Review Article

Cooked Air: The Kitchen and its Exhalate

Liz Gálvez

> Etymologically speaking, a breath is not neutral or bland – it's 'cooked air'; we live in a constant simmering. There is a furnace in our cells and when we breathe we pass the world through our bodies, brew it lightly, and turn it loose again, gently altered for having known us.
> Diane Ackerman, 1995[1]

Every kitchen needs to vent

The whiff of Lysol enters slowly, drying the back of the nose, then the throat, hitting, finally, deep in the lungs. The subtle displeasure is momentary, and now counter and cook are ready. Opening the freezer, a stale cold waft immerses you, a slight draft of warmth swirls at the feet. Ingredients for tonight's dish scatter the snow-white counter. A slight tug at a garlic bulb, the quick smash of a clove, the stickiness of its flaky peel, a rhythmically mechanised knife. Its layered companion suffers a similar fate, although not without a teary revenge. Tiny sulfuric compounds levitate and mix, befriending surrounding oxygen particles. A deep inhalation and a slow out breath confirm hunger. The subtle sizzle of a nearby pan welcomes the minced and diced ingredients confronting the pungently rich air with the roar of the extractor fan.

The kitchen marks the site of sense-able odours – pleasant and unpleasant, pungent, sweet, smoky, steamy, crisp, stale. Its historical formation as a room within the home faced rich challenges, especially concerning inhalation and exhalation. Conceptually, our attention in the kitchen centres on food, on cooking, on ingesting, and yet, it is the more elusive – air – in its almost invisibility that enables the indoor kitchen. Breathing equipment, model codes and standards prescribe design and regulation towards mechanised exhalation within the kitchen as the focus site for domestic respiration. An examination of kitchen processes begins to suggest our existence within and abounded by 'cooked air'. In fact, all the major implements, everything and the kitchen sink, instrumentalise air-related processes. The refrigerator cycle constantly extracts hot air. Ovens use flames to heat enclosed air. The extractor fan draws and extracts smoky air. The well-plumbed sink penetrates the architectural envelope, both exhaling and inhaling. This equipment, its regulation and standardisation models do not only enable, but direct human behaviour and activity. We can trace domestic air management strategies, such as air cooking and cleaning, via an examination of *ASHRAE Standard 62.2: Ventilation and Acceptable Indoor Air Quality in Low Rise Residential Buildings*. Since 1996, *Standard 62.2* has provided guidelines for residential ventilation. As ventilation becomes increasingly scientised, quantifiable, and reliant on hyper-specific equipment, technical literacy on ventilation narrows.[2] The relationship between architecture, inhabitants and air management has become increasingly reliant on ventilation standards.

The air gap

The air gap, technically speaking, is the unobstructed vertical space between the water outlet and the flood level of a fixture.[3] A void space, empty, in name reminds us that this seeming 'nothing' is actually filled with something – with air. Extending this vocabulary to the ventilation cycle, designated kitchen air spaces – between tap and basin, stovetop and extractor hood – enable cooking activities – washing, rinsing, mixing, simmering, frying, boiling. Discharge of cooked air begins between the cooking surface of the stove and the suctioning extractor hood. Cooking steam, smoke, and odours are drawn within this gap. Between cooking surface and drawing mechanism, fuel and resources are transformed, spent, used up. In the kitchen's gaps, gas (or electricity) morphs into heat and smoke, water into sewage, supply becomes waste.

Delicate relationships towards air management encouraged early societies to limit their cooking to exterior settings. By cooking outside, fresh, breathable air remained plentiful despite odour, smoke, and cooking exhaust fumes. The risk of domestic fire was minimised. In the camp fire, 'the distribution of heat is biased by the wind, and the trail of smoke renders the downwind side of the fire unappetising, so that the concentric zoning is interrupted by other considerations of comfort.'[4] Wind direction and its direct relation to the fire's smoky exhaust fumes, a nuisance to the human nose and lungs, had spatial, and hence architectural repercussions.

The kitchen emerges as a discrete concept within fireplaces and ovens characterised as room-like chimneys that were large enough for human habitation.[5] Flame strength required physical control by experienced cooks, as too much fuel could quickly make matters too hot or smoky, risking the quality of the dish. 'Repeated instructions on how to overcome [the perils of fire and smoke] testify to how constant a concern this was for cooks.'[6] The medieval recipe included architecturally scaled climactic and ventilation strategies that implicated both the intellectual and physical abilities of the cook towards managing the surrounding cooking air. Few recipes today, if any, consider ventilation. 'Ventilation recipes' no longer address domestic chefs, but rather ventilation experts, designers well-versed in the science of air.

Before the popularisation of the gas or electric stoves we see today, solid-fuel stoves regulated combustion and cooking fumes through distinct ventilation cycles.[7] More nefarious smoke from the firebox was ducted directly to the exterior through a prominent vent flue that was embedded within the fixture. [Fig. 1] On the other hand, off-gassing emitted throughout the cooking processes was required to be vented by the user. Prior to automated controls or the development of instrumentalised architectural systems, mechanical signification relied on the cook's senses – sight, smell, taste, sound and touch – for operation and human intervention within the ventilation cycles. Contemporary kitchen cooking mechanisms merge combustion and cooking gasses into a single exhalate, while discretising the object of combustion supply and ventilation extraction into two objects of hyperspecificity. The physical separation amidst an invisible medium slices the exhalation cycle into exhalation and subsequent inhalation, thereby decreasing visual perception of the physical continuity of cooked air. Distance between physical equipment creates a conceptual break between related functions.

Intellectually, the ventilation cycle continues to be understood by the cook, but perceptually it belies continuity. Standards consolidate demand-controlled ventilation into an air-extracting appliance, while increasing reliance on automatic controls to mitigate the gap in technical knowledge. Yet, the connection between intellectual and phenomenal knowledge is imperative to making things real.[8] Upon displacement of the cookstove's prominent flue, discretisation into stovetop and ventilation hood, the invisible medium of the air gap continues to offer clues, if subtle, in the form of odours and momentary visibility of spent particles. [Fig. 2] Appliance fragmentation and the necessary implementation of an air gap between them to sustain the development of hyper-specific equipment functions, makes what was previously explicit more abstract to the cook while retaining the modern tendency towards explication for the ventilation expert. The invention of the air gap, then, is understood as both a physical and an intellectual fragmentation.

Measuring is believing

Interior air management has shifted from architectural solutions such as the chimney, the fireplace and the hearth, towards specification of combustion and air cleaning equipment and mechanical systems. In tandem, evolutions in scientific and applied disciplines render air 'quality' calculable. Air quality meters monitor air for pollutants, and standardised simulations measure air movement and system efficacy. Formal – meaning physical, aesthetic, and sensorial – value associated with air management shifts from architectural knowledge to applied, quantifiable, scientised knowledge. Disciplinary models dictate collaboration between architects who design interior space and enclosing form, and mechanical engineers who make that same space habitable through mechanical air management solutions. Significant discourse continues, and yet responsibilities are respectively relegated along lines of disciplinary knowledge. In relation to the air handling systems, the architect comments on flues based on aesthetic and compositional expertise, while the engineer undertakes flue arrangement based on mechanical expertise. Air quality and movement, historically managed formally and aesthetically, now falls to mechanics, to science. Objective quality can be measured through air-sensing instruments. Their reported data is 'seen' by those literate in the science of air via their associated instruments.[9]

Discrete model codes and legal jurisdiction are complicit in the disciplinisation of air knowledge. The architect's expertise ensures that ventilation equipment complies with egress regulations while the engineer ensures that ventilation equipment complies with air volume metrics. The technical project of building ventilation is advanced and described by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). To guide the science of ventilation in the domestic sphere, ASHRAE developed ***Standard 62.2: Ventilation and Acceptable Indoor Air Quality in Low Rise Residential Buildings***.

> *Standard 62.2* is the national ventilation and indoor air quality (IAQ) standard developed specifically for residential buildings via the ANSI process. The standard describes the minimum requirements to achieve acceptable IAQ via dwelling-unit ventilation, local demand-controlled exhaust, and source control. Dwelling-unit ventilation is intended to dilute the unavoidable contaminant emissions from people, materials, and background processes. Local demand-controlled exhaust is intended to remove contaminants from kitchens and bathrooms that, because of their design function, are expected to contain sources of contaminants. [Fig. 3] The standard includes secondary requirements that focus on properties and performance of residential ventilation systems.[10]

The quality of our interior air, its breathability is measured as interior air quality (IAQ). The model suggests the required ventilation rate for achieving an acceptable, compliant IAQ based on the following calculation:

> The total ventilation rate … (Q_{tot}) shall be … calculated [as follows]:
>
> Where
>
> $Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$
>
> Q_{tot} = total required ventilation rate, L/s
>
> A_{floor} = dwelling-unit floor area, m^2
>
> N_{br} = number of bedrooms (not to be less than 1).[11]

Those who are technically literate are conceded the specification of normative formats and quantifiable acceptability, in turn shaping the lifestyles of those under the domain of municipally embraced standards. For example, *Standard 62.2* sets the 'total required ventilation rate' according to a specified calculation, leaving little discretion based on diversity of user preference and values, or playful solutions

Fig. 1

Fig. 1: George Eastman, Interior with wood burning stove, Oak Lodge Trip, April 29, 1921. Digital positive from the original gelatin silver negative in the George Eastman Museum's Collection. Courtesy of the George Eastman Museum.

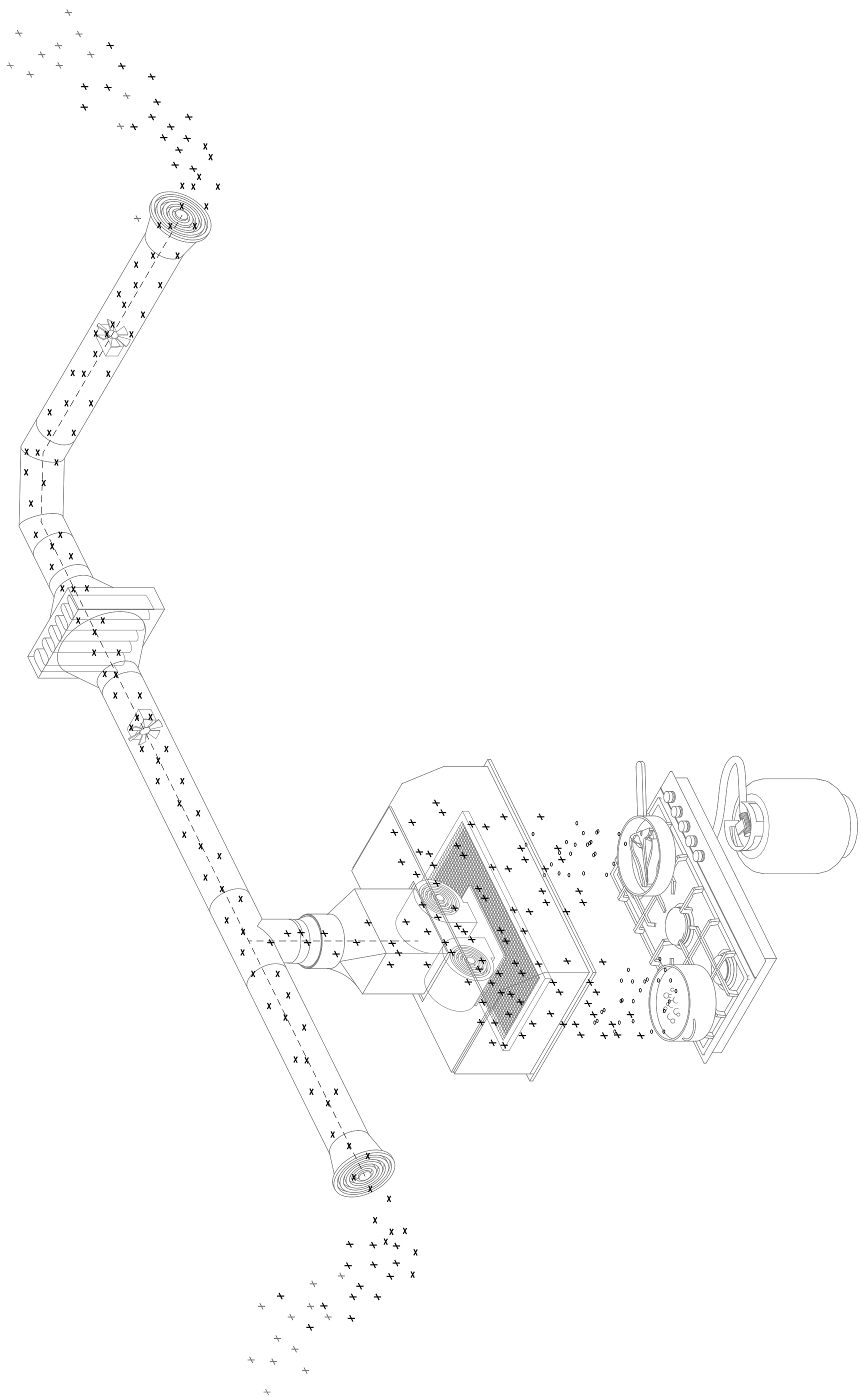

Fig. 2

Fig. 2: The air gap between cooking surface and ventilation system. The exhaust fan draws cooking steam, smoke, and odours from the cooking surface, into the exhaust hood and subsequent ducting. Diagram: author.

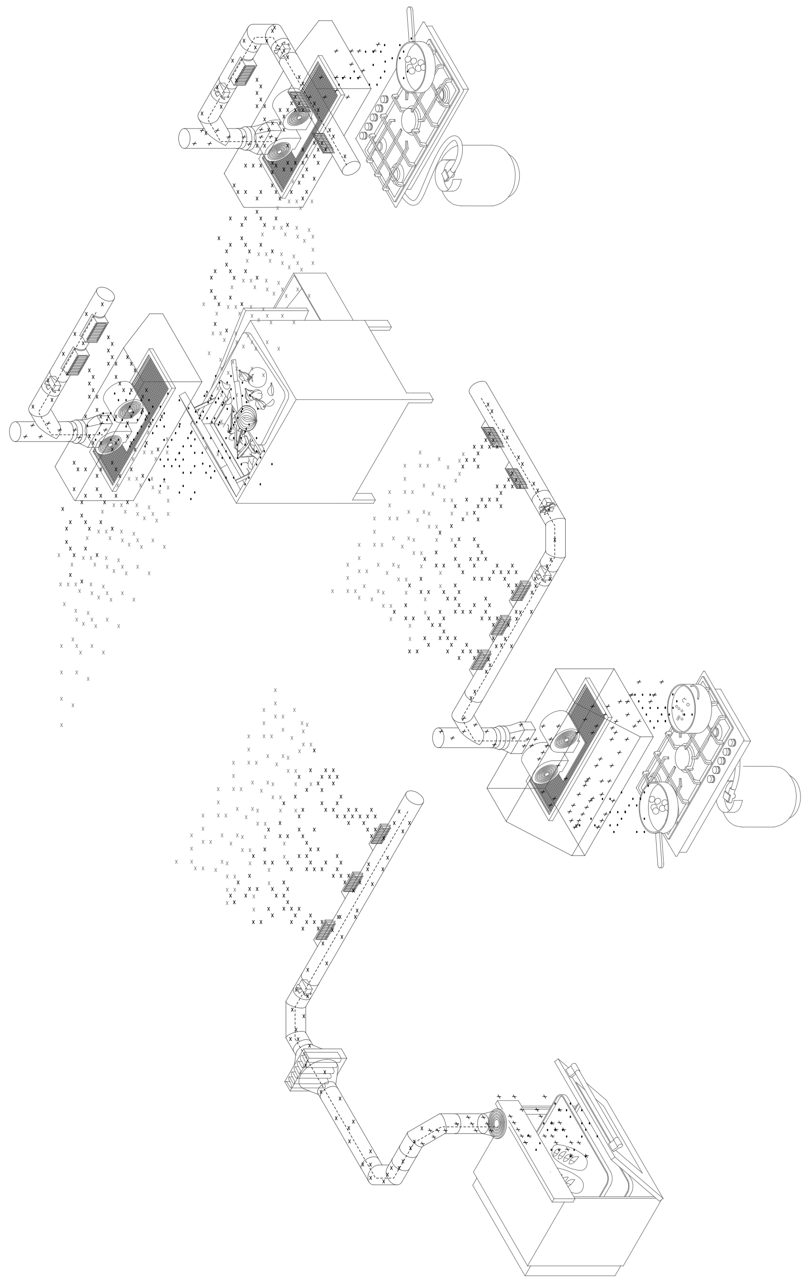

Fig. 3

Fig. 3: A C-shaped kitchen ventilation system is organized to eject cooked air into the centralized area while allowing for collective cooking along the exterior of the form. Diagram: author.

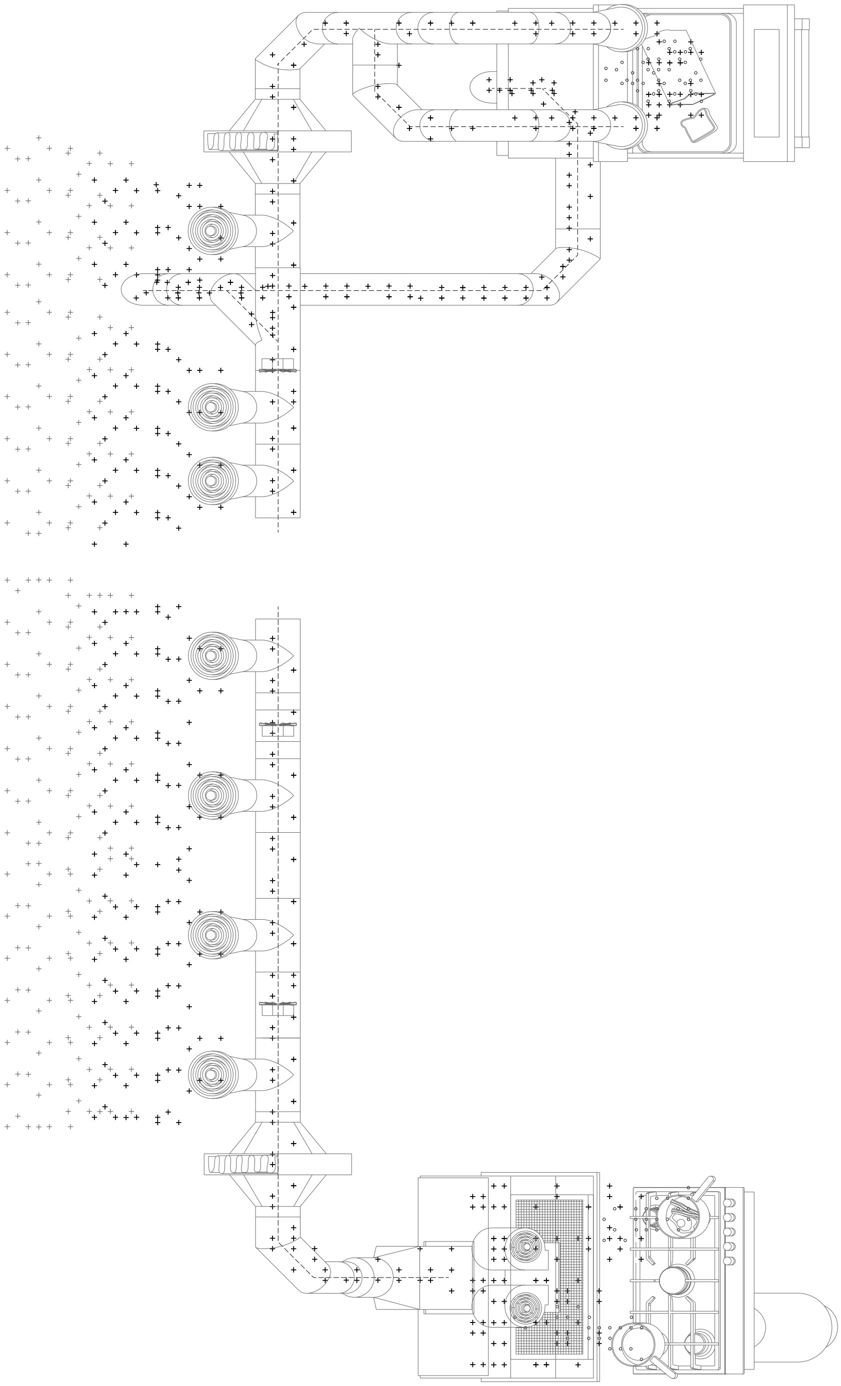

Fig. 4

Fig. 4: A linear kitchen ventilation system reorients cooked air particles and ejects them as a linear element. Diagram: author.

towards ventilation strategies. The discrete repertoire of knowledge between disciplines continues to set rules for a similarly discrete collaboration. Air management remains in the purview of those technically literate in its management and measurement media. Ventilation rates and normative equipment formats are determined by a discourse limited to professional associations such as ASHRAE who determine standards of care and practice, inviting little input in technical terms from those outside of the engineering disciplines. Yet, if air quality was previously managed through a combination of formal and sensing strategies, does evaluation and jurisdiction remain quantitative only?

Assessment of air

ASHRAE describes the purpose of *Standard 62.2* as defining 'the roles and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality … in residential buildings.'[12] Acceptable indoor air quality is defined as 'air toward which a substantial majority of occupants express no dissatisfaction with respect to odour and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.'[13] ASHRAE offers the limitations of their scope:

> While acceptable IAQ is the goal of this standard, it will not necessarily be achieved even if all requirements are met
> a. because of the diversity of sources and contaminants in indoor air and the range of susceptibility in the population;
> b. because of the many other factors that may affect occupant perception and acceptance of IAQ, such as air temperature, humidity, noise, lighting, and psychological stress;
> c. if the ambient air is unacceptable and this air is brought into the building without first being cleaned (ambient outdoor air cleaning is not required by this standard);
> d. if the system or systems are not operated and maintained as designed; or
> e. when high-polluting events occur.[14]

The list underlines a series of supplements to the quantitative assessment of IAQ: influence on a population's habits, the user's sense perception, habituation, and, lastly, the importance of healthy exterior conditions, all affect our assessment of air quality. Metrics and perception together play an important part in shaping care and assessment toward the air around us. Perception of acceptable air in collaboration with mechanical understanding is written into the code itself. While IAQ has measurable qualities, these are often visible only via air sensing instruments and their reported data. The scope for the standard suggests that quantitative measurements do not provide sufficient assessment towards IAQ on their own.

Scientisation trends towards bringing knowledge to light, making qualities measurable. Why is it that, as ventilation processes become more measurable, there is an equal tendency to reverse this process in relation to the human sensation, when the code itself underlines the reality of both phenomenal and intellectual knowledge towards assessment? Although user sense perception and evaluation are listed as potentially critical to IAQ, they remain unaccounted for, ignored within the subsequent sections that deal with strategies towards IAQ assessment and application. Perception remains, instead, a caveat or limitation to calculability, opposed to a valid authority towards IAQ. As a disciplined science of air advances explication towards the expert, air management remains with the technically literate, both in terms of evaluation and execution.

Moving air

Despite public perception and mental images evoked by the term 'air pollution', known pollutant values are significantly higher in indoor air. Air pollution occurs not only on highways, nuclear power plants or in factories. It also occurs at home and curiously, most common indoor air pollutants can be found in the kitchen. At the domestic scale, cooking represents a high-polluting event. Recall our kitchen scene – cleaning products, odour particles, combustion, decomposition of food and waste. Cleaning products are sources of volatile organic compounds. Food and food waste are sources of bio-aerosols such as bacteria, fungi, and other biological matter. Combustion is a source of indoor aerosol or particulate matter as well as of carbon monoxide and dioxide.[15] As such, the kitchen continues to be a major contributor to indoor air pollution and the focus of 'air cleaning' interventions in the home.

Sealed enclosures preclude air movement and thus measures must be taken to mitigate indoor air emissions, such as those caused by breathing and cooking processes, in relationship to stagnant air. An improvement to the air quality then must focus on an increase in air movement, which is measured at the rate of cubic metre per minute (m^3/min). Air movement or ventilation focuses on creating movement via the introduction of outdoor air, while air cleaning focuses on filtration, which also requires moving air to be pushed through the filtration mechanism. Indoor and outdoor air is differentiated as follows:

> *air, indoor:* air in an occupiable space.
> *air, outdoor:* air from outside the building taken into a ventilation system or air from outside the building that enters a space through infiltration or natural ventilation openings.[16]

ASHRAE defines ventilation as 'the process of supplying outdoor air to or removing indoor air from a dwelling by natural or mechanical means'.[17] The air that is captured as part of the ventilation process becomes ventilation air, or outdoor air delivered to a space that is intended to dilute airborne contaminants.[18] Air cleaning is 'the use of equipment that removes particulate, microbial, or gaseous contaminants (including odours) from air'.[19] Ventilation, then, is tasked with ejection, or removal via the movement of air. However, are contaminants not so much re-moved, as they are simply moved? Air particles are trapped onto filters or re-moved to the 'exterior'.

Fresh air supply is necessary for healthy indoor air, and yet air is nefarious in its tendency toward diffusion. The concept of ventilation, passive or mechanical, thinks of air as constantly moving in and out. In other words, the way we formally and institutionally define a matter like air – bound, unbound, proximal, separable, cleanable, spent – influences how we think about that air and thereby how we conceptualise it.[20] Prescribed spatial qualifiers such as 'outdoor air', 'indoor air' or 'ventilation air' separate air and mask the complex unbounded and fluid nature exhibited by statistical particle movement. Air is more or less proximal. Air cannot be pinned down – mixing, simmering, cooking – in, out, in, out, or out, in. Qualifiers such as 'fresh', 'exhausted', 'moving' or 'stagnant', on the other hand, recognise the delicate continuity, mutability, and instrumentalisation of air as a surrounding medium. Is air separable? Does air have a form? And if so, what is the nature of this form? Who manages or composes this form?

As breaths come in pairs, air quality relies on a vital inhale/exhale relationship. Cooked air is extracted from the cooking surface, inhaled by the ventilation hood. Subsequently, cooked air is ejected through mechanical exhaust systems to the outdoors. Exhaust systems direct spent air outward. Ejected air, after all, should not find its way back in. Yet, the potential re-inhalation of exhausted air poses a challenge to ensuing air intake. To mitigate this, ASHRAE regulations devise inhalation and exhalation protocols via the deployment of required minimum separation distances between air outlets and intakes and through the incorporation of air dampers throughout the ventilation system. *Standard 62.2* indicates that 'air inlets that are part of the ventilation design shall be located a minimum of three metres from known sources of contamination such as a stack, vent, [or] exhaust hood'.[21] Although, backflow prevention regulation recognises a paired breathing process, 'user controlled' breathing equipment focuses primarily on air extraction or exhalation processes. Questions of where and how (location, volume, velocity) air movement occurs remain in the purview of the ventilation expert, while mechanical intake takes place largely through automatic control systems. A local-demand-control operation focuses on exhaust mechanisms in which the 'when' can be controlled by inhabitants as specified in Section 5.1-5.2. Moreover, Section 5.2.1 specifies that mechanical exhaust equipment provide 'on-demand user control'. This control, usually in the form of an on-off switch, enables the cook to exhale cooked air on demand via the extractor fan while mandating a minimum ventilation rate of fifty litres per second.[22] Movement via controlled ejection lies with the user.

Domestic-scale breathing habits currently rely on standards of care for indoor air, which is the focus of *Standard 62.2*. Yet, interior air quality relies on air cleaning via a supply of fresh exterior air. We then rely explicitly on the availability of high-quality exterior air. To become re-implicated in the healthiness of our exterior air, we keep in mind we have to draw the air nearest to us back in. It is deceptive then to 'separate' air into interior and exterior qualifiers, where air pollutants are circulated constantly throughout the day. As exterior air is considered 'healthier' or fresher than our interior air, indoor air cleaning is, in fact, achieved via the removal of contaminants from interior air and subsequent ventilation which focuses on the introduction of exterior air. What does it mean then to exhale, when there is only air, as opposed to indoor and outdoor air? How do we, as both architects and users, implicate ourselves within air-management once again?

Explication, or what cooked air can be

The form of air lies with those technically literate in its art, the movement of air, its inhalation and exhalation. Technical literacy implies design control. *Standard 62.2* shows that the form, velocity, path, location, volume, and quality of air lie with the technical expert, the designer of mechanical air systems. Movement via controlled ejection lies with the user. Architectural designers collaborate towards composition in relationship to current understandings of architectural aesthetics of the architectural project, that which is 'material'. The architect is additionally tasked with decisions regarding the concealment or revealing of ducting via the integration of shafts and mechanical rooms into building design. Air has (im) material form; though it cannot be explicitly 'seen' through typically architectural aesthetic mediums, it is nevertheless material as made explicit in the mechanical systems needed to form and move it. Yet while mechanical systems form the vessel for air movement, hardware materiality should not be conflated as congruent to the (im)material form of air.

Should we not only be more aware of our domestic emissions, but also more readily implicated in their inhalation/exhalation relationship? How we think air, and where we think air, in turn influences how we care for air, as well as who cares for it. Cooked air, then, is the air which architects together with users and air movement specialists choose to implicate readily. Focusing on the inhale-exhale relationship, the possibilities of 'what cooked air can be' lies latent in kitchen respiration through, first, the language of technical literacy. Air mechanics can expand from the merely technical analysis of air to include the aesthetic and formal qualities of air itself, not merely that which we are trained to 'see' as material. Second, the aesthetics of cooked air includes the movement of air and an understanding of air as a continuous medium that is always in motion through an inhale-exhale relationship in the home. The behaviour of air, managed through mechanical equipment, as well as the qualities of air itself, its velocity, the particles it carries, its freshness or cooked-ness, in turn give form to air. Lastly, architecture can expand the science of air to include aesthetic sensibilities through air explication.

Air particles exist as physical, (im)material pixels that surround and fill a breathable milieu. In *Terror from the Air*, Peter Sloterdijk describes the military's instrumentalisation of mechanical air knowledge.[23] In this case, air is managed towards the making of weapons. An 'airquake: … the explication of air, climactic and atmospheric situations calls into question the basic presumption of beings concerning their primary media of existence.'[24] Explication, then, is more than simply explaining, or making ventilation functional. Rather, air explication entails 'technical redesigning'.[25] In the attack of an opponent's atmosphere, or breathable environment, lies latent the fact that humans exist as 'beings-in-the-air'.[26] We are in a constant state of breathing that air which surrounds us. Of the biological cycles supported by our home, none is more immediate than the ability to breathe easily.

> Explication is a matter not just of the conceptual instruments that we deploy to illuminate the phenomena of life – such as dwelling, working, and loving – it is not just a cognitive process. Rather, it has to do with real elaboration. That can only be achieved using an expressive logic or a logic of production.[27]

Explication, then, in the repertoire of architectural thinking toward air management, is not merely to resolve the functioning of air, or to concern the composition of mechanical equipment for its own sake, but to implicate this equipment towards the 'design of air'. To remake air-management as architectural, technical literacy, jurisdiction and assessment must appeal to the aesthetics of air. Human interactions with equipment, cooking activities and exhalation mechanisms can relate to architectural acts. Simply ejecting spent air is not explication. Architecture could explicate – meaning that we could use that air to do something with it and that would be an actual 'control' over the substance – being creative with it, doing something with it. Yet, to design requires deeper understanding than that which we have acquired as mere users of these systems. Architectural air explication requires transdisciplinarity: 'retying the Gordian knot' of knowledge from fragmented disciplines, the aesthetic, the technical and the legal.[28]

Architecture's domain centres on formal and aesthetic logics. Expanded technical literacy and interest are necessary if architecture is to engage mechanical equipment within an aesthetic domain. Compositional thinking must then not be limited to the arrangement of pipes, rather the mechanical arrangement of pipes is the instrumental language for their management and design. How can the architectural discipline embrace technology to create forward-looking architectures? Reyner Banham offered a significant critique of modernist and high-tech architectures in relationship to the machine aesthetic.[29] While arguing for a well-tempered environment, Banham was simultaneously disillusioned with the treatment of mechanical equipment as an aesthetic itself. The task of looking towards new technologies to inspire an advancement of architecture is not to make architecture look like these technologies or to treat technologies as compositional objects in themselves. Rather, the task of the architect is to 'accelerate their possibilities'. Such an expansion suggests an authentic relationship to the machine in itself as opposed to only its immediately assumed instrumental use. What is already the main task of ventilation is the movement of air. A pursuit of accelerating the design possibilities of air-moving machinery might then entail an 'explication of air'. What might a technical redesigning of ventilation mean then? It is certainly not an aesthetic obsession with the arrangement or aesthetics of the flues, but rather an instrumentalisation of those flues towards an advancement of architecture. To 'accelerate the possibilities' of what mechanical equipment can do is not simply to resolve ventilation but to play with it. Walls of smoke, facades made fuzzy by ejected steam, floors of sewage gasses. [Fig. 4] While such interventions remain mostly unseen to the naked eye, felt qualities can also communicate architectural elements. Designing with air appeals to the senses, that of touch, of smell, of hearing. Additionally, a vast availability of measurement and visualisation technologies already expands our methods of 'seeing' within architectural discourse.

Maintaining one's biological care cycle relies on and extends to the management of (im)material resources through equipment. One removes abject air, through the sneeze, the ticklish or used-up air from one's home via a series of technological formulations. To make environmental issues real they must be understood both intellectually and perceptually, known and felt.[30] The development of domestic air explication can make explicit the relation between individuals and environmental care in everyday, localised, biological cycles. *Standard 62.2* acknowledges a tension in achieving air quality as both technical and perceptive when setting out the applicability of such standards. Yet in its subsequent pages, the standard disregards susceptibility or perceptual knowledge, with a bias towards an objective ventilation science, achievable via explicitly techno-scientific air management epistemologies. In essence, this specificity refutes the potential redesigning of air to engage its perceptual or felt possibilities. It remains to those concerned with its aesthetic, formal and material qualities to extend the science-of-air to engage the 'susceptibility of the population' in terms of occupant perception.

Notes

1. Diane Ackerman, 'Smell', in *A Natural History of the Senses* (New York: Vintage Books, 1995), 6.
2. See Gilbert Simondon, 'Man and the Technical Object', in *On the Mode of Existence of Technical Objects* (Minneapolis: Univocal, 2010), 103–70.
3. International Code Council, 'Definitions', in *2015 International Residential Code for One- and Two-Family Dwellings* (ICC, 2014), https://codes.iccsafe.org/content/IRC2015/chapter-2-definitions.
4. Reyner Banham, *The Architecture of the Well-Tempered Environment* (Chicago: The University of Chicago Press, 1984), 20.
5. Odile Redon, Françoise Sabban and Silvano Serventi, *The Medieval Kitchen: Recipes from France and Italy*, trans. Edward Schneider (Chicago: The University of Chicago Press, 2000), 16–17.
6. Ibid., 16.
7. The solid-fuel stove, also known as a cookstove, is a stove that is heated by burning bio-mass such as wood or charcoal. It includes a vent flue which ducts fumes directly from its firebox to the outdoors.
8. Georges Canguilhem, 'The Living and its Milieu', trans. John Savage, *Grey Room 03* (Spring 2001): 7–31.
9. Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), 22–79.
10. ASHRAE, *ANSI/ASHRAE Standard 62.2-2019:* Ventilation and Acceptable Indoor Air Quality in Residential Buildings (Atlanta: ASHRAE, 2019), 2.
11. Imperial units have been omitted from the description. For total required ventilation rates in Imperial units, refer to *ASHRAE Standard 62.2*, 6.
12. *ASHRAE Standard 62.2*, 2.
13. Ibid., 3.
14. Ibid., 2.
15. United States Environmental Protection Agency, 'Introduction to Indoor Air Quality' (2020), https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality.
16. *ASHRAE Standard 62.2*, 3.

17. Ibid., 5.
18. Ibid., 3.
19. Ibid., 2.
20. 'It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories.' Donna Haraway, 'Making Kin', in *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016), 12.
21. *ASHRAE Standard 62.2*, 13.
22. See Table 5-1, Demand Controlled Local Ventilation Exhaust Air Flow Rates in ASHRAE Standard 62.2, 11.
23. Peter Sloterdijk, 'Increasing Explication', in *Terror from the Air* (Cambridge, MA: Semiotext(e), 2009), 47–71.
24. Sloterdijk, *Terror From the Air*, 28.
25. Peter Sloterdijk, *Foams: Spheres Volume III: Plural Spherology* (Cambridge, MA: Semiotext(e), 2009), 66.
26. Sloterdijk, 'Increasing Explication', 48.
27. Peter Sloterdijk, 'Talking to Myself about the Poetics of Space', *(Sustainability) + Pleasure* I, no. 30, *Culture and Architecture* (S/S 2009), http://www.harvarddesignmagazine.org/issues/30/talking-to-myself-about-the-poetics-of-space.
28. Bruno Latour, *We Have Never Been Modern,* trans. Catherine Porter (Cambridge, MA: Harvard University Press, 1993), 3–5.
29. While modernism engaged questions of new materials and technologies, the architecture it produced continued to be primarily about form, aesthetics, and artistic problems. See Reyner Banham, *Theory and Design in the First Machine Age* (Cambridge, MA: The MIT Press, 1980), 320–30.
30. Canguilhem, 'The Living and its Milieu', 7–31.

Biography

Liz Gálvez is a Mexican-American educator and a registered architect. She is a visiting critic at the Rice School of Architecture and directs Office (e.g.), a practice interested in examples of possible architectures. Her work focuses on the interface between architecture, theory and environmentalism. Gálvez received her Master of Architecture with a concentration in History Theory and Criticism from the MIT School of Architecture and Planning. She has taught at the University of Michigan's Taubman College, where she was the 2018–19 William Muschenheim Fellow. She has practiced at various award-winning firms in the United States and in Mexico, including Will Bruder Architects, NADAAA and Rojkind Arquitectos. Gálvez's writing has been published in *PLAT*, *Footprint,* and *Pidgin* (forthcoming). Her work has been exhibited at MIT, the Hohensalzburg Fortress, The University of Michigan, and at the Space p11 Gallery in Chicago.