Author copy. Please cite the published version in the Extractive Industries and Society
https://doi.org/10.1016/j.exis.2022.101168

Taming air and water:
The fight against *shimoke* in artisanal and small-scale gold mining in South Kivu

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Abstract

How do miners in South-Kivu *tame* air and water in the underground? And in doing so, how do they manage and moderate leaks that creep into their mining gear? In this article, we use the so-called *shimoke*, deadly, invisible, and odorless fumes that exude from a small water pump, as an ethnographic entry-point to engage with these questions. In doing so, we weave a story that meanders and traces engagements from the import of mining gear under colonial rule to current underground attunements and aboveground socio-technical engineering.

Keywords:

Pumps, Air compressors, Tools of empire, Technological choice, DR Congo, Hard-rock mining, Technological appropriation, Toxic fumes

Introduction

Vignette 1. Kamituga, South Kivu, Democratic Republic of Congo (DRC). 5:30 a.m. The gold mining town is waking up. On one side of the muddy street, mopeds carry people. On the other, people passing by on foot make traces of coagulated mud pile up as a pathway. Bottle caps, plastic bags of hard liquor, and painkiller strips are mixed in with the dirt. The mine sites themselves emerge in red from the iron oxide in the soil. Blue UNHCR tents for refugees are strewn about on which freshly quarried stones are left to dry. Men and women (bongeteurs) break the rocks with a hammer. Crushers powered by Chinese Changfa diesel engines grind rocks into "bunga" (cassava flour) under tents. Around the bend, almost hidden, diesel pumps (motopompe) and mobile air compressors (souffleurs) meander into underground tunnels. Like intravenous probes into a body, rubber tubes enter and exit the tunnels. They evacuate toxic fumes and putrid water or push air in.

At the heart of artisanal and small-scale mining (ASM) are two elements that either guide and enable or block and impede the extraction of gold-bearing stones: air and water. This is a general claim about artisan mining in the Global South, yet at the same time allows us to pry and engage with some socio-technical particularities and non-linear contingencies involved with everyday work surrounding mining sites in South Kivu; as described in the opening vignette.

Perpetual aeration is necessary to breathe in underground workplaces. Water, however, has the power to rot the wooden structures of handmade tunnels, causing noxious odors (*harufu mubaya*) to rise in the underground, and it also restricts access to the lower levels of the mine if the shafts are flooded by groundwater. During the rainy season, from September onwards, water greatly increases the risk of collapse and drowning. And yet, it is that very same element through which minerals can be separated, through manual techniques such as panning and sieving.

Since the late 1990s, there has been a noticeable increase in small machinery surrounding the mining sites in South-Kivu resulting in the co-existence of manual and mechanized forms of labor. Some of this machinery is mentioned in the opening vignette, such as small crushers, pumps, and air compressors. The latter two can be understood as prolongations of manual attempts to address the challenges involved in keeping mines sufficiently aerated and dry. On the one hand these machines can be theorized as compact and transportable responses to the challenges posed by increasingly deep mining structures (Verbrugge & Geenen, 2019; see Dunia Kabunga and Geenen in this series). On the other, they need to be understood in conjunction with global flows which allowed Chinese-built engines (ICE's) to find their way into the rural part of DR Congo: places that are often disconnected from any power grid. Here, ever-shifting extractive workplaces challenges ethnographers to not only see the underground as a material outcome of manual engagements, but also requires one to adequately think *with* the mediation of technologies and machinery, and the complex "assemblage" and design of embodied practices and routines that emerge from the interweaving of those interactions (Latour, 2005). However heterogeneous, at times odd, and multiple the techniques described hereafter appear to be, they do remain consistent and widespread as "an assemblage of practices that embody the experiences of long-standing miners" (D'Angelo, 2018).

There is, however, one thing most hardware and compound machinery have in common: they leak. In the case of the ASM sites in eastern DRC, a small leak (*fuite)* from a single-cylinder, diesel-powered pump placed in a shaft can cause death by asphyxiation of artisanal miners. This is the case if the ring is not properly placed in the pump, or if the exhaust valve is not securely attached to a pipe that discharges the toxic fumes. Miners in South-Kivu call these deadly, odorless, and invisible fumes *shimoke.*[1] At that moment, the seamless mediation between environment, machine and miner ends, and other urgencies, routines, and often improvised engagements to counter these risks tread to the fore (Rolston, 2013). It is this, seemingly inattentive leak, which forms our main ethnographic entry point into the underground.

Moto pump charged to a modified bike (Credit: Simon Marijsse)

Seen from the vantage point of recent debates, scholars have increasingly come to highlight air as something that is no longer an invisible given or a passive *a priori*, but which can be designed and actively integrated into the workplace (Sloterdijk, 2009). At the same time, it has fueled post-human studies

[1] In the Mwenga territory they speak of *Shimoke*, while in the Shabunda territory they speak of *Shimoko*. Another problem with pumps is for example the risk of electrocution if electric pumps are used instead of diesel pumps, locally called *pompe weda*. (see, for example Pijpers & Luning, 2021).

surrounding "suspensions and volatiles" (Choy & Zee, 2015; Agard-Jones, 2014) and socio-technical assemblages around toxic and harmful workplaces (Murphy, 2006; Reno, 2015; Kopf, 2020). In the case of mining, our attention is directed toward the particularity of leakages that toxic suspensions miners internalize, and which are often an effect of technologies that initially sought to improve underground access (Cartwright, 2016).

This article takes the motor pumps' leak as way to disentangle and understand the ambivalences and challenges involved in technological deepening of mining sites (Moore, 2010). As such, it makes a case for the intimacies involved in the mediated relationship between miners and their environment through machines (Rolston, 2013). Why is it ambivalent? Although the motor pump can be seen as a success story, allowing access to ever deeper pits, it has simultaneously raised local concerns about an increase of deaths by asphyxiation (Beisel & Schneider, 2012). Subsequently, it has forced local engineers to "fight" (*combat*) toxic exhausts leading to forms of socio-technical creativity and the re-purposing of technical objects — alongside embodied remembrances of toxic exposures to "heavy air" whilst working for the state mining company SOMINKI.

Previously, Tubb (2015) described the use of water pumps as the most visible technological change since the beginning of the 20th century in ASM in Colombia, Chocó region. In relation to the mechanization of mines in Ghana, Philippines, Burkina Faso and DRC, recent studies show a global tendency toward coexisting forms of manual and mechanized extractive processes (Teschner, 2012; Verbrugge, 2014; Lanzano, 2018; Mulonda et al., 2019; Radley et al., 2019). Although mechanization is sometimes described as the integration of *new* technologies, in many of these cases, this integration could be considered as one of old technologies which retrieve a renewed technological "momentum" (the motor pump, for example, had been invented at the beginning of the 20th century) in a different setting. And yet, so far, very little ethnographic investigation has been conducted into the ambivalent relationships and linkages between hardware and the layered (dis)continuities between the embodied remembrance of past engagements and actual concerns about either chronic or acute body harm and toxicity (Mol & De Laet, 2000; Beisel and Schneider, 2012; Cartwright, 2016).

As Lambertz (2021) remarked, the effects and use of ICE's remain poorly studied in Africa. In this way, highlighting the use pumps and air compressors in the workplace helps to counter a few omissions. First, it helps to dispel the notion that technology is totally absent in the DRC or that it remains traditional. As such, labelling the DRC as a "failed state" consisting solely of "colonial mines, laboratories, deteriorated infrastructure" means that localized tools, engineering capacity and ingenuity barely enter the analysis (Schouten, 2013). Second, due to the emphasis on presumed smart(er) technologies and the digital age, thinking with hardware has remained omitted from scholarly investigation (Mantz, 2008, Smith & Mantz 2014, Smith, 2015). As, for our own methodological limitations. The research, for example, would benefit from further scrutiny that engages with specific mining techniques through a gendered lens (Bray 2007; Cuvelier, 2014).

In the following article, we zoom out and jump scales, thinking through leaks and levels of exposure, allowing us to showcase the subtle and non-linear meanderings of murky arrangements. These threads link machines first imported under colonial rule to the import of Chinese engines in a workplace that currently foregrounds re-engineering, improvisation, and technological creativity involving connections between modern and traditional tools. This allows us to highlight both the affordances between geology and humans, and between humans, techniques, and machines, and why not even in between machineries. In extension, it also counts as an active critique against modern accounts of technology transfer which often leave out the contingencies, non-linear accounts and "temporal and spatial twists" involved (D'Angelo, 2018).

Writing from a perspective of socio-technology (Pfaffenberger, 1992; 1998), we opted to frame the current struggle with leaky technologies within an ongoing, persisting, and shifting task to *tame* the elements (water and air) in underground workplaces.[2] Here, we also use the concept of 'taming' as a form of decolonial critique. As the verb cannot be disconnected from the stigmatic weight of colonial rule which sought to 'tame the wild man', we utilize this verb to try and pry open the debate. Showcasing actual technical moderations and improvisations as forms of 'taming', and being quite literally called as such by miners, also highlights our aspiration to advocate for an active deconstruction and decolonization of technology studies, allowing actual African technologies to enter the debate – without unmooring it radically from either colonial extractive practices or techniques and moderations that spilled over from non-mining domains (D'Angelo, 2018).

First, we examine the use of compressed air as an imperial tool in colonial (and post-colonial) transportation and mining infrastructure – being used to power jackhammers and to ventilate tunnels. Second, we focus on the importation and use of Chinese machinery and equipment. In the third section, we examine how these diesel pumps allow for the resurrection of past colonial trauma into current understandings and practices around airborne toxicity. Finally, we examine local responses and technical choices (Lemonnier, 2014)
What follows is based on ongoing ethnographic research in South Kivu from 2018 onward, and on archival research (Museum of Africa, the National Library of Belgium, the Archives of the Ministry of Foreign affairs). It relied primarily on in-depth interviews, informal conversations, observations of gold mining in alluvial, open pit and underground mines, as well as participant observations.[3]

[2] *Taming* has previously been used in the field of anthropology of technology by Akrich and Beck (1993, 2001). The former described the ability of engineers to be *cunning* or to *challenge* a machine, when faced with its "tricks". Beck, on the other hand, described the taming of pumps in the Nile Valley in the context of a perpetual system of repair and maintenance.
[3] was financially supported by an EOS-FWO and VLIR-UOS research grants as well as a FWO long stay abroad grant. We are grateful to the reviewers and the journal editor for their kind remarks and comments. The

Compressed air as a tool of empire

When walking around in Kamituga, it is hard enough to cancel out the ever-lingering shadow of the state-run mining company SOMINKI (1974–1997). During the 1920s, the Belgian Congo colony began to become the classic example of a satellite state seen as a reservoir of primary resources for the metropole. At the same time, Belgian industrial interests in the Belgian Congo increased, "merging the expansionist agenda of capital with the imperial opportunity of having a colony" (Abbeloos, 2008). This allowed Belgian industrial companies such as Cockerill Inc. (based in Seraing), Dutrannoit (based in Marcinelle) and Carton (based in Tournai) to produce transportable machinery, such as mills, air compressors and pumps, for prospecting, exploration, extraction, and preliminary processing of minerals (Pasleau, 1992; Cornet, 1952).

In his book *Endogenous Knowledge*, the African philosopher Paulin Hountondji presents the colonies not only as economic reservoirs for metropolitan factories, through for example the extraction of natural resources, but also as an external market for industrial goods and machinery (Hountonjdi, 1997). It is then a question of setting up "miniature cities" which revolve around a capitalist commodity such as tin, gold, and other minerals but which presuppose logistics, a workforce, and tools (Nye, 1996). Belgian expansionism had effectively linked technologies, investments, and infrastructures in the first half of the 20th century, transforming the Congo into "useful Africa" (*Afrique utile*), at least from the perspective of the colonizer's metropolis (Headrick, 1988; Bunker & Ciccantell, 2005; Adas, 2015; Pourtier, 1989). As described by Mathelin de Papigay, Federal President of the Belgian Colonial Action for National Colonization, in 1937: "It was also in the Congolese enterprises of these large financial groups that Belgian technicians stood up who, little by little, replaced in the colony the foreign staffs of the beginning." In this way, Afrique utile was not only established as a market for tools and infrastructures, but also as a job market for technicians.

When it came to mining infrastructure, the main purpose was to achieve better mineral recovery, access to the less exploitable parts of the bedrock, and to reduce its dependence on indigenous labor. Up until the 1930s, mining had been largely a manual endeavor, with the use of wheelbarrows, picks, Banka drills, metal gutters, saws, shovels, nails, and machetes.[4] Aqueducts, canals, and clay dams were built to transport water to the extraction sites. For some of these infrastructural developments the use of small air compressors and mobile water pumps with diesel engines was employed. As a result, mechanization became a goal, which the colonial civil engineer Anthoine called "the era of mechanization" (Cornet, 1952). It increased profits by making the extraction of low-grade ore more efficient. For this reason, investments in internal combustion

development of the arguments profited from ongoing discussions with Peter Lambertz. Pictures were taken by the main author or stem from a collaboration with Robert Carrubba, who we cordially thank

[4] The Banka drill was a large manual drill that could be moved, assembled and operated to loosen the underlying bedrock and make mineral prospection possible. It was designed by a Dutch engineer and named after the tin region Bangka in Indonesia.

engines, wooden steam boilers, and later, hydraulic turbines became a necessity (Anthoine, 1933; Cornet, 1952).

In the context of the mechanization of mining, the use of steam is specifically a problem for underground mines. Steam engines or simply the use of hot water increase the risk of firedamp in coal mines - often called smoke or steam. In the early 20th century, two options became available to address the problem of firedamp in the underground. The first was the use of small groups of "motor-compressor" machines to support the construction of the main extraction galleries. These small air compressors were first produced in the USA and then refined in Düsseldorf, Germany. Here, the compressors were smaller in capacity but could be easily transported to keep up with the construction of the underground galleries. The second option refers to the use of a main, stationary compressor with a higher force that was installed to drive a specific extraction location for all drills. For this reason, a specific room for the compressor(s) was set up (Denis, 1909). In this sense, the choice of infrastructure and machinery is consistent with the estimated time and revenue that a mine could generate.

In the case of the colonization of Algeria, the air compressor was described as a tool of colonization (or rather of imperial powers) thanks to its flexibility and ease of installation.[5] Mobile air compressors played an important role in establishing early colonial settlements to support its future extractive economy. In this sense, they would have been described as "tools of empire" by imperial scholars of history (Headrick, 1988; Adas, 2015). Similarly, the air compressor and diesel engines were the main tools used in the construction of viaducts and tunnels in the Belgian Congo (Anthoine, 1936). The Belgian Congo pushed towards a "dieselization" not only in terms of its river transport (Lambertz, 2021), but also in the form of air compressors used in road construction and mining.

When talking to miners in Kamituga, they explained that next to one of the entrances to the large underground tunnel named after the neighboring *Petite Mobale* river, a compressor room ensured the mine's energy supply in compressed air. Two old single-piston horizontal air compressors of the French brand, *François*, known as *le grand* and *le petit François* and a two-piston compressor of American manufacture Ingersoll Rand, were used for this purpose. The large compressors were driven by a hydraulic turbine. Now, clothes are left to dry where these turbines operated and miners are seen leaving, wearing headlamps, the still operative, but partly flooded, *Mobale* mine. Elsewhere, mobile air compressors (Atlas-Copco, Ingersoll Rand) that belonged to the company are standing rusty and desolate in abandoned workshops. They had been attached to an iron pipe which was then attached to polyethylene pipes and finally to tools such as a pneumatic drill or a crowbar.

[5] Journal général de l'Algérie et de la Tunisie : affiches algériennes et tunisiennes : organe de la propriété foncière et des intérêts économiques.... 1925-09-20. Supplement Figaro: Friday 23 July 1937, consulted on gallica.fr

Artisanal *orpaillage* (gold mining) mainly expanded in the Global South throughout the 1980s as part of liberalization policies (D'Avignon, 2018). First, manual techniques were used in a landscape that often retains the image of an open-air museum of colonial extraction (Smith 2021). Extractive techniques spilled over from the company's employees and know-how from other social domains (D'Angelo, 2018). Since the integration of small-scale machinery, however, improvised ways of re-engineering and local welding techniques have stimulated the re-purposing of iron-cast residuals in the post-colonial landscape. It is in this space of embodied memories of previous extractive practices and the very material remains that remain tied to these that the ensuing story is rooted.

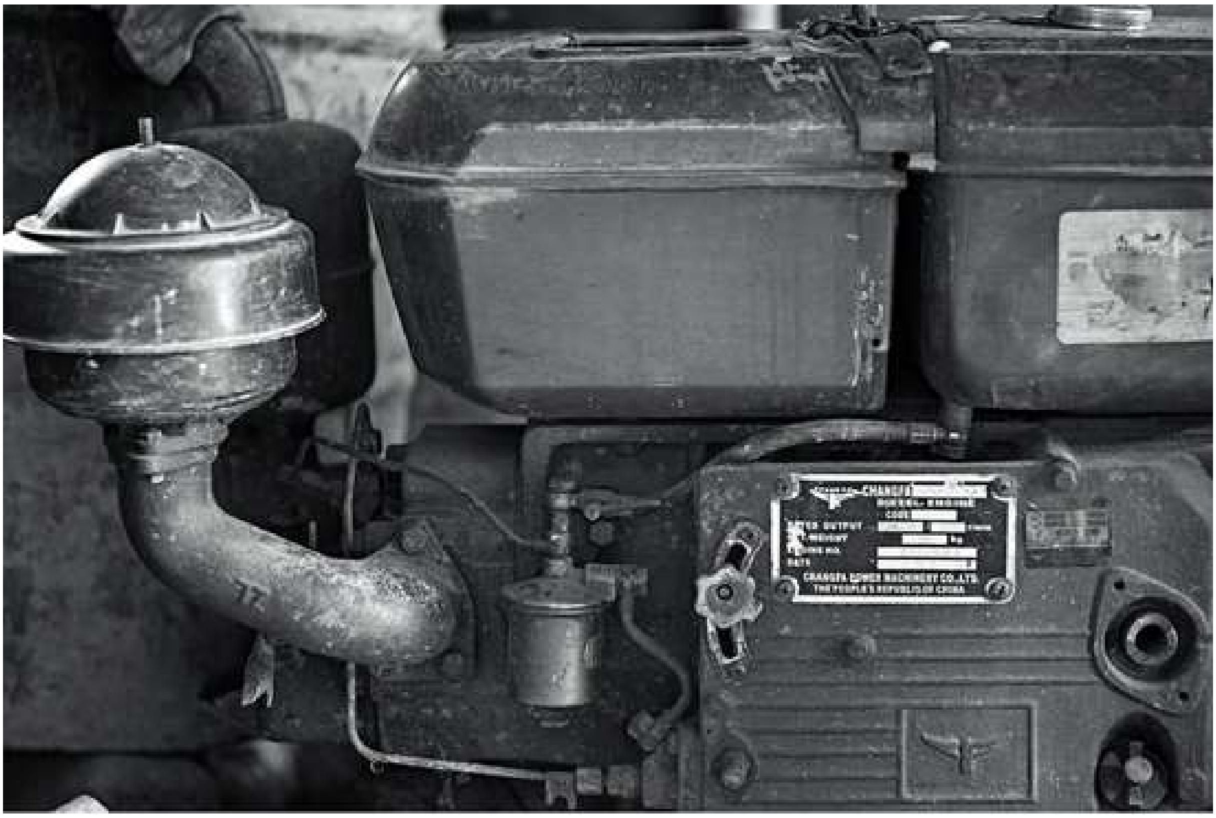
Mobile air compressor (SOMINKI workshop) (Credit: Robert Carrubba)

Pumps from the East

In Kamituga, clandestine mining slowly developed in the shadow of industrial mining (Geenen, 2015). Faced with an ongoing economic crisis and plummeting state revenues, an effect of falling mineral prices and increasing external debt, the Mobutu regime opted to alleviate state control over its mining industry and allowed its citizens access to the subsoil. The rising influx of artisan miners into the region together with hyperinflation, political crisis and armed rebellion against the Mobutu regime gave a final deathblow to an already disintegrating mining industry (Geenen & Marijsse, 2020). As a former Congolese employee of the enterprise explained:

When the company left in 1996, people felt free to dig wherever they wanted in the old leases. That's when the pits started to get deeper and deeper, and they started using diesel engines inside those pits - which was not happening before.But to understand the arrival of these diesel engines, we need to shift our attention briefly elsewhere. We change the scene to Bukavu, the capital city of South Kivu which lies to the east beyond the green hills of Kamituga.

> Vignette 2: Dust and the rumbling sound of motorcycles fill the air in the Kadutu market. A distributor of mining hardware holds his battered mobile phone in his right hand, dials 3030, confirms, types in 2, international calls, charges his devices to call abroad and dials his supplier at the Dragon Mart in Dubai. He needs a new stock of ChangFa, King Max, Kipor, Eagle and Koshin diesel and petrol pumps, shipped from Guangzhou, located on the Pearl River in China - or in the case of Koshin and King Max, from Japan. “High price, Low price,” he coos into the cellphone.



Changfa Fuel Engine (Credit: Robert Carrubba)

In Eastern DRC, China's presence is often associated with mining practices. Its presence first began with Mobutu's projects in the 1970s, when Chinese construction workers participated in the inauguration of the new Martyrs’ Stadium. Later, Kabila and his policy of *5 chantiers (5 construction sites)* allowed the influx of Chinese labor to prevent its national infrastructure from further deteriorating, in return for access to its mineral wealth (Marysse & Geenen, 2007; Marysse & Geenen, 2009). Another movement, however, found its embryonic moment in the late 1970s, and made itself felt some twenty years later (see mainly, Lambertz 2021).

In 1978, China initiated a radical reform of its rural economy. It moved from an economy in which the state was the main purchaser of large-scale agricultural equipment to one in which farmers were capacitated to buy smaller versions of these machines themselves. The *Beijing 12 foreign agricultural machinery exhibition,* held in 1978, was emblematic of this change, stimulating both the import and export of small-scale agricultural machinery such as generators, motor pumps, and tractors (Yuan, 2005). Highlighting small-scale mechanization not only revolutionized rural entrepreneurship in China but also impacted elsewhere. During the 1980s, China started to expand its exports to Nepal, Sri Lanka, and Bangladesh (2015). At the same time, local seasonal contexts, and states of crisis, as was the case during the onset of drought affecting cattle in Bangladesh, also help explain the success of this machinery (Biggs, Justice, & Lewis, 2011). As for the small-scale farmers and rural entrepreneurs in East Asia, Chinese equipment proved similarly to be effective in rural contexts in Sub-Saharan Africa. Here, pumps, for example, became a significant player to generate access to drinking water and irrigation. In Zambia where the national electricity grid reaches only 4% of rural areas, diesel or petrol driven motor pumps have become the main source of power (Colenbrander & Van Koppen, 2013).

In Zimbabwe, the B-type Bushpump, a cylindrical pump with a closed cover that was modernized by the Zimbabwean government after independence, owes its success to its local malleability, mechanically robust nature, and technical “fluidity” (Mol & De Laet, 2000). However, if engines resist malleability, they need to be tamed and cared for continuously. This had been the case when diesel pumps took over from the traditional *saquîa* – an oxen-powered wheel – which previously dominated the Nile Valley in Sudan. Its introduction not only led to the reconstruction of irrigation canals and the demand for fuel, but the technological complexity of the pumps and mechanical engines necessitated a local repair system. This system became based on previous skills, new experiences, and improvisation, and ultimately lead to the deconstruction of the diesel engine itself. Repair ultimately led to modifications which integrated palm leaves, mud, plaster, spare parts from previous engines, and the use of the Nile as a direct cooling system into its design (Beck, 2001).

In eastern DRC, the combination of low maintenance, low fuel consumption and the ease of transport – often one man can carry it on his head – combined with poor electricity supply in rural areas explains the success of the motor pump. Here, preference is given to Chinese pumps because of price differences. When China started exporting its agricultural equipment, it offered a cheaper price to the consumer, compared to similar equipment made in Japan or Korea (Yuan, 2005; Biggs & Justice, 2015). In Kamituga, the departure of the state mining company SOMINKI in 1996 (coupled with the increase in artisanal diggers after 1982) and the surge in gold prices in the early 2000s meandered alongside an increased demand for the import of diesel or petrol pumps. At the same time, the price of pumps fell. The price of 3 to 5 horsepower pumps dropped considerably in the late 1990s (Colenbrander & Van Koppen, 2013). This has allowed these pumps to be bought and then rented at half a gram of gold per thirty minutes.[6] However, all 2-to-4-inch portable pumps have a suction limit of 4 to 8 meters. As a French geologist working in South-Kivu explained:

> To avoid the possibility of water leakage at the beginning and to keep the suction power high, you should position the suction hose of the motor pump near the place where water needs to be evacuated.

These pumps are mainly used for irrigation and flooding in agriculture. That had been their original purposing. In this way, placing these pumps in an underground gold pit can already be understood as a technical improvisation. However, when used as such, the diesel particles must be evacuated effectively through a tube attached to the muffler or exhaust valve. Due to the continuous increase in depth of tunnels, the pumps themselves are often placed inside the shaft. Depending on its use, every technology has the tinge of ambivalence as toxic fumes can rise in the pit.

Noticing ***shimoke***

We hide from the sun in the office of Belgique, president of a mining cooperative in Kamituga. When asking about dust prevention strategies, implying mainly the dust escaping from the hinges of the crushers, he nodded and confirmed with a sense of urgency: "Here there is a lot of dust". On the one hand, it could be interpreted as a confirmation of the amount of dust in Congolese mining towns during the dry season. In this sense, dust is represented as a homogeneous vector of ongoing environmental discomfort. On the other, his remark could also be read as a reference to a history of dust that started under colonial rule, with trucks transporting ore along dusty roads and drills that stirred up dust in the mining shafts. However, as the conversations continued, it became clear the president of the cooperative used dust to refer mainly to diesel vapor (*shimoke*) leaking from the valve of a motor pump installed in an underground tunnel. All the sudden, it became clear that the amorphous nature of dust or airborne toxins carried so much more than what had been initially postulated in the question. It infers multiply attunements to toxicities (chronic and acute; past and present) and implied layers of embodied and tactile techniques in subterranean and invisible workspaces (See, e.g. D'Angelo, 2019; Morris, 2008; Nystrom, 2014). A former SOMINKI worker explained:

> It (*shimoke*) is derived from the English. Smoking. Even in an airplane they say not to smoke, no? Back then, there were problems with silicosis [a pulmonary disease tied to exposure to rock dust], tuberculoses, and gas [both TBC and silicosis are called *kampaku* locally, or 'to cough a lot']. They (the miners) have popularized it, it is the smoke in the mines, which comes from the fuel. You will

[6] At Kadutu market, a motor pump today costs USD 300, and a *Changfa* machine (*alternateur*) (1115-20) which can propel a large air compressor or crusher costs USD 650.

> often hear, he died because of smoke, but smoke is mostly after a drill or a leak in a motor pump, if you are mining there will be dust. It is all part of the *shimoke*.

Very often, responses to these questions started to coalesce around memories of a colonial and post-colonial past, both inferring cases of acute asphyxiation in the underground as long-term effects of silicosis caused by dry drilling into the bedrock — which simultaneously increases the risk of tuberculosis (Rosenthal, 2017). According to the sons and daughters of deceased miners who worked for some of the Belgian mining companies in Shabunda Territory (Kivumines, Cobelmines, SOMINKI), *shimoke* is the foul smell (*harufu mubaya*) of the Belgian spirit *Dundunje*, a word borrowed from the French *nom de dieu* or the Flemish *nondedju* meaning a curse. In other places, such as Kamituga, *Dundunje is* found in narratives of acts of cannibalism by Europeans (with regards to similar narratives, see White, 2000). A miner narrated:

> In my father's time, the Belgians were at the club every weekend, or they played tennis. In the club, the white people dug a cellar and when the night fell, they ate the black people there. They would capture you and put you in the cellar. They would not give you food, but only salt... salt and more salt. They even throw salt at you where you sleep. After some time, the prisoners' bodies changed completely. When the white people celebrated, they would eat you. *Dundunje*, they said, and they drank whiskey: *Aaah dundundjeee*! With their swollen bellies, with cigarettes, with their whiskey. *Dundunje!* After grilling you, they sang and danced. [...] It is also said that there on the hill *Kibukila ya Pangu*, there was a gold rock guarded by a Belgian snake. Its name was *Dundunje*. If you dared to go there, it swallowed you.

The spirit, either in the form of foul-smelling smoke or in the form of a snake, and at the same time associating it with anthropophagy, can be understood as an intimate example of *colonial naming* in which colonial lexicons became locally appropriated, and persist in ongoing narratives which at times resurge in the face of social change (Likaka, 2009).

Nowadays, faced with the increase in success of cheaply imported and easily transportable Chinese diesel pumps, *shimoke* and *Dundunje* have become *odorless.* It has turned into an invisible suspension of diesel particulate matter due to incomplete combustion and pyro-synthesis: carbon dioxide, water, and nitrogen. In the case of motor pumps, if combustion is incomplete, the smoke from diesel engines can produce large amounts of carbon monoxide in areas with little ventilation, such as dead-end tunnels. Similar cases can be found in the oral histories around the mines in the Katanga region and the Zambian Copperbelt. There, people share their complaints about sulphur dioxide emissions, locally called *senta* or *kachoma*, being the cause of severe lung trauma (Peša, 2021).

The term *shimoke* actively brought out, associated, and re-energized colonial memories about asphyxiation, tuberculosis, and silicosis, with current mechanical leaks. These forms of aerosols are not particularly natural elements. They are toxic side effects, leaking from the dated technologies that are used and manipulated at these mine sites in the context of addressing water and air challenges. In Uganda, for example, narratives emerged around "spraying" practices (White 2000). European fumigation technologies were used as a "plague control measure in southern Uganda in the 1930s" engendering a link between public health campaign fumes and personal attacks – as the fumigants (poisonous insecticides) used on human dwellings were lethal and provoked a "strong smell". At the same time, narratives of past toxicities and deaths are welded to a present in which the debris of deteriorated colonial infrastructures meets circulating global technologies (Stoler, 2013). Memories of drills, air compressors, ventilation systems and pumps fermented like colonial vignettes that allowed miners to speak and come to terms with the dangers to which current technologies expose them. But at the same time, these memories feed the contingencies and unease that operate in these narratives of invisible threats with or without odor. Englebert is 56 years old, manager of a mining pit and president of a mining cooperative in the mining site called Calvaire in Kamituga. He looks out of breath, but he speaks with great vigor:

> *Shimoke* is a heavy air, which you do not smell, but you feel [both are *sentir* in French]. It happens when the diesel pump heats up and a leak in the suppression tube causes the fumes to spread through the tunnels. Then, it becomes difficult to breathe. It is neither silicosis nor tuberculosis. It paralyzes you and you feel it in your body. I remember that in the years 1981-1985, during the SOMINKI era, I worked as a clandestine miner (called a ninja) in Cabo, in the site which was called Danger. We were a team of 12 people in Joseph M.'s pit and we worked in two shifts (*go*) from 6am to 12:30pm and from 1pm to 4pm. That day I arrived late. Around 10am. I was late because I needed to buy batteries for my headlamp, and I was waiting for the shift to change. While I was waiting, at about 10:30 a.m., I saw a man staggering out of the tunnel. I did not understand what was going on. I asked him where he was going but he did not answer, and I stood perplexed. I knew something was wrong. I went in. I was fast, but I could not do it, and I went back in. It was too late. Six people had died that day. We could not smell anything, but it was in the air. That was the first time we were confronted with the *shimoke* of Chinese diesel pumps.

In the case of the activities in ASM, the frustration, anxiety and despair created by water and air, lead to a challenging workspace. Words of resignation surge from the mouth of a miner:

> I was sitting in the *lutanda*, and the screams came out of the pit (*shimu*). 'Help, help!' We went into the pit, but there was no air. We chose two *pulmoneurs* [lit. lungers, to describe those who can resist the strong retention of breath] so that they enter where our colleague had fallen asleep in the *lumpwitipwiti* [the mud in the pit]. They arrived near him. He was unconscious and breathed with

> difficulty. They brought him not directly out of the tunnel but a few steps from the exit. We looked for fire and garlic. We put the fire under the soles of his feet and introduced garlic into his nostrils. After a few dozen minutes, he coughed and caught his breath."

To manage risks, certain cries, gestures, movements, whistles, and ropes are introduced by diggers to connect the underground to the surface. This, in and by itself, are attempts to control and tame the risk of *shimoke*. A miner explained:

> I have been a pump operator for four years now and I must admit that our pump rarely breaks down because there is a communication with the cabin outside. If needed, five of us line up in the pit to sound the alarm. I whistle and the others reply until the pump stops. However, our air compressor keeps supplying air to it. If it also breaks down, we must stop, run away, and abandon the pump in the *kanyonga* [the hole in which a pump is placed to draw water].

Talking about airborne toxicities in a fuzzy or non-delineated way - from the smell of rotting wood to gases escaping from rocks to memories of gelignite fumes, explosions, diesel fumes, and outright dust from drilling – clashed with our own ethnographic need to categorize, delineate, and specify these vectors of discomfort and harm. And yet in some cases, it is the compressed air itself which, according to our interlocutors, caused headaches and dizziness in the underground. Most often, miners do not specify the scientific or chemical element that causes harm, but they refer to types of *shimoke* as "heavy air" and have associated that with sensory qualities, faulty mechanisms, as well as temporal qualities of exposure (chronic or acute) and the lexical persistence of remembrances of harm whilst working for SOMINKI.

Here, airborne substances cannot simply be reduced to a singular biochemical category of that dust or those fumes, but it shows agentic capabilities that include embodied remembrances to past ecosystems and attunements that directly speak to ongoing forms of exposure to mining substances and environmental encounters in the workplace. Here relations of harm become embedded into the used tools and machines and require the constant reworking of their "pit sense" — the ability to continuously adapt their extractive techniques to a working environment that is precisely moderated through their actions (Rolston 2013). What takes priority is the threat itself based on multiple previous experiences with heavy air and the immediate action which needs to follow once it is noticed.

Tinkering with compressed air

Let us recap. Concerns about exposure to "heavy air" revolve around two key issues. First, it has reframed local conversations about *shimoke* in industrial mines that were tied to acute cases of asphyxiation and chronic pathologies. Second, the former resurged and became modified through the recent use of Chinese diesel pumps in underground mines. In the final part we focus on the confrontation with *shimoke* from the point of view of an engineer. The confrontation with death has simultaneously fueled the need for local modifications, retrofitting, and the re-integration of air compression.

We meet 81-year-old Etienne, who worked as an engine and diesel specialist for SOMINKI. At the end of the 1980s, faced with the increase in deaths in the mines due to diesel exhaust fumes, he sought for different ways to prevent fatal accidents. In his recollection, underground miners were already importing compact Japanese Koshin motor pumps in the early 1980s. It was then that he noticed the increase in the number of deaths in the mines, known locally as death by asphyxiation. He explained:

> *Shimoke* is the air that takes the quality of being heavy, instead of being light. You start breathing faster because of the leakage from the motor pump. Or a driller hits the underground rock with a crowbar and a heavy gas emerges. If you take it in, you are going to die.

Faced with these toxic fumes, Etienne began to cast iron pipes instead of rubber ones. He named the pipe *balobola* in 1986, after the name of his partner's clan (*mu/walobola*). In another interview, the manager of a mining pit told us an alternative story to understand the origin of the name *balobola*. At the same time, through his tale, he demonstrated the interplay between technology, death, and local narratives:

> At that time, our *balobola* clan leader was carried on *tipoi* [a carrying device made from wood]. He was carried on the shoulders of others. When the chief wanted to get out, he would just order them to lower him. And so, he left the *tipoi*. A little snake came and nested on the *tipoi*. When the chief returned, the people took the *tipoi*. While he was being transported, the snake bit the chief. He died. The people started to shriek: 'It kills and stings!' People died. And this (*shimoke*) stings too! This motor pump, it breaks down, it finishes you (*kufa, to die*). It kills 5-10 persons.

The snake-like pipe that feeds the tunnel also suggests the bite of the poisonous snake. In the case of the motor pump, the poison is found in the combination of the toxic soot from the combustion and the leaking rubber pipes. "But", Etienne says, "the cast iron pipes proved expensive and as the depth of the tunnels increased, other means of ventilation became necessary." For his cast iron pipes, Etienne prefers the use of iron scrap from the abandoned workshops of SOMINKI or galvanized iron over the ferroaluminum of Chinese machinery – the latter refusing to be actively welded because of its alloy. It refuses to be tamed.

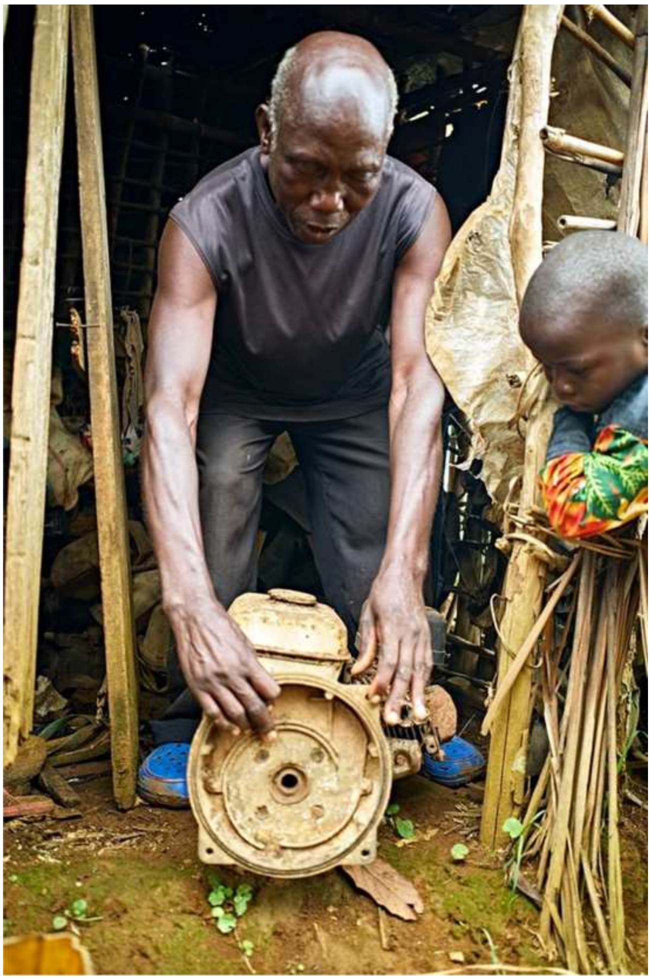
But aeration, and the solutions it offers cannot be reduced to the domain of extraction. Before the colonial era, in the regions of Mwenga, Shabunda, Walikale and Pangi, artisan blacksmiths (*batumbi*) of Lega communities used traditional two-handed bellows, called *muguba*, to create a fire hot enough to melt iron (*bitale)* (Masandi, 1985). In Lega society, these blowers go hand in hand with specific techniques, proverbs, and songs. During the Belgian Congo, these devices were modified to become one-handed blowing devices that operated by means of a wheel locked in a vessel (*chungu*) which pushed air onto the furnace. The use of a handle attached to a wheel allowed for one-handed operation.

Home-made blower (Credit: Robert Carrubba)

In the early 1970s, Etienne worked in a car garage in Bukavu. When he started repairing car engines, some of the workers fainted and lost consciousness because of the poor ventilation. At the time, they attached a small engine to a one-handed blower to ventilate the place. During the 1990s, when he returned to Kamituga, he was confronted with an increase in deaths from the motor pump. At first, the *balobola* did the trick, but to ventilate beyond 100 meters, Etienne started to propose the same device used in the car garage to ventilate the tunnel. The use of locally welded air compressors (similar to *muguba*) attached to small gasoline engines (the very same used in a motor pump) was used to manage the increased depth of the tunnels beyond 100m. Etienne's story showcases the encounter between traditional air compression techniques, attunement to available materials, multiple affordances between what is at hand and similar challenges in different mechanical domains, and local ingenuity in the face of increasing tunnel depths and rising toxic fumes in the tunnels.

A similar case of integration of traditional techniques and tools in an assemblage with fuel-driven engines (locally called *dakadaka*) is found in the case of the whaleboats on the Congo River (Lambertz, 2021). While these boats expose people to increased risks on the waterways, they also make less accessible places accessible and have a significant impact on livelihoods and the transport of goods. In our case, the success of the motor pump is ambivalent. On the one hand, its success can be attributed to its simplicity, cheapness, and compactness, allowing increased productivity. On the other, its deadly fumes have engendered different forms of local ingenuity that necessitate a symbiosis between traditional and modern tools and thus refutes a classic understanding of one-way-fits all technology transfer and linear progress (see Bessant & Francis, 2005).

The socio-technical biography narrated by Etienne showed similar symbiotic relations between pre-colonial air compression systems on the one hand, and the import of small machinery. Motor pumps, being part of the solution as well as a new problem simultaneously valorized local engineering skill and the re-purposing and valorization of iron scrap. The desire to tame elemental states (air and water) and technological leakages around the mines has driven the advancement of technologies that in themselves are afflicted with an ambivalence towards the miners' lives. As described previously, various stories around compressed air demonstrate the necessity of *air design* in ASM sites, providing technological and creative answers to unbreathable workspaces (Sloterdijk, 2009).



Etienne showing the silt to make a motor blower (Credit: Robert Carrubba)

The motorized blower (Credit: Robert Carrubba)

As already mentioned, when SOMINKI left its concessions, ASM activity increased. This growth in ASM, in turn, stimulated and energized the inventiveness in tunnel aeration. Taming the challenges of air and water is addressed in multiple ways. In the late 1990s, other small devices, such as portable backpack agricultural sprayers, known locally as *King Max*, after the Japanese brand, provided the tunnels with a source of artificial air supply. Instead of filling the sprayers with pesticides or using them to blow leaves, the small backpack is left empty, a hose is attached to its handle, and the device is placed on the edge of the tunnel.

King Max blower (Credit: Robert Carrubba)

Recently, larger mobile air compressors with a tank (locally called *kibuyu*) have started to be introduced to the sites. With the increase in manpower and tunnel depth, the mobile air compressor has become a more valuable option and a definitive answer to *shimoke*. This version is sometimes called *kiboko ya shimoke* (meaning, to tame *shimoke*).

Two piston air compressor (Kiboko ya shimoke) (Credit: Robert Carrubba)

At the same time, the possibility of ventilation also depends on the way in which the tunnel is constructed. For example, another solution is to introduce holes (*acheminé*) in the dead-end tunnels to increase air circulation. According to the President of the COKA cooperative:

> The problem is that there are a lot of pits and there are no openings. You must drill holes in all these shafts, to increase the flow of air. If we connect tunnels (*percement*), there is air circulating. That way, people's lives are spared from the smoke. In vertical shafts (*descendrie*), there are more risks of asphyxiation, than horizontal ones (*direction*). In horizontally constructed tunnels, there is air that enters and returns. With a vertical tunnel, those who are down below, are in trouble because there is less air circulation.

However, if one considers the use of holes (*percements*) to aerate, it may allow potential competitors to gain access to a gold vein. In this sense, underground mining shafts, that is, humanly assembled subterranean spaces, dictate other mechanisms of power that often contest or challenge the notion of "sealed territorial boundary" of the surface (Humphrey, 2020). Often, miners refrain from using holes and use other means to aerate to allow a sense of privacy over one's revenues. Yet it also highlights that the quest for aeration cannot be reduced to a simple question of engineering and that questions of technology open an array of new questions that pertain to the reconfiguration of politics and power in between the underground and the surface (Luning, 2022).

Conclusion

This article sought to weave a story around the invisibility of toxic exhaust and dusty leakages. We integrated and simultaneously unfolded temporalities and actors involved in the technologies and design that represent these toxicities (Murphy, 2006). In this way, we have highlighted different uses and meanings of compressed air, such as a blacksmith's use of *muguba*, the import of mobile air compressors under colonial rule, and finally, the integration of both into current moderations which seek to confront the, often lethal, ambivalences involved in the use of the moto pump.

Our story starkly contrasts with classical understandings of technology transfer which remain tied to 'modern' notions such as innovation, the quest for one-way fits all solutions, and linear progress (Bessant & Francis, 2005). When we observe what is currently being used and moderated, and the simultaneity between manual and mechanized labor, then we need to adjust our scope (Edgerton, 2011; Mavhunga, 2014). Ethnography necessitates us to pay attention to the contingencies and interweaving of different heterogenous, reworked and simultaneous histories and engagements and the recurrence of possibilities offered by older gear and skills and tools that predated colonial rule (D'Angelo, 2019). Here rather, novelty, if we still dare to use this notion, is partly enabled through refurbished elements of the past together with ongoing attunements, for example "pit sense", to changes in the workplace.

Together with the use of mechanical engines, artisan mining foregrounds a workplace in which re-engineering and creativity come to play a central part. In a rural environment with little or no access to electricity, the use of a small, compressed air is to a motor pump what an oxpecker is to an elephant: they communicate with each other in a symbiotic socio-technical relation (Latour, 2005). Although this leaves room for further scrutiny of the machine-machine relations, and admittedly this a limitation of our paper, we sought to stage these engagements through the lens of technology as there are currently used (Edgerton, 2011). Despite the unreducible role global flows of engines produced in so-called "invisible spaces" played in our story, the socio-technical momentum we sought to capture still requires it to be understood as a form of "humanized nature" which requires permanent maintenance, boot-strapping forms of repair, and careful monitoring (Gewald et al, 2009; Pfaffenberg, 1998 in D'Angelo, 2022).

As we have progressively shown, these pumps are not health-promoting technologies or community-building technologies as in the Zimbabwe *Bushpump*. Even if they can be described as successful in terms of cost, accessibility, and size, seen from another vantage point, they can very well be described as a negative technology leading to death and a recollection of death of the times past. At the same time, re-surging narratives around *dundunje* and *balobola* actively contest that these technologies could be reduced to their material or engineered extension, whilst simultaneously increasing the demand for local answers, moderations and even producing new questions of a political nature. In this sense, we have described how a complex meandering of heterogenous elements and histories allows miners to work in otherwise unbreathable and flooded environments – of which the underground warren is already produced (and continuously re-structured) through previous and ongoing human-machine mediations (Rolston, 2013). In sum, thinking *with* pumps and air compressors conjured an assemblage of engineers' attempts to tame air and water, local attunements to danger, technological creativity, and connections between 'traditional' and 'modern' tools (Appadurai, 1988).

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