes a medium for aspiration (Archambault 2018). This tracks with my experience of Hewa. Bricks were everywhere, piled up as people invested capital in perhaps the signature asset of social reproduction in East Africa and beyond: the house (Lewinson 2006; Mercer 2017). The form of the brick allowed for this piecemeal savings, allowing one's projects to be disaggregated into a series of modular increments. In a world of shifting fortunes, concrete is a main medium of value-storage, a way of securing the future.

But such futures are not without their burdens. In the summer of 2018, I returned once again to Hewa and caught up with my friend and sometimes research assistant, Ali. Part of the local Zaramo ethnic group who have lived in this region since the precolonial era, Ali had inherited a tiny plot of land that had been sold off piecemeal and broken up across his siblings. He was poor, and ever since I had known him, he had been working casually and sporadically hauling locally pressed bricks onto trucks that ferried them out to construction sites in the area. When we first met in 2010, Ali was utterly beautiful, sculpted as the blocks he hauled. Nearly a decade later he was still strong, but by his own estimate grown older and weaker. A decade of heavy lifting had depleted him and he felt he barely made enough money to nourish himself, much less build for his wife and child. Currently, they were living rent-free in a large house built by a retired civil servant, but being dependent on his goodwill made for a precarious situation. Recently the civil servant's son had moved into the house and resented Ali's presence, adding to the tension.

One day we learned that the son's cousin had died in town and would be brought back to Hewa to be buried. Obligated to play the dutiful kin, Ali joined a few other young men to dig the grave and watch over it until the deceased arrived to make sure no ne'er-do-well would steal a handful of earth for malicious purposes. As they dug, an older man perched above them, offering direction and commentary. Muslims, he instructed me, don't use coffins like Christians do. Eventually the earth eats even the bones of the deceased. When the body finally came from the city late into the night, it was taken to the mosque, wrapped in a white sheet, and carried in a procession of thirty to forty people to its final resting place. Maybe it was the funeral that was on Ali's mind when, a day or two later, while walking deep in the interior of the area, he pointed to a small, unfinished, single-story, concrete house. 'Even just that', he said longingly, 'would be enough. You have a roof over your head, you can't get kicked out. You farm, you eat *ugali* with your family and the days pass. You could die in the house and no one would know, because it doesn't rot (*haiozi*). It's a permanent house that lasts forever (*nyumba ya kidumu zinazoishi milele*)'.

Photo 1: The house
that lasts forever.
(Photo by the author)

Ali's comment blends the security of owning a house with the qualities of the physical structure itself, and in so doing captures something about the political logic of concrete. Compared with building materials with more organic compositions such as wattle and daub, concrete does seem to defy entropic processes such as rot. Its durability and modularity help it to act as a metonym of modern countries and peoples that are not subject to whims of nature or history, but are rather its masters. On this count, James Ferguson recounts an illuminating exchange with an elderly man in Lesotho who was hoping to build a 'European style' house of concrete blocks and a galvanized steel roof. Ferguson, with proper anthropological feeling, gently protested:

I had developed an appreciation for the virtues of the local architecture. The round houses were, thanks to their thick mud-and-stone walls, admirably insulated, staying cool in the summer and warm in the winter. They were built entirely with local materials and local labor, and they nestled beautifully into the hills from which their rock walls were dug. The cattle-dung plaster used on the walls and floors was even

said to have naturally antiseptic properties. The Sesotho roundhouse seemed to me, in the language of the times, an ‘appropriate technology’ ... Why, when one has a valuable culture of one’s own, would one seek a copy (a bad copy, at that) of the culture of the coloniser? (2006: 18–19)

What comes next is a clever inversion whereby multicultural sensitivity turns out to be a species of Western parochialism, oblivious to the fact that ‘modernity’ is above all a question of material inequality and, by extension, the way certain materials in particular index membership. Indeed, concrete was a favoured material of the aptly named International Style that characterized so much self-consciously modernist architecture in the twentieth century, including that of postcolonial Africa (Hoffman 2017). In the early decades of independence, architects (mostly foreign) designed massive, often brutalist concrete structures meant to instantiate new African nations’ entrance into the modern world stage, their sober rationalism and formal elegance signifying emancipation from the fog of custom and the provinciality of place.

Still, despite (or perhaps because of) his intense longing for the security of a concrete house, Ali ends on an intriguingly ambivalent fantasy: you could die in such a structure and no one would know. In other words, you could find yourself in a situation in which you *cannot be buried*. Its permanence might seal you off so effectively as to entrap you between what Jacques Lacan (2010) called the two deaths, physically deceased but not reintegrated into the broader social – and, we might note, ecological – life cycle via memory and inheritance. On one level the opacity of a modern house might be understood as a metaphor for the way over-accumulation entombs the living, severing them from circuits of social recognition and obligation. This is in fact a common trope in contemporary Hewa, where people speculated just who exactly lived in elite gated compounds and what they were doing in there. It is also evident in the historical record of the colonial period, where one can find swirling rumours about industrial enclosures – colonial hospitals, police stations, ambulances – that concealed ‘vampires’ who abducted people and drained their blood (White 2009). Most importantly for our purposes, the idea that accumulation is a severing of a social *interdependence*, and thus amounts to a kind of self-negation, runs parallel with ecologically oriented critiques of capitalism, in which the price of transcending any and all local constraints is metabolic rift. The obverse of hypersubjective capitalist civilization is a mounting pile of waste with nowhere to waste away *to* – ‘vital’ (Bennett 2009), perhaps, but unmetabolized. Neither dead nor alive.

In Tanzania, houses and graves weave into each other through the movement of sand and gravel aggregate. That summer, Ali and I were exploring the chain of brick production in Hewa and had traced it back to its primal scenes: young men who, for a pittance, clamber up the back of rusted out lorry trucks and are ferried out into the deep interior of the district, past a prison and military base to a blasted landscape of massive sandpits. It was whispered that this land belonged to a British expat in the area who owned vast acreage, but who was more or less helpless to stop the massive plundering. Central to concrete production, sand was

an incredibly valuable commodity, to the point that other residents would sneak out in the middle of the night and dig up the sand from public paths that snaked through the settlement.

Hewa's sand pits are part of a global archipelago of blasted landscapes. Due to the soaring demand for concrete, sand mining is at the centre of a global ecological crisis, with mafias around the world digging up beaches, riverbeds and generally terraforming on a massive regional or even planetary scale (Khalili 2019; Livingston 2019). In terms of sheer magnitude, the concrete produced from that sand is a plausible stratigraphic signal of the Anthropocene (Zalasiewicz and Waters 2018). Cumulatively there is enough to cover every square metre of the earth in a kilo of concrete. Of that mass, 90 per cent has been produced since the mid twentieth century, and 50 per cent only in the last couple of decades (Zalasiewicz and Waters 2018: 82). The construction industry is one of the largest global emissions producers, accounting in 2009 for nearly 23 per cent of all carbon emissions (Huang et al. 2018). In building with concrete, it is hard not to feel like we are digging our own graves.

Moreover, while Ali might have thought of the concrete houses in Hewa as eternal, in reality they can wear down after just a few years. Concrete is highly porous, allowing for physical and chemical deterioration. Wind and rain can erode

Photo 2: Labourers transfer sand from a truck that had broken down under the weight of the haul. (Photo by the author)

its surface, salt cavitates its interior. The iron rebar that modern concrete is often reinforced with can corrode and crack the concrete through what is called oxide jaggings. Thanks to Hewa's tropical coastal climate, evidence of these vulnerabilities was everywhere, particularly since the region was recovering from particularly bad flooding, leaving crumbling concrete bridges and eroded foundations in its wake. Moreover, poor workmanship, substandard materials and overloading can lead to stress fractures. In 2013, a sixteen-story building collapsed in downtown Dar es Salaam due in part to substandard concrete and steel bar reinforcement;³ I was somewhat concerned to learn that the standard 33.5 grade of cement available in Hewa would be illegal to build with in the United States. Finally, even discounting the degeneration, concrete houses are not particularly well suited to the local environment, since their poor insulation and metal roofs can create a literal brick oven effect. In 1977, on the ten-year anniversary of the Arusha Declaration of African Socialism, Julius Nyerere punned that the obsession with concrete houses and metal roofs over locally produced burnt bricks and tiles was a kind of 'mental block' (quoted in Brownell 2014: 216).

Photo 3:
Cracks in the concrete.
(Photo by the author)

For reasons both environmental and political-economic, then, concrete weighs heavily. Like any capitalist commodity, it depends on the capture of 'cheap nature' (Moore 2016) – the extraction of virtually unlimited quantities of sand. But the chronic and cruddy quality of the houses so realized also reflects the fact that Africa has historically been relegated to the status of cheap nature itself. The 'congealment' of knowledge and energy in the form of building codes, training, industrial manufacturing and maintenance that characterizes building in the global north is unavailable in peri-urban Hewa, and indeed is in some ways made possible by that absence. We have to take seriously Ferguson's difficult point that in a very real way Africa is full of 'bad copies' of modernity, if by modernity we mean a certain global standard of wealth, of congealed energy. A concrete house is a modern gesture, an aspiration or 'claim', certainly (Ferguson 2006: 19). But, in a sense, it remains so much sand.

Mindful of the ecological toll and structural inequality embedded in concrete, African architects and designers are at the frontlines of thinking beyond it, exploring the use of materials that are locally situated, better ventilated, cooled, easier to construct and maintain, and more energy efficient. Some of these materials rely on vernacular traditions, such as in the projects of Tanzanian-based architectural NGO C-RE-Aid which has experimented with adobe sun dried bricks and traditional vaulting techniques, or in architect Francis Kere's stunning design for the Lycée Schorge Secondary School in Burkina Faso.⁴ These impulses resonate with a tradition that architectural historian Simon Sadler (2008) calls 'tool globalism', which emphasizes holistic, ecologically minded and pragmatic design exemplified in 1970s-era countercultural experiments such as the Whole Earth Catalog. Other alternatives to concrete are oriented around recycled materials such as plastic, while in the global north, designers are also experimenting with alternative building materials, including bio-composite bricks made of mushroom spores (Yaneva and Benjamin 2017) or hemp (Bedlivá and Isaacs 2014). Aircrete can be situated at the intersection of this complex global field of transition: in some ways it is a kind of popular bricolage and in other ways it is akin to a lab-born experimental material. Let me explain.

Of cures and moulds

I was sitting with Ali hanging out one day in the middle of the afternoon when a couple of mechanics I knew from a local garage came looking for me. 'There's one of you here,' they said, 'and we can't understand what he's saying.' I looked across the street and in front of the garage was a middle-aged white guy gesticulating expansively. And that is how I met James.

James, as he almost immediately began explaining to me, had become interested in developing a business around aircrete. I would later learn that aircrete is well known in construction and masonry. It was first invented in the 1920s by a Swedish architect, and many companies in Europe and Asia now produce the material for building, insulation and reinforcement. Like most industrial operations,

they rely on expensive and proprietary chemicals and machinery, such as autoclaves to cure the material and synthetic-enzyme based foaming agents. And yet with little more than an air-compressor, cannister, PVC tubing and some gauges, James had designed a small-scale, sub-\$200 system that produced thick, tightly packed foam using local soaps that could in principle be mixed with water and cement and cured. James had come to this little neighbourhood in Hewa because a mining friend of his had an uncle with a brick-making enterprise down the road who could provide him with a workshop and some supplies. Now the next step was to get some local welders to design an implement that would help him mix the foam and cement into a slurry.

After about five minutes of listening to James, I was entirely convinced I had to follow this project to see where it would go. I made myself useful by translating his requests into Kiswahili and explaining to my own friends at the garage what exactly he was after. Eventually, we managed to get a crude augur welded and did a couple of experimental trials over the next few days. At first the plastic cannister containing the solution exploded from pressure and we had to go back to the

Photo 4:

The aircrete machine.
(Photo by the author)

drawing board, eventually repurposing a brake tank from an old truck. Through fits and starts and a bit of improvisation, we managed to put together the foam, properly mix it into a slurry, and then pour it into a mould we quickly constructed out of plywood. On our first attempt the slurry leaked out profusely and this loss of moisture created a dry, brittle cure of the material. But we were off, and over the next few weeks we experimented with a wide array of prototypes.

The promise of aircrete is that it foregoes much of the density of aggregate for a different structural principle: the bubble. Sustaining structural integrity through a foamed mass of air bubbles first of all retains the load-bearing compression strength of traditional concrete while remaining incredibly light. This lightness makes it feasible to pour extended panel or even wall-sized moulds. Lightness also frees the material from the Euclidean geometry of the brick; moulds can curve and arch into graceful shapes such as domes. This is the idea behind DomeGaia, a company specializing in aircrete architecture that has its own proprietary machines and mixes geared towards rich northerners looking to go off the grid in a decidedly 1970s Whole Earth Catalog style.⁵ Once outside the mould it can be further cut, carved

Photo 5:
The moulds.
(Photo by the author)

Photo 6: Prototypes.
(Photo by the author)

and drilled with woodworking tools. It could thus serve as a material for planters, landscaping or other decorative objects. Its lightness, moreover, saves costs on production and transport of aggregate – no backs or trucks break under the strain of hauling aircrete blocks. Finally, it has incredible insulation properties: it is fireproof, for instance, and can float. It could make for homes that are ten to fifteen degrees cooler, that are impervious to fire and pests and rust, and resistant to moisture and water damage. The appeal was obvious, and our prototypes garnered lively interest, with passers-by asking what the stuff was, how we made it, and how they could buy some. In what way would aircrete become *available*?

In many ways, the answer to this question was bound up in the broader sweep of events that brought James to Hewa in the first place. An American with family links to the national security state, James had since the 1990s spent time in Afghanistan, Iraq, and conflict zones across Africa. He also described stints running a hunting resort, working as a mountaintop technician for forest firefighters, owning a bar next to a state university party school, and dealing African art. For the better part of the last ten years, he had lived in the western part of Tanzania, where he had op-

erated a small mining company and specialized in designing and repairing mining machines. In 2017, John Magufuli's presidential administration revamped the mining law, raising royalties on gold, silver and copper, and requiring the government to own a 16 per cent stake in all projects (see Jacob and Pedersen 2018). These changes essentially nullified James's mining licence, and he described emboldened local people coming in and stripping him of his equipment soon after the law went into effect. For a while he was doing what he wryly called urban mining, extracting gold from discarded cell phones and computers. Eventually police came and confiscated that equipment as well, and he laughed as he described how they came to his house complaining that the chemicals had burned a hole in their truck bed.

James, we might say, was hyposubjectivized, caught up in cycles of postcolonial retribution and reclamation that have their origins in the *longue durée* of imperial extraction. After these upheavals, James was ready for a change. Mining was a violent, nasty business, he said, requiring him to shout at people and rough them up. He also hinted at unsettling memories from his time as a military contractor. A few years ago he had married a Kenyan woman and they had a child together, and this had started to change his outlook on things. He had a knack for machines, and extensive experience in what he called 'African engineering'. He was now wondering whether he could do something pro-social with it, whether he could, as he put it, 'come in from the bush'.

Because of his background as a mining engineer, James's commercial instincts centred around the foaming machines with which aircrete could be fabricated. In other words, rather than any particular product or service – an architecture or construction company, say – the idea would be to let ordinary people see what could be done with aircrete qua material; he would get his cut by acting as the infrastructural/commercial channel through which that material propagates. 'The more people get interested in aircrete, the more they will figure out what to do with it,' he reasoned. 'They may even figure out how to make the machines – but we'll get to the market first, and we'll do it better.'

In emphasizing open-source collaboration, James's strategy diverged from the standard strategy of market capture, common to solar panels, lamps and other 'humanitarian designs', in which what is sold is a fully realized end product. Not only would aircrete be environmentally friendly and pro-social, but the means of its production would be relatively democratized – far cheaper, for instance, than the massive electric mixers and brick compressors required for concrete, and in no particular way proprietary. It would find a ready market in the seemingly endless small-scale brick-making operations that dotted Hewa and indeed Dar es Salaam more broadly. In other words, the product was not really an *object* with a self-evident purpose but rather, precisely, a *material*, a set of possibilities for further transformation. Its intervention was not (just) aimed at the end consumer, but at the whole local economy of dwelling, its energetic processes of extraction, construction, insulation and decoration. It would make building cheaper and dwelling better, James assuredly pronounced. And it would do so by tapping into the demand for housing that had already congealed in the region, severing its reliance on an

extractive resource model that was itself bound up in a longer history of colonial exploitation and ecological violence.

For any of this to take off, James needed a convincing prototype as proof of concept, and it was here that politics blended into seemingly simple technical questions. After all, companies all around the world make high-quality versions of aircrete. But James not only needed to get the technology right, he needed to get it right in such a way that it could be done cheaply and with local inputs. Resonating with what Gilles Deleuze called 'minor' or 'nomadic' sciences such as chemistry or metallurgy (or for that matter gastronomy; it is significant that the aircrete is 'cured'), the development of aircrete does not obey any transcendent law but rather proceeds outwards towards increasing differentiation (see DeLanda 2016: 86–87). What aircrete does or should be depends on where it is and what other forces it comes into contact and assembles with; it has no essence, just a series of family resemblances across a population. If it was to be truly affordable and useful, an 'African' aircrete would have to grow through the energetic transfer and transformation of local materials.

A major concern was structural integrity. Like concrete itself, aircrete has remarkable compression strength, but its lateral tensile strength is weak. And as with concrete, we experimented with various sorts of structural reinforcements, from cheap, locally recycled plastic rebar to filler such as wood shavings. Thus, for example, DomeGaia reinforce their aircrete by wrapping it in fabric. James borrowed this idea but instead put the plastic mesh in the slurry as it cured. He also followed the surprisingly lively online community of bubble enthusiasts to figure out the optimal density and size of the foam. Indeed, for things like foam parties getting the right kind of bubble is a serious – and profitable – business. Ultimately though, African aircrete had to pass the test of local materials: the particular grade of cement, the kind of wood one might use for curing moulds; even the Ph of the water and the humidity of the air had to be negotiated.

This was easier said than done. As the weeks passed and we continued to experiment, our local collaborators applied what I consider to be a fairly sensible calculus to the spectacle of two white men developing a still experimental material. They would be interested when the tech was refined and perhaps profitable, but until then it was not particularly useful to invest too much time or money into workshopping our endeavours. After all, the spectacle of foreign-led 'development' projects coming and going is an all-too-familiar one in Tanzania. For James, I think, this simply underscored a kind of neo-colonial common sense about Africans: that they were petty and undermining, that they couldn't see the big picture. Indeed, he and his local patron who had provided the workshop fell out over misaligned expectations over what kinds of tools, resources and time each was providing to the other. Growing aircrete from the grassroots was difficult when, like James, you were working on a shoestring budget, when you didn't quite speak the language and when your motives were not always clear. There is no better way to appreciate the complex infrastructure that sustains even our most basic tasks in life than by trying to make a wooden mould that doesn't leak, or fabricating an augur that spins

evenly (cf. Redfield 2013: 71). As I have written about elsewhere (Degani 2018), the romance of the bricoleur, tinkering with what is at hand, can all too quickly lapse into a farcical running around in circles, constantly moving but getting nowhere.

After my short stint of fieldwork ended and I returned to the United States, James relocated to a wealthy, expat part of Dar es Salaam and start talking to local NGOs and other project-oriented actors there. He spoke with an art educator that wanted to use aircrete as a design material, and with a homeless youth shelter that was interested in having its wards use it to make and sell products. Eventually he linked up with the head of an animal rights NGO who had experimented with making and selling plexiglass fishing boats in Dar, and who had become interested in building furniture out of recyclable materials, as well as the cousin of a well-known Tanzanian businessman who owned a rice plantation a few hours outside of the city. James had contacted the latter because he was getting interested in rice hull ash, a siliceous material that could be mixed in with aircrete slurry and used as a stabilizer and filler. In following potential links between materials, James was also following the social and economic actors that might provide the resources to make them.

It is unclear what this next chapter will mean for African aircrete – whether it might provide a sustainable and useful material in the region's ongoing construction boom, or remain a minor footnote. One of the lessons of James's relentless curiosity – he was often on his dilapidated smart phone late into the night, acquiring and texting me interesting factoids from the web – is just how many alternative techniques and materials have been overlooked, ignored, underestimated or simply forgotten: from the environmentally friendly sealant 'waterglass', to the limestone-based architecture of the Swahili coast, still standing sometimes centuries after construction. What particular energy or material becomes hegemonic entails a high degree of contingency; much depends on who or what 'enrols' it (Latour 1984) – or rather who or what captures its possibilities. When I returned to my university I was introduced to a bright Nigerian-American engineering student who had taken an interest in alternative building materials, and who took it upon herself to win a grant to spend the following summer in Dar es Salaam, working with James and his new NGO collaborators. There is a parallel between anthropology's gradual recognition that 'the field' is not a place but a situation (Pandian 2019), and the basic lesson of the Anthropocene: there is no true elsewhere, only more or less obvious interdependencies. This entails not purifying mastery but engagement – a more equitable redistribution of its energies and materials, however clumsy or minor.

Conclusion: air in unexpected places

'Confronting the Anthropocene,' Hecht (2018) writes, 'in Africa and elsewhere, requires fresh sources of imagination.' I have found that physically working with aircrete has allowed me to viscerally reimagine the qualities of dwelling in the African cities of the twenty-first century. As Rosalind Fredericks recently explored in her book *Garbage Citizenship* (2018), such spaces have long been understood to

be wastelands, dirtiness incarnate. And yet I would venture another, structurally related, qualisign: heaviness. From the massive modernist buildings of the post-colonial era, to the strain of shovelling sand and lifting bricks, to the precariously overloaded ferries, trucks and buildings that break down and capsize, African cities are too often made to carry more weight than they can bear. Lurking in this condition I sense a planetary form of life organized around the structure of aggregate, in which energy is compressed and congealed into incredible densities that leave dispossession in their wake. By contrast, foam organizes itself around the principle of distributed stability, which allows for the improbably elegant form of the sphere, and whose minimized surface tension might generate lightness, durability and insulation. Its capture in cement allows us to imagine how urban denizens might be able build easier, live with less rot and corrosion, or perhaps simply find a new artistic material through which to capture their experiences. To be sure, aircrete may seem like a sort of speculative bubble itself, a 'utopian' flight of fancy that can only pop against the rough ground of the Anthropocene. But as Peter Sloterdijk points out in his massive philosophical treatise on spheres, that has always been the scandal of foam, which is 'almost nothing, yet not nothing' (2011: 27), which subversively creates gaps in solids or liquids, making them non-identical to themselves. 'What then would a first definition of foam have to be?' he asks. 'Air in unexpected places?' (ibid.: 28).

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Notes

1. Cf. Michael Fisch's (2017: 815) discussion of the capitalist domestication of silkworm and salmon, in which life's matter-energy is disconnected from 'relational milieus of becoming and [confined] to an overly determined enclosure'. See also Amy Zhang's (2020) nuanced analysis of enclosures and the 'becoming black soldier fly' of organic waste in urban China.
2. See <https://twitter.com/afrigadget>
3. See https://en.wikipedia.org/wiki/2013_Dar_es_Salaam_building_collapse.
4. See <https://c-re-aid.org>; <http://www.kere-architecture.com/projects/lycee-schorge-secondary-school/>.
5. See <https://www.domegaia.com/>.

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