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AN ELEMENTAL ANTHROPOCENE

Breathing in the Anthropocene: Thinking Through Scale with Containment Technologies

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Respiration is a process of trade. It occurs at surfaces where different elements meet, where air is moved into a biological container and transformed into something a bit different—such as when oxygen is converted into carbon dioxide (CO^2), or CO^2 into oxygen, in the case of plant matter—and then sent back out into a shared atmosphere. In humans and animals this happens through breathing, inhaling and exhaling; in plants, through photosynthesis. On average, human bodies process between 2,100 and 2,400 gallons of air a day. The air we breathe oxygenates blood through a process of gas exchange. Air sacs deep within the lungs contain and facilitate this cellular process, generating energy and sustaining life. Respiration shows air at work, a labor and exchange, as more than a static substrate or medium. It is transformative movement operating within and across time and space. This is a point that we will return to again and again in this essay: air is, drawing on Gabrielle Hecht, an 'interscalar vehicle'.[1]

Interscalar vehicles are both analytic devices and empirical objects that connect 'stories and scales usually kept apart'.[2] The concept references interstellar travel where science-fiction characters travel through timespace, learning 'new ways of seeing and being' along the way. Interscalar vehicles enable analysis across spatial and temporal scales with the aim of highlighting political, ethical, epistemological, and/or affective relations that get rendered invisible otherwise. It also avoids the trap of thinking of scales as conceptually given, particularly when imposed on research objects.[3] Air is not an interscalar vehicle on its own but is made such when it is contained by engineers, absorbed by plants, inhaled by humans, measured by scientists, contaminated by fireworks, or deployed by interdisciplinary scholars (like us).

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In this thought-piece, we consider together the potato chip bag, asthma inhaler, and climate positive design as scalar practices of Anthropocene air,[4] which could be characterized in part by the growth in levels of greenhouse gases at a speed out-of-sync with other earth systems. But Anthropocene air is also the pockets, flows, and exchanges of atmospheric matter in local, everyday spaces, which perform under scalar politics, too. Air is a matter of history, writes Tobias Menely, weighty and thick with a decisive temporality. Menley's characterization of Anthropocene air taps into the broad, transdisciplinary literatures on air and atmosphere that may initially appear segmented, but upon closer examination reveal themselves as overlapping and playing off each other.[5] For example, novelists and literary scholars demonstrate that air can express social and political conditions;[6] doctors and public health experts, often considered far from the realm of the literary nonetheless similarly practice air, documenting the minute relationships between air and disease.[7] Environmental activists use the right to clean air as a foundational pivot point in demands for justice.[8] Alongside these, changing winds and other weather references stand in for movements, pressures, and differences, felt with curiosity and/or anticipation across a range of scales.[9] More recently, air's elemental status has been interrogated in geography and cultural studies using analytic moves that draw on much older philosophies.[10] Air's affective qualities have been productively linked to musings about atmosphere as a shared timespace that signals political, economic, and technological enfoldings.[11] As a transdisciplinary conversation, these literatures gather together the substrate that we understand as Anthropocene air, while zooming in on the performance, impact, and uptake of atmosphere in specific locales and moments.

Across these conversations, much of what has been said about air, particularly in the last several decades, implicates the Anthropocene, if not always by naming it as such. Recent conversations around climate change center fossil fuels, directly and indirectly implicating air pollution and its toxic effect on the living and nonliving, industrial residues of the last three centuries, and how today's accelerated byproducts continue to have long-lasting impacts on humans and nonhumans. These effects are not evenly distributed, even as their impacts accumulate at a planetary scale.[12] Proximity, place, and political and socioeconomic dynamics all shape air in the contemporary era. Thinking at the scale of the Anthropocene risks a disconnect between the functioning of planetary atmospheres and the functioning of local airs.[13] Yet local air, too, in an elemental sense, contains and makes life across scale for many beings, but always with difference, in an uncommons.[14] We contribute to this transdisciplinary conversation about air and atmosphere by figuring Anthropocene air as an interscalar vehicle. By leveraging this elemental feature—air's ability to scale timespace—we show connections between matter and relations that seem distant and disconnected. We do this by honing in on respiration as a transformative atmospheric process that has been designed, in advanced capitalism, to extend life for some people in some places. Of course, respiration requires containers—lungs, buildings, cells, plastic bags, machines—to make such atmospheric exchange possible.

As STS scholars concerned with the Anthropocene demonstrate, containment highlights the politics of containing, an analytic move that we extend in this paper by thinking through Anthropocene air. Border fences—real, proposed, or regulatory—define what and who is considered an acceptable entity within a space.[15] Buildings bar nonhumans, and sometimes humans, from their insides, while also increasingly concentrating harmful chemicals through their energetic efficiency (or simply cheap design).[16] Black plastic balls and nuclear waste barrels posit that containment can disrupt connection and interaction—or materialize new relations.[17] In these cases, containment is a protective mechanism designed to keep harmful things at a distance. Of course, this is not to say that there are no ill side effects produced along the way; in fact, the by-products of containment technologies can easily be framed as examples of slow violence.[18] In this paper, we build on this scholarship by examining the productive attributes of containers in capitalism, which all too often go unnoticed in consumption landscapes. Advanced capitalism is very good at hiding away or enticing us to look elsewhere, instead of at problematic relations and practices.

Looking at the problem, especially when it is something as difficult to capture as air, calls for a flexible methodological and analytic approach. One tactic recommended by cultural studies scholar Zoe Sofia is to study containers that get culturally and technologically backgrounded. For Sofia, containers easily go unnoticed as spaces where air is both containing and being contained. Breathing, our own interface with air, is a 'space-maintaining' labor that passes unnoticed for a majority of people most of the time. It is as Luce Irigaray described it, a pervasive element that supports everything, a substratum that has been backgrounded and thus forgotten.[19] Of course air extends well beyond and below individual breathing space and human lungs. This is one of air's elemental qualities. It scales time. It scales space. Indeed, atmospheric change over time is part of what allows us to index the Anthropocene. This scaling of time and space becomes most evident when containers are framed through their action, such as processes of respiration in breathing and photosynthesis, a 'structurally necessary but frequently unacknowledgeable precondition of becoming'.[20] The same might be said of containment technologies that enable respiration in consumer products, buildings, and medical devices, where gas exchange and the movement of air is rendered invisible by design. Indeed, over the last century, a variety of industries have developed containment technologies that leverage respiration in order extend the capacities of (some) humans to consume; food, comfort, and medicine are examples we explore in this paper.

Material objects have been taken up in Anthropocene literatures to explicate entanglements of time, human-nonhuman relations, effect and affect—the *Cabinet of Curiosities for the Anthropocene* is a great example of such work.[21] We adopt this analytical style and use interscalar vehicles to question capitalist and technoscientific logics in three examples where air is a problem to be managed using techniques of containment. Focusing on these examples, our purpose is to use objects and stories that scale from the granular to the grandiose—to borrow Rob Nixon's language[22]—in order to highlight how Anthropocene air is engineered to perpetuate advanced capitalism, whether through more efficient products, sustainable communities, or with medications that keep us breathing while air quality becomes more toxic. If air is contained and allowed to respirate in the right ways, for the right purposes—so the logic goes—we can circumvent the demand to confront advanced capitalism, its structural and slow violence.

Thinking with Zoe Sofia and her work on the agency and complexities of containment as a technological relation, we trace the experiences, relationships, and new materials created through atmospheric containment. How are objects, surfaces, practices, and even politics ordered and articulated, specifically within Anthropocenic frameworks that have gotten us to this place and that are also offered as a way to get 'us' out of it? Each of the three cases we examine show how air has been engineered in the Anthropocene to solve problems of time: the fading quality of potato chips; the overwhelming speed of medication delivery; and the inability to use outdoor spaces due to seasonal change. We identify these as problems of the Anthropocene in order to locate this 'charismatic mega-category'[23] in things produced and consumed in and against time. Using three different case studies that traverse and relate multiple scales, this paper invites further engagement with elemental air and the practices of containing it. Locating the Anthropocene within things, we argue, subverts thinking at a grandiose scale that exceeds intervention. If the Anthropocene is contained by the same logics as food packaging, energy efficient buildings, and asthma inhalers—what new practices might be observed by shifting the story? It is this question, increasingly asked and answered in Anthropocene literatures, that we engage with in this paper.

Trapping Time in the Envelope

If ordering the temporality of air is both characteristic of and characterized by the Anthropocene, there may be no better place to think about how the logics of science and technology order time at scale than via the potato chip bag. In its singularity, a potato chip bag on the shelf in the store may seem an odd place to examine how the practice of Anthropocene air works at the local and planetary scale. Yet taken in its entirety, with Mintel reporting U.S. sales of chips (58% potato; 42% tortilla) at $14.6 billion in 2018, the simple bag scales out to proportions that, like climate change, exceed singular moments of apprehension. These human-made envelopes shift respiration to new rhythms that compress time and space. Examining the making of these familiar objects highlights that as Anthropocene air is practiced as both a container and a thing to be contained it remakes human relationships with temporality and environment.

One of a range of packaging techniques currently referred to as modified atmosphere packaging, potato chip bags delay the inevitable molecular transformations that occur as foods interact with the environment. In the case of the potato chip, these transformations are most often caused by oxygen found in air interacting with fats found in the low-water environment of a crisply fried potato. When present, oxygen can promote a change in the molecular structure of the oils present in the chip, leading at first to off flavors and odors, and then to complete rancidity. Environmental factors like humidity further accelerate or slow down the process of oxidation. In sum, atmospheric exchange between oils and air carries risk: oxidation of oils leads to rancidity, degradation of colors, loss of flavor, shifted textures, and from the perspective of the producer, lost income.

Modified atmosphere packaging works by shifting what atmospheres are present in the package, and choosing packaging materials that allow certain forms of atmospheric exchange, while preventing others. Enter the potato chip bag. An envelope that contains both air and potato chips, the contemporary potato chip bag places chips in a state of temporal suspension that allows them to circulate beyond their places of production. Doing this requires removal, substitution, and scavenging, all made possible by the modification of the air found within the bag. By flushing out oxygen-containing air and replacing it with a more molecularly inert substance such as nitrogen, industrial potato chip producers remove one critical component from what humans like to think of as air—oxygen—and substitute in another. This process of exchange allows the shelf life of chips to extend from weeks to months.

This suspension of time offered by packages point to ecologies and politics of life and death, as well as of perception and sensation. At first glance, using packages to modify atmospheres seems straightforward, an effort of suspending change. Suspension, Timothy Choy and Jerry Zee point out, 'denotes both a condition and a process with a tempo proper to its specific mixes'.[24] Following Choy and Zee, here we briefly examine what suspending the tempo of food's respiration through containment *does*, to see how human modification of air (dis)orients and (re)arranges not only the potato but also potato chip eaters in ways that contribute to and shape the environment of the Anthropocene. As may be obvious to some, potato chips have not always been able to travel for days and kilometers. Rather, they used to be served in bulk from countertops, carted away in tins or waxed-paper bags. Respiration—the exchange between the surface of the chip and the local air—tied chips to place and point of production, limiting their crunchy lifespan to a few days. Transforming the potato chip into a product that delivered consistent sensation at scale was also a transformation of how chip producers thought about how potatoes, oil, and packages interacted with air over time.

Allowing the potato chip to travel over increasing spans of space and time called for intervening in air itself. Optimization of potato varieties, as well as research into frying oils or cooking temperatures could only take a chip so far before atmospheric exchanges at the chip's surface transformed its texture from crisp to soggy. In fact, the efforts to create a miniature atmosphere housed in a lung temporarily immobilized, a lung resistant to respiratory exchange across surfaces, started as early as efforts to optimize variety and texture. Examination of patents filed over the twentieth century reveals an ever-increasing complexity to the surface of this immobilized lung. A 1935 patent application by the Dixie Wax Paper to 'prepare water proof and moisture vapor proof paper useful in wrapping articles of food' highlights a simple paraffin wax layer on one side and a combination wax-resin layer on the other;[25] fourteen years later the same applicant applied for a patent adding 'a cylcized rubber derivative and a rubbery hydrocarbon material' to the layering (see Figure 1).[26] By 1982 the waxed-paper combination (commonly known as glassine) had proved expensive enough that the Rexham corporation filed a patent for a material that layered polypropylene, low density polyethylene, polyvinylidene chloride, high density polyethylene, chocolate polypropylene, and ethyl methly acrylate.[27] When compared with a more traditional glassine packaging material, Rexham's new invention reduced oxygen transmission by approximately two-thirds. Each additional layering sought to increase the package's ability to suspend the chip's respiratory processes, while still maintaining and even promoting the package's other core and cross purposes of communicating desire, protecting the chip, and resisting any effort one may be making at limiting portion size through the inevitable awkward tear required to open the bag.[28]

With the entrance of first rubber derivatives and then plastics formed from petroleum, the labor to make an envelope for modified air increasingly intersected with extractive activities around the globe.[29] The desire to avoid respiratory exchange posits a unidirectional relationship between human need and environment: corporate desire for profit, reimagined as the consumer desire for a perfectly crisp potato chip, justifies attention to the production and distribution of the chip, rather than attention to the how the materials used in making the enveloping bag continue persist.[30] Patent applications, spread like chip crumbs across the countertop of the twentieth century, show a shifting attention to managing the fluxes between surfaces beyond that of air and chip. What once was on-the-spot visual evaluation facilitated by glassine or cellophane windows in bags gets replaced by on-package and advertising communications. This shift from seen to unseen is accompanied by a shift in what the chip does: rather than just being a potato, it is increasingly mobilized as a delivery base for a range of extraordinary flavors.[31] Bar codes embedded on the internal, printable layer, of the package track the respiratory processes of entire economies, while nutrition labels offer the attuned reader the opportunity to imagine how many steps, and how many breaths, an entire package of potato chips might make possible. Containing the chip remakes landscapes of need and desire, shifting a once-in-a-while thing to a potential daily indulgence, to be contained by the body as stores of energy that threaten health. The potato retreats, replaced by a hungry economic engine made possible by envelopes that contain specific airs.

Other respiratory tempos hide in the bag. A 2008 patent filing from Frito-Lay notes that the thin, petroleum-based flexible films resist recycling; the very properties that make them ideal immobilized lungs also result in low degradation rates.[32] These low degradation rates, the application dryly notes, means that 'discarded packages that become inadvertently dislocated from intended waste streams can appear as unsightly litter for relatively long periods of time'.[33] They propose a bio-based alternative: plastics made from lactic acid produced by fermentation of agricultural by-products, a process that brings plant respiratory fluxes to the entirety of the package.[34] Composted, the authors noted, the plastics would break down, a potential return to an earlier era when the envelopes that had held chips could be composted or reused, rather than ending up spread across various planetary surfaces and then buried, a nearly permanent testament to human hunger. The patent authors note that if placed in a landfill, the proposed package would, by virtue of its tendency to end up in waste streams, 'provide a carbon dioxide sink for greenhouse gases'.[35] Although difficult to believe, when presented this way the temporary respiratory immobilization offered via the patented package design is proffered not only as a way to protect the chip, it also appears as a mode for immobilizing humanity's respiratory excesses. Rather than a picture of human desire and activity continuously compromising the environment,[36] the envelope of the alternative bio-based package unfolds and expands into a global promise: buy this bag; eat its contents; save the world.

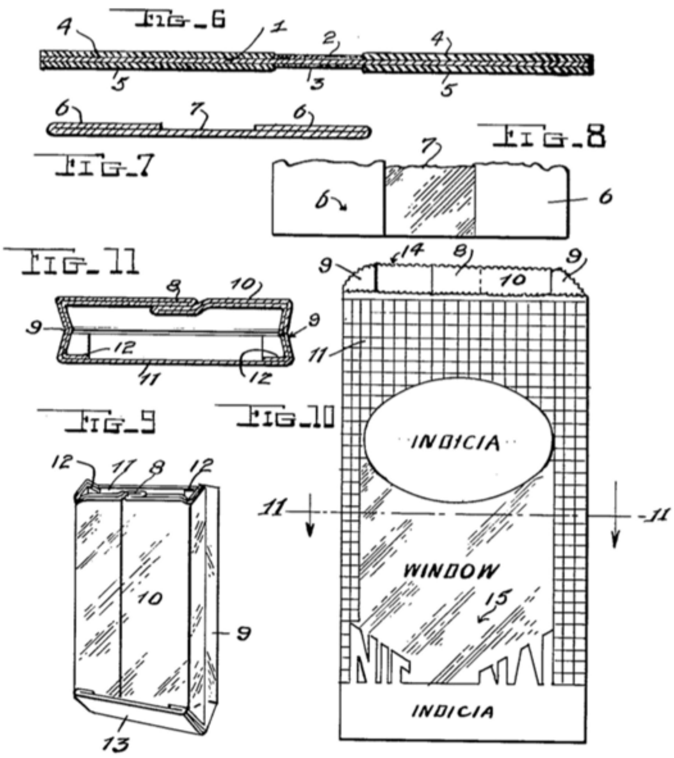

Figure 1 Schematics of a reinforced paper bag with moisture resistant qualities. Bryce, 1950.

Community Comfort Zones

The food industry and grocery aisle are not the only sites where companies are attempting to engineer container technologies to reduce greenhouse gas (GHG) emissions and waste burdens. Like food packaging and patents, architectural plans are imaginaries that aim to moderate exchanges between inside and out, human and environment, consumption and production. Sidewalk Labs, a subsidiary of the Alphabet company, is working with Waterfront Toronto to create Quayside, one of more than a dozen C40 'climate positive communities' aiming for net-negative operational GHG emissions.[37] The rhetoric of climate positive communities heralds a future where cities and their communities not only withstand the Anthropocene's risks but also thrive in a newly designed comfortable climate. In this case, examining air as an interscalar vehicle reveals how architectural imaginaries can produce a desire for sustainability without questioning the logics of consumption in advanced capitalism. Sidewalk Labs' proposed, climate positive atmospheres materialize a counterpublic that critiques, not only the sustainable imaginary pitched by the proposal, but the design process itself. How did comfort come to supersede other values and conditions in an otherwise sensible intention to reduce community GHG emissions?

Architects articulate comfort in terms of the thermal exchanges of the body with its environment, an exchange that occurs via air. While the historical roots of comfort trace back to the 17th century, the increasing ability to control the environment through mechanical ventilation entangled the notion of comfort with public health and sanitation.[38] During the interwar years in North America, as labour transitioned from factories to offices, comfort replaced hygiene as the virtue permeating indoor environments. In the hands of the American Society of Heating and Venting Engineers (ASHVE), comfort reemerged as an environmental attribute, attainable through a narrow range of values—air temperature, humidity, and air flow—which also made standardization and universalization possible across space.[39] Today, comfort includes variables such as air movement, radiant heat sources, activity levels, and clothing. This drives the manufacturing and marketing of specific 'airs' as containers deemed conducive to particular ways of inhabiting indoor environments.[40]

Comfort anchors much of Sidewalk Labs' plans for outdoor environments. The twofold proposal for outdoor spaces centers around adaptable building structures, forming a 'stoa' that can be quickly reconfigured and occupied on short term bases for a range of uses. In their 'Master Innovation and Development Plan', Sidewalk Labs links development of Quayside's ground floor market to the agora in Ancient Greece. Juxtaposed with the stoas of the agora, Quayside's stoa is positioned as a civic centre for public engagement, likened to earlier spaces where 'vendors sold goods and the public gathered to debate new ideas—from the Hippocratic Oath, to the Pythagorean Theorem, to the practice of democracy itself'.[41] Achieving such a public requires a network of outdoor spaces that could be used for longer time periods throughout Toronto's seasons. Climate engineers and architects envision pleasant microclimates, facilitated by weather mitigating appendages to buildings, as well as modified urban grids and landscapes. 'According to Sidewalk Labs' vision, the flexibility of the stoa and increased time spent in these spaces will allow Quayside 'to stay in lock-step with the market forces increasingly driving towards "experience-based-consumption"'.[42] The buildings and interfaces that produce this desired air—microclimates to be consumed by a future vibrant public—will be managed by an assemblage of building experts, sensors, and digital infrastructures.

Figure 2 Year-round use is facilitated by architectural interventions (i.e. raincoat in top illustration), in a modular space shaped by flexible wall systems (middle illustration). Open structures encourage flows of people between indoor and outdoor spaces (bottom illustration).[43]

The parameters for a comfortable outdoor climate are imagined using the 'Universal Thermal Climate Index', which considers the waterfront to be too hot, too cold, or too wet for nearly 70% of the year, and thus in need of systematic, atmospheric improvement.[44] The multilayered outdoor comfort systems promises a 30% increase in outdoor usage through a two part plan that coupled design decisions with environmental data collected in specific microclimates. With this data, the 'Sidewalk Labs-adjusted' layout of the urban grid and neighbourhood landscape optimizes sun exposure and reduces wind speeds by an average of 35%-45%.[45] Three architectural interventions, Raincoats, Fanshells and Lantern Forests, work to mitigate weather at specific sites around and amongst buildings and public spaces, acting as temporary containers for outdoor community events.[46] Together, the interventions aim to engineer comfort from the atmosphere, down into the nooks and crannies of urban spaces, and thus engender new terrains for public gathering.

Two sets of material innovations facilitate expansion of public space: tall timber for building construction, and ETFE (Ethylene Tetrafluoroethylene) for the building appendages. Both utilize air in specific ways, and are instrumental for creating comfort in the network of public spaces. In fact, the imagined energy efficiency, durability, air quality, and comfort of the proposed buildings depend on the condition of the wood itself.[47] Wood enables interaction between air and water. Airflow brings water into the building and vapour pressure diffuses water to the outside. These differences in air pressure, airflow and air density, caused by outdoor wind and temperature, become a focal point for intervention and management.[48] With Sidewalk Labs intention of curating a sustainable community in mind, the proposal projects what geographer Ben Anderson has described as affective atmospheres, a 'class of experience that occur before and alongside the formation of subjectivity, across human and nonhuman materialities, and in-between subject/object distinctions'.[49]

The architectural intervention into microclimates is facilitated by ETFE, which can be used to form panels of adjustable, air-filled cushions. These appendages are meant to modulate energy performance through sensor enabled inflation and deflation of the cushions. The air, contained in the buildings' second skin, acts as an interface and mediator between the weather, the mitigation system and the local sensors and microclimate measurement instruments. This provides a 'layer of resilience and climate responsiveness' across the Quayside landscape.[50]

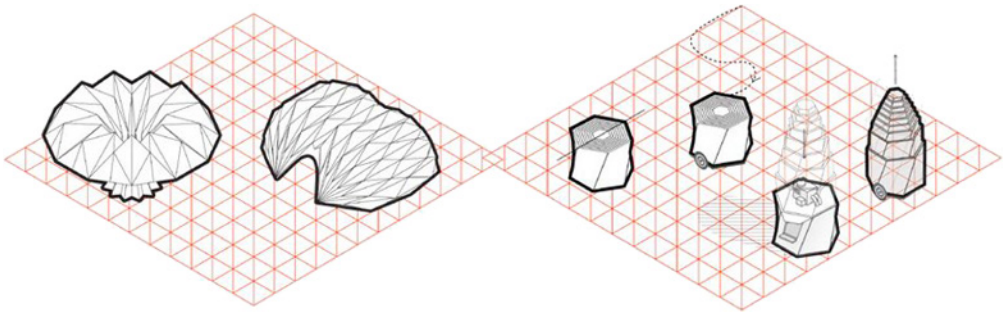

Figure 3 Fanshell and Lantern Forest architectural elements.[51]

Sidewalk's plans for the public realm also aims to influence the actions of future neighbourhood inhabitants: air quality monitors (for carbon monoxide, particulate matter, and sulfur dioxide), noise level sensors, radar, laser rangefinding, and computer vision track the flow of vehicles, cyclists, pedestrians, as well as hyperlocal weather (temperature, wind speed, humidity).The urban data generated by these measures is available to the general public, retailers, and other professionals; Sidewalk designers imagine this data could guide decisions about where and when people use the space, the best time for a pop-up shop, or the most scenic and uninterrupted route for a jog. If implemented, the combination of materials and technology will bring together built and natural elements, creating a collaboratively engineered atmosphere that leverages containment and respiration techniques for inhabitants' comfort.[52]

Despite Sidewalk's proposal for comfortable, controlled spaces that foster sustainable community, numerous publics have emerged with questions about the project's potential toxicities and the 'sustainable' infrastructures that support its implementation and lifespan. A group of Toronto-based community members, politicians, scholars and activists have come together under the banner of #BlockSidewalk, to hold accountable the people and processes at the helm of Quayside's proposal; their charge is that the project disregards the city's public interests. #BlockSidewalk foregrounds the fact that little consultation went into the recruitment of Sidewalk Labs as the favored developer by Waterfront Toronto. In the months following Sidewalk Labs' bid for Waterfront Toronto's call for proposals, #BlockSidewalk has worked alongside city politicians, journalists, and community organizers to make sense of Sidewalk Labs' documents, and help communicate a broader range of stakes to concerned members of the public. In process, #BlockSidewalk managed to slow down the project's fast sprawl and make room for community consultation. Digital governance, data collection, and surveillance are some of the key issues raised during this phase of events.[53]

Comfort did not secure the sale of Quayside to Toronto communities. The affective atmosphere, which incorporated a throwback to the publics of Ancient Greece, never happened. Or maybe it will yet, though in a form very different from Sidewalk's vision, as the #BlockSidewalk campaign continues. If atmospheres have the power to dispose people towards certain modes of being and action, then the case of Sidewalk Labs' Quayside demonstrates how different real and speculative airs in and around the project transpire a wide range of political relations.

Breathing with Medicated Containers

In the first two examples, air has been contained and manipulated for industrial and consumptive purposes. Both cases are feats of engineering in which air is placed in the service of human desire. Specific kinds of respiratory technologies are the result, developed to conserve energy, and extend imagined quality and time according to parameters defined by engineers and scientists. They exemplify human efforts to manipulate environments for consumer comfort and taste by making matter more efficient through controlled air exchange. Our final case focuses on a very different mode of human-environment interaction, one where respiratory technologies are designed to save human lives in the face of suffocation. At first glance, this lifesaving medication seems categorically different than the former examples. Yet just as food packaging and energy efficient buildings push against the time-bound quality of atmosphere—the number of days a chip stays fresh before oxygen causes it to spoil, and seasonal change in North American habitats, which curtail how much time can be spent outside or how much money goes towards a heating bill—asthma inhalers also operate around time.[54]

Thunderstorm asthma is an atmospheric event that aerosolizes environmental allergens in new ways. These epidemic events happen in close proximity to large metropolitan areas, always during summer months, when grass pollen counts are high. Still not well understood by scientists, such storms often produce a five to ten-fold increase in asthma exacerbations. When grass pollen and other ground-level particulates amass in high concentrations on the ground (often due to a prolonged dry spell) a particular type of thunderstorm -- perhaps one with a mesoscale boundary or "gust front" coupled with strong winds -- can easily sweep pollen, fungal spores, and other air pollutants into its clouds by way of updrafts.[55] Pollen and spores become bioaerosols with the help of early summer air currents.

Airborne and enclosed within storm clouds, atmospheric moisture ruptures the grass pollen. When these pollen grains rupture, conditions become exponentially more problematic. One grass pollen grain, for example, can release up to 700 starch granules.[56] These granules are now matter that is respirable, meaning that its size is of a scale that can be inhaled deep into human lungs. Under normal conditions, pollen grains are too big for such a journey inward. They stay stuck in the upper respiratory tract. But when the storm's cold, downdrafts transport ruptured grains back to ground-level breathing space, they are inhaled by breathers and can easily pass into the lower respiratory tract, the lungs. This of course triggers an allergic reaction—an asthma attack—in anyone sensitized to grass pollen, as well as those with existing respiratory disorders. It is considered an 'epidemic' because of the sheer number of people impacted when an urban atmosphere becomes saturated in allergens, at this dimension, in a short burst.

While some scholars caution against thinking of scales in nested formation[57], we can certainly acknowledge differences between them. These different scales include: the currents of a storm front, which include temperature drops and high wind speeds; pollen grains modified by water to become respirable; public notification systems for severe weather (an altogether different kind of airwave); and, airways that constrict when the body comes into contact with allergens. It is the relationality of matter, discourse, events, and temporal durations that thunderstorm asthma gathers together, multiplying by many scales the number of asthma attacks a local population would have over a 48-hour period.[58]

Disordered breathing is an old phenomenon. First described by Homer, and later by physicians across the ages, asthma has almost always been written about and cared for in relation to air—pollution, meteorological conditions, and seasons, but affective atmospheres, too.[59] Today, asthma is defined as a chronic respiratory disease that disorders breathing through narrowed airways, which causes wheezing, coughing, chest tightness, and an inability to move air in and out of the body. The disease is often tied to inflammation, which expands airway surfaces so that the container for respiration becomes smaller. Asthma rates increased dramatically in the 1980s in countries that included Australia, New Zealand, the U.K. and the U.S. This is around the same time that scientists and public health experts began to document thunderstorm asthma epidemics in these same regions.[60] Some have suggested that climate change, and increases in greenhouse gas emissions specifically, played a role in the uptick in both asthma prevalence rates and the onset of thunderstorm asthma in cities around the world.[61] But the dominant response to the asthma epidemic and its triggers has largely been a medicalized one, anchored in technoscientific developments in the twentieth century.[62] The pharmaceutical time of inhalers convenes with the meteorological time of atmospheric events (which is sometimes industrial time in the case of toxic release from factories). It is easier to give thousands if not millions of individual breathers a biochemical respiratory technology than it is to recondition regional air quality, let alone the global atmosphere. It is a problem, again, of scale which brings 'bodily temporality into dialogue with planetary temporality'.[63] Where in breathing space to intervene?[64]

Inhalation technology to treat disordered breathing is thousands of years old as well—as old as asthma itself. The earliest known devices contained herbal remedies and were delivered with smoke or mist that the sufferer inhaled to alleviate symptoms, a remedy that required the user ground themselves in place, at least temporarily.[65] Today's inhalers, however, are a portable technology, handheld containers of propellant and medication that easily fit in a pocket or bag. First developed in the 1950s, metered-dose inhalers are pressurized containers of medicine that use hydrofluroalkalines to propel bronchodilators into the breather's lungs (hopefully) and expand airways during an attack.[66] Like the ruptured pollen grains, the medication is aerosolized to a scale that can penetrate the lower respiratory tract. These inhalation technologies are designed to be effective immediately; to be a lifesaving antidote to whatever environmental trigger—pollen grains, particulate matter, or cat dander, for example—has caused the respiratory system to seal off or restrict air flow. It is this very fast-moving medicinal quality, however, that makes these respiratory technologies less effective delivery devices than, perhaps, thunderstorms. The size of matter, whether medicine or hazard, is not the only dimension that determines respirability. There is also a difference between breathing in a substratum and breathing in a pressurized shot of medicine.

Both voluntary and involuntary, breathing carries a double valance. In order to use a metered-dose inhaler in the event of asthma symptoms, the breather must mechanically coordinate squeezing the pressurized container while inhaling the medication. If this is not done correctly, the medication ends up coating the mouth and back of the throat, instead of descending into the lower respiratory tract. One might easily imagine executing such effort (or you may be an experienced user of such pharmaceutical devices), but for very young breathers, of nine or ten years old, and elderly breathers, that task is much more difficult. You must breathe in at the speed of the propellant-laced medication, which is being projected into your mouth. The serious problem of effective medication delivery via metered-dose inhalers, documented as early as the mid-1970s, eventually led to the development of spacer —a plastic tube that serves as an addendum to the quick relief inhaler that gives the breather more time and space to consume medication, dilate airways, and recondition the respiratory system.[67]

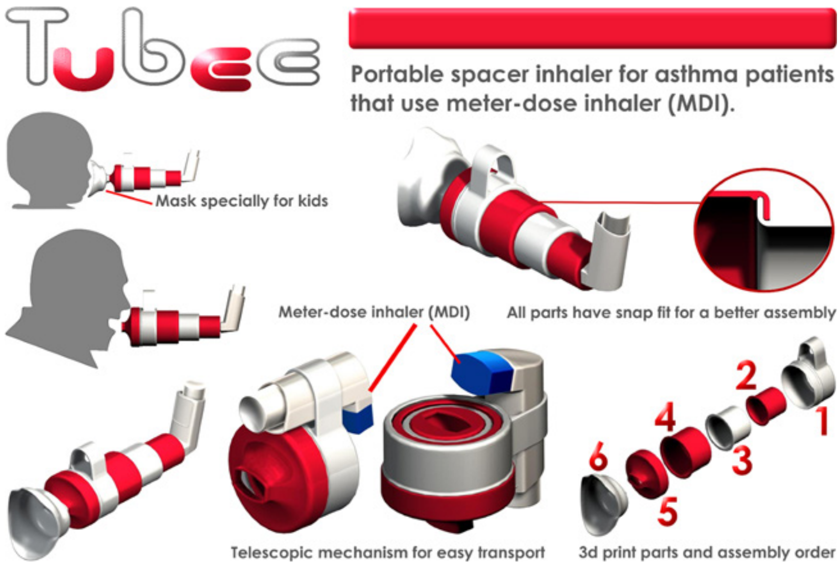

Figure 4 'Tubee' (Portable spacer inhaler for kids)[68]

Contrast this dynamic, the challenge of making space in human airways via aerosolized pharmaceutical delivery, with thunderstorms as an atmospheric delivery system for ruptured pollen grains. No voluntary inhalation need be coordinated with the pollen grains; involuntary breathing, unbeknownst to the asthma or allergy sufferer at the time, is all that is needed to consume these triggers. In contrast, the 'spacer' for asthma inhalers extends time with the plastic container, holding the medication in suspension so that the breather can catch up to the propellant.

In the atmospheric relationship between breathing and bioaerosols, containers are ruptured and infiltrated at several airscales. Asthma shows scale variance by bringing together mechanisms happening in the clouds, human lungs, pollen grains, and respiratory technologies.[69] This suggests the 'polyscalar agency' of air, where we see specific atmospheric components moving and transforming in relation to other matter.[70] Thunderstorm asthma is one event among many that allows us to see and understand very quickly what air contains, and how air enables biological exchange and transformation. If air as container is a "facilitating environment" for some people in some timespace, what does a thunderstorm contain when it materializes in the Anthropocene?[71] And what does it mean for atmospheric events at such a scale to be uncontainable?

Conclusion

This paper emerged from the 2018 Anthropocene Campus Melbourne and the Anthropocene Campuses that preceded it. These events are designed to encourage the discursive and theoretical experimentation that we attempt in this essay. Our thinking about atmospheres, containment, and respiration began when we worked together as participants in the 'Air/Flesh' curriculum stream at the Melbourne campus.[72] As a thought-piece, this essay pulls 'in contrary directions', which, Claire Colebrook writes, is characteristic of thinking focused on time and (post)humanity in the Anthropocene.[73] We look, for example, at containers that are designed to make human consumption more amenable, and carry the potential to invite non-attention (at least in the case of envelopes and buildings) but we do so within a framework that puts anthropos in question. And while the Anthropocene sticks a flag in deep time, we point to seconds, hours, days, weeks, and seasons in our examples. We do this because we think this is the analytic work made possible by interscalar vehicles, objects that raise questions about the politics of material-temporal relations. It points to connections between techniques, discourses, industries, and practices, in a mode politically attuned to question given and emergent environmental sensibilities[75].

Engelman and McCormack note that, 'the elemental is alluring because it both captures something tangible about the world and also remains excessive of human agency or intervention'.[74] Strung between potato chip bags, comfortable microclimates imagined to cultivate community, and lungs that expand out, cyborg-like, into a constantly shifting atmosphere, is a thread that reveals how the element of air has been contained and engineered for human consumption. By focusing on tangible, human interventions into the temporalities and rhythms of air, these cases offer an entry-way into dealing with the wicked problems anthropogenic activity have brought into being. Situated within broader debates about how to locate agency between humans and nonhumans in the Anthropocene, these cases highlight containment technologies and respiratory processes, demonstrating how Anthropocene air is excessive of some humans' agency, while also liable to engineering. This move offers insight into where different scales of action can be mobilized. In this sense, container technologies engage elemental air in efforts to extract and get something more from it—whether to maximize the shelf life of food products and accentuate taste; direct airflow in ways that produce heat and attract a vibrant public; or with inhaled medications that allow people with breathing disorders to continue activities undisturbed by weather. By focusing on these technologies and their engagement with air, we write alongside and against the abstract, elusive, and invisible characterization of atmosphere in order to 'generate an alternative kind of environmental sensibility', as David Macauley encourages us to do, with elemental air.

With this in mind, the interscalar cases examined in this paper highlight three things: first, how the techniques of twentieth and twenty-first century science leverage air for consumable products; second, how these containers attempt to extend time and thus comfort for humans; and finally, questions about the impact of inserting engineered air between human consumers and their environments by way of atmospheric devices. A key thread in these cases is that the success of containment relies on practices of constraining or curating how elements and atmospheres are known and function; the language and techniques of twentieth and twenty-first century science dominate in these cases, but other institutions and industries emerge as well. Managing the respiratory desires inherent in the human dream of making potato chips (and perhaps ourselves) relatively immortal does not easily call the everyday consumer into intimate awareness of the changing atmospheres around them. But closer examination reveals entire disciplines (architecture, city planning, food science, logistics, biomedical engineering) that have been called into being precisely because of anthropogenic activity that makes more apparent, rather than less, the ways in which the world respires. We wonder what containment technologies and their respiratory attributes might look like in the near and far future, and how these might reproduce or transform relations between elements, nonliving, and living beings.

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