

What can we learn from the Bubble Man and his Atmospheric Ecologies?

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ABSTRACT

With this essay I present the fragile thought-image of the soap-bubble to venture an augmented understanding of what an atmospheric ecology might be, what it might include, and how it might contribute to a thinking of interiors. In contemporary digital design the soap-bubble or soap film is most often investigated for what it can tell us about material behaviour, and how an understanding of material behaviour as it occurs in 'Nature' can be innovatively applied to design problems. Soap film can be studied in terms of what it tells us about surface tension and minimal distribution of material, which then allows the designer to better understand tensile structures. It also contributes to an understanding of cell walls (from the scale of the microscopic to the macroscopic), and how an interior condition responds to the pressure of an exterior condition. Appropriated from nature through a process of biomimicry the behaviour of soap film and soap-bubbles has been broadly used to test speculative design schemes and also to generate new digital techniques and technologies. I propose to liberate the thought-figure of the soap-bubble from this set of technical studies and applications in order to extend an understanding of how it can be used to frame atmospheric ecologies, especially after the manner in which soap-bubbles cluster and froth. Ecology here must be understood in an expanded sense that encompasses not just naturally occurring systems, championed by special interest groups that fight for a specific environmental niche, but also subjective and social ecologies, and how these different systems remain profoundly intertwined. I draw on the work of Peter Sloterdijk, Jakob von Uexküll, and also Gregory Bateson to offer other visions of what an atmospheric ecology might be, and how it can offer us more open definitions of the interiors in which we need to find a way to survive.

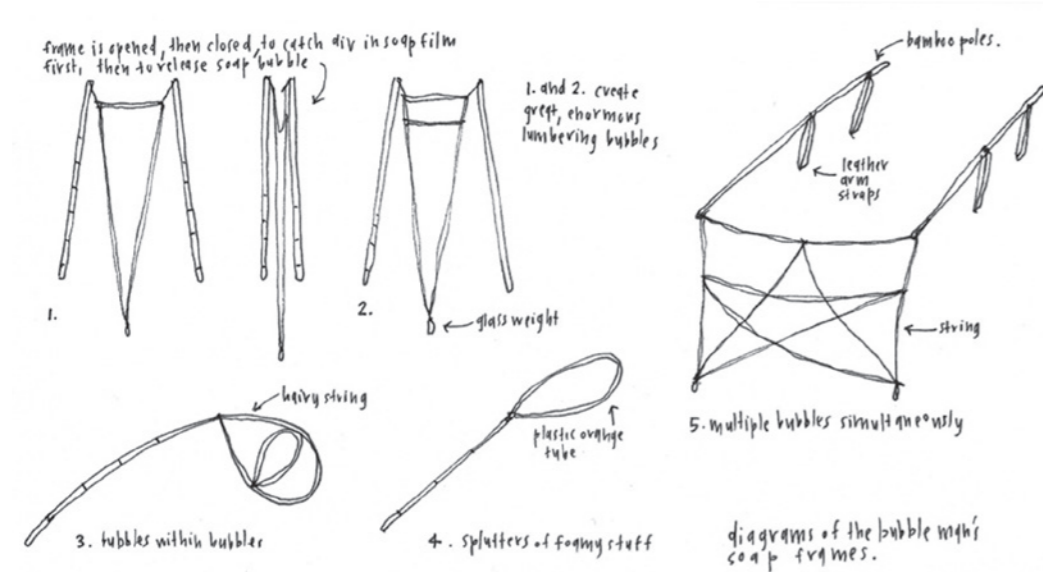
He would arrive nearly every Saturday mid-morning on Kathe Kollwitz Platz, Prenzlauerberg, Berlin, in the vicinity of the statue of Kathe with her slumped shoulders and large, benign face. We called him the Bubble Man, and his jubilant and participatory audience was composed mostly of children who had strayed from parents busy with market-day activities around the square. As the grown-ups collected fresh produce, drank beer or sipped coffee, or simply lazed in the playground – one eye on the little ones – the bubble man would serenely arrange his instruments and his large bucket of soapy water. He would wield one humble home-made instrument after the next. Makeshift loops of string would be languorously dipped into a mess of suds and then held aloft at the end of long slender bamboo poles and moved in slow arcs through the air until enormous deformed spheres would bulge and sway above the waving arms of screaming children hell bent on their destruction. (Figure 1) The bubble blowing instruments were all constructed of flexible bamboo rods, sometimes with leather arm-bands, and weighted with glass baubles. They sported string frames of varying degrees of hairiness. Different lattices of string created different bubble



Above
Figure 1. Image of the Bubble Man at work in Kathe Kollwitz Platz, Prenzlauerberg, Berlin.
Photograph by Hélène Frichot, 2009

effects. There were star-shaped frames, simple loops, and V-shaped frames that could be opened and closed. (Figure 2) Some bubbles were enormous lumbering beasts, and others spluttered in clusters of smaller rainbow streaked spheres. There were also bubble-blowing hoops that flung foam through the air, which landed in the hair of gleeful children. What the Bubble Man wielded between his deft hands was a set of instruments by which worlds, fleeting in their existence, ecological niches of exquisite ephemerality, appeared briefly only to abruptly vanish. With this essay I hope to liberate the thought-figure of the bubble from the techniques and technologies of contemporary design with which it has come to be predominantly associated. Instead, after such thinkers as Peter Sloterdijk, Jakob von Uexküll, and also Gregory Bateson, I suggest that the bubble offers us a glimpse of existential territories that might be provisionally defined in terms of their fragile atmospheric ecologies. As Sloterdijk has pointed out, what is the so-called atmosphere if not that large scale sack or bubble within which our very world is contained?¹ This simple thought effectively offers up the conception of a global ecological interior, accompanied by the exigency of care lest the delicate atmospheric bubble that supports us be obliterated once and for all.

If you listen to the mathematicians and geometers, as well as to digitally adept architects and designers hunting for novel form-finding techniques, you will hear that the soap-bubble, erstwhile symbol of *vanitas*, can be defined by the strict rules that determine its geometry and surface tension and what happens when one soap-bubble encounters another soap-bubble. A study of the soap-bubble informs the designer's attitude to technicity, that is, it suggests what technical benefits and applications can be derived from an understanding of how soap film systematically organises



itself. An understanding of how soap film distributes itself into surfaces can then be employed toward form finding procedures. Manuel De Landa explains:

The spherical form of a soap bubble ... emerges out of the interactions among its constituent molecules as these are constrained energetically to 'seek' the point at which surface tension is minimized.²

In a later essay he adds:

Soap film will spontaneously find the form with the minimum of surface tension. Without any constraints (such as those exerted by a frame made of wire or rope), the form that emerges is a sphere or a bubble.³

By adding constraints, such as additional frames composed of string, bamboo poles, and the like, the symmetry of the bubble-sphere is broken and a wide variety of other shapes emerge out of a space of possibilities. Although the tendency of the bubble is toward the perfect sphere, contingencies and irritations, most often created by an environment, will take the material of soap film and deform it in one direction or another producing a plethora of bubble permutations. The soap film, in response to its chance encounters in a world, settles on a form for the time being, and then, as the bubble man knows so well, it disintegrates into its ambient surrounds. As De Landa has pointed out, investigations by architects and engineers into soap film have led to an understanding of the architecture of cell walls from a microscopic to a macroscopic scale, and the way cell walls, such as those belonging to the bubble, are supported by internal pressure. Knowledge gained in the study of material and biological systems can and has been transferred into the scale of architectural constructions. While the sphere might be the most essential version of the bubble, as an ideal imposed from above, or 'transcendentally' it is not so interesting. What is interesting, as the Bubble Man demonstrates, is the immanent behaviour or 'expression' of soap film. Despite their apparent insularity, we can assume that no individual bubble operates in isolation, at the very least a bubble will become deformed in contact with the environment into which it is released, as the temperature, the breeze, the light, will challenge its spherical perfection. Or else, one bubble-cell will bump up against a neighbour, and local relations between neighbours will in turn influence how a larger system develops, and how a recognisable form or foam emerges: Bubble forming feedback loops. These interactions, relations and encounters, and circuits of affect all contribute to what can be identified broadly as atmospheric ecologies, which operate across a range of scales.

In response to a given a number of determined constraints that act as a simple set of rules, soap-bubble experiments develop as form-finding techniques that are not determined from above or in advance, but self-organise their relations from below. That is to say, soap-bubbles arrange themselves in the neighbourhood of each other to create foams that are not moulded by some master-creator, but erupt on a scene as though happenstance. Once we begin to speak in this way, about

Opposite
Figure 2. Diagram of bubble making tools used by the Bubble Man.
Hélène Frichot, 2009



self-organising systems, about what has come to be described by many as the phenomenon of emergence, we enter into a whole discursive and practical arena of contemporary, digitally orientated, architectural fascination, a new biotechnological and augmented material paradigm.

The expressive behaviour of soap-bubbles have inspired the experiments of contemporary avant-garde digital architects such as Lars Spuybroek of NOX, who is keen to pursue biomimicry, or how to borrow from 'Nature' to create forms that perform well in response to environmental and other specified conditions. The architectural follies designed by NOX do not necessarily look like bubbles, but they do tend to be billowing, bulbous and sleek, and sometimes even seem to foam up out of the ground. NOX's celebrated HtwoOexpo water pavilion (1994-1997), suitably located by the foaming waves of coastal Netherlands, is an early example of their work. While images of the water pavilion tend to focus on its external silvery form as it heaves up out of the ground, it was in fact dedicated to the interactive experiential qualities that are aroused in contact with water. That is to say, the emphasis in this architecture was supposed to be located in its atmospheric interior. Writing about Spuybroek's work, De Landa argues that 'Soap film models are literally analogue computers with which the shape of a large variety of tent forms – simple sails as well as pointed, arched, humped and wave tents – can be calculated.'⁴ Spuybroek's soap-bubble experiments were originally inspired by the German engineer, Frei Otto, who is well-known for his collaboration with the architect Günter Behnisch on the stadium and associated pavilions designed for the ill-fated 1972 Munich Olympics (Figures 3 and 4). This was an early study in light-weight and tensile structures that took advantage of soap film experiments to gain a better understanding of what could be achieved in spanning broad areas by using minimal materials stretched gossamer thin. In addition, there are those design schemes that literally copy the structure of clusters of soap-bubbles, for example, the broadly publicised Beijing National Aquatics Centre, or 'Water Cube' designed by PTW Architects, and constructed for the 2008 Beijing Olympics. It is also curious to note that the fragile soap-bubble has more than once lent itself to being represented through monumental design means at the scale of the global event that is the Olympics.

Opposite Left

Figure 3. Image of the Munich Olympics Stadium. Günter Behnisch architect with Frei Otto 1972. Photo by Hélène Frichot 2009.

Above Right

Figure 4. Image of the Munich Olympics Stadium. Günter Behnisch architect with Frei Otto 1972. Photo by Hélène Frichot 2009.

The soap film experiment could be undertaken by a child. A simple frame is dipped into soapy liquid, and the film that results self-organises such that a surface of minimum tension results, which can in turn be mathematically defined. Such experiments have allowed advances in the creation of tensile, or tent-like structures, which operate under tension, rather than compression (such as the sedentary brick house). Once the minimum surface is resolved this also allows for an efficient and lightweight distribution of materials. The material and behaviour of the soap-bubble informs experiments employed in form-finding for designers and engineers both pre and post the ready availability of digital design technologies. The benefit of the digital augmentation of design processes means that these experiments can be accelerated and considerably complexified. As a result the soap-bubble loses some of its ephemeral qualities and the emphasis is placed instead on the architectural end product, or what the final built form should look like and how it should perform. Although there are aspects of contemporary architecture and design that increasingly engage in ephemeral, experiential, and interactively immersive environments, the design disciplines still prefer that their forms do not promptly splutter out of existence following their precarious construction.

The German philosopher and public intellectual Peter Sloterdijk, who has constructed a magnum opus based on the sphere, which includes a celebration of the humble figure of the soap-bubble, also makes an account of the structural physiognomy of this wondrous form.⁵ Sloterdijk admits a particular interest in bubbles where they cluster as foam: 'From a physical perspective, [foam] describes multichamber systems consisting of spaces formed by gas pressure and surface tensions, which restrict and deform one another according to fairly strict geometric laws.'⁶ He is interested in extending the figure of the soap-bubble, where it clusters and congeals into foam, and suggests that '[i]t seemed to me that modern urban systems could be easily understood with analogy to these exact, technical foam analyses.'⁷ Sloterdijk takes the bubble that we know from childhood adventures, and attributes it with an ontological, as well as an ethical and ecological weight. Being is not quite round, but rather like a fragile, wobbly, bubble-like environment that atmospherically envelops

us. In the context of the contemporary city in particular we are like co-isolated bubble beings colliding randomly into each other, suffering briefly, sometimes beautifully, only to be directed haplessly toward dissolution: An explosion of air and sticky stuff.

As a retort to clever digital architects Sloterdijk says: 'it's mainly an expression of the fact that modern mathematics has caught up with organic form', of course, novel graphic and animation software programs also help. It is not simply the triumph of mathematics over nature, he warns: 'It's not at all a question of a return to nature, it's an insolent game played by computer-assisted mathematics at the expense of organic form ... architectural biomorphism should be interpreted as a symbol of the fact that technique has attained the necessary *savoir-faire* to declare its responsibility over organic form.'⁸ Sloterdijk instead tempers such form-finding enthusiasms with how foam can describe the "episodic clusters and enduring symbioses" of social collectives.⁹ He explains: 'The co-isolated foam of a society conditioned to individualism is not simply an agglomeration of neighbouring (partition-sharing) inert and massive bodies, but rather multiplicities of loosely touching cells of life-worlds.'¹⁰ The bubble here, and the way it amasses into globules and heaving masses of foam can not only be remarked upon for its elegant formal and material implications, but also suggests a way in which to approach all manner of atmospherically bound ecologies or environment-worlds. With this essay I venture a critique of the ways in which soap film as a system is studied in a restricted sense, which only allows for specific technical applications. By making the soap-bubble an image-thought instead, other kinds of systems can be considered that move beyond the technical sphere into the question of social collectives. It is from Sloterdijk that I borrow the 'atmospheric' component of my conceptual conjunction 'atmospheric ecologies', as he recognises the atmosphere as extending beyond that sack of air that encloses planet earth. In essays such as 'Atmospheric Democracy' or 'Airquakes'¹¹ he also forwards arguments that tie together historically emerging understandings of contextual atmospheric conditions, such as the invention and application of gas warfare during the second-world-war, and how these impede on social and political relations.

The multifarious chambers that compose foam are both fragile and resilient, opaque and transparent. Like Gottfried Leibniz's simple monads these chambers and their relations to one another own both obscure and clear zones, they apprehend each other in moments of blinding clarity, or else they remain oblivious. If you lend foam an ear, as we did when we were children listening to our bowls of rice bubbles, the sound of its fizzing, snap, crackle and pop, is the white noise, continuous murmur of the city composed of so many lives and things emerging and then passing away. Or else, it is the static and electric hum of our increasingly electronically mediated existences, with attendant software and hardware, twittering, flickering, googling. Don't listen too closely to the geometers and mathematicians who will tell you that the meeting place between bubbles always follows the same predictable geometry. What cannot be predicted is which bubble will survive, and for how long, and with what constellation it will discover itself circling. Determined to meet, yes, but how this encounter will work itself out remains part of the creative unpredictability of a plethora of contingent forces. Each bubble is a life. And as the 17th Century Dutch *vanitas* painters show through their depictions of fragile soap bubbles, life is fleeting, ephemeral. What we have through the thought-image of the bubble, and how it seethes as foam, is an image of environment-worlds whirling about in a maelstrom, a plurality of singular bubble-worlds jostling about. I argue that it is crucial to extend the image of the bubble and soap film from its technical specificity and understand and remember how the bubble also illustrates the structures of existential territories inclusive of dire ecological catastrophes, both natural and manufactured.

Rather than becoming a form whose shape and behaviour we mimic, the bubble can offer a way into understanding our intimate relationship with our environment, whether we are a tick, a house fly, a child or a grown-up. Sloterdijk suggests that the biological concept of the environment emerged with the work of semiotic biologist, Jakob von Uexküll (1864-1944) who identified the 'mutual belonging' that coheres between organism and environment.¹² Uexküll's essay *A Stroll Through the Worlds of Animals and Men*¹³ depicts bubbles as spheres of existence. He proposes that we take a stroll into the unfamiliar worlds that

surround us, those microscopic as well as macroscopic celestial worlds to which we most often remain oblivious. To do so, he says, 'we must first blow, in fancy, a soap bubble around each creature to represent its own world, filled with perceptions that it alone knows.' Then, should we find a way to step into one of these bubbles, these otherwise closed monadic cells, 'a new world comes into being.'¹⁴ We see that each bubble of organism-plus-environment reveals another world and its few or several, simple or complex, carriers of significance, or affects.¹⁵ Different organisms own different sets of affects that make them more or less likely to identify and respond to some object in their environment. These affects or 'perceptual cues' pertain to the range of the organism's perception, what they are apt to perceive of a world, and therefore what their perception necessarily excludes. Each soap-bubble, as Uexküll explains, 'harbours different loci, and in each there exist the directional planes of operational space, which give its space a solid framework.'¹⁶ The soap-bubble that encloses each creature in its world owns not only a specific spatiality, but a particular tempo. While some affects seem to suggest innate or genetically derived responses on the part of the organism, other affects emerge as a matter of habit, for instance, the way we typically follow one pathway or another to get to work or school in our environment-world, or even the way we become habituated to the use of the everyday tools and utensils that are available to us. When our habitual pathway is blocked, or our tool breaks down, then we can become confounded and momentarily lost in our bubble-world. Perhaps we are even momentarily given a fleeting view into other bubble worlds through this moment of rupture.

Under Uexküll's curious gaze environment-worlds [*umwelten*] multiply profusely, and should we be privy to all of these worlds simultaneously our senses would be overwhelmed, as would our capacity to make sense. A balance must be struck, so that we can achieve at least a minimum of communication between our environment-worlds, whether our concerns are shared or divisive. Sloterdijk argues that at the scale of the human organism such worlds can even include: 'a national assembly, a 'love Parade', a club, a freemason's lodge, a workforce, a shareholder meeting, a concert hall audience, a suburban neighbourhood, a school class,

a religious community, drivers stuck in traffic jam.¹⁷ The challenge would appear to be how to avoid these environment-worlds amassing as isolated archipelagos or congealing homogeneously like dough. The delicacy and resilience of foam suggests a structure that is neither too heterogeneous nor too homogenous, neither too individuated, nor overly indistinct. Importantly the bubble-cell also reveals something of our seeming will to individuation and cellular or capsular existences. If the bubble that is our cellular environment-world only allows us to see so much, and keeps us blinkered in a habitual tuned-out way to all the rest, then no wonder we manage so badly when it comes to the bigger ecological picture, what Uexküll calls, quite simply, Nature. Is it that we are constrained to do the best that we can given the limited affects and circumscribed environment-worlds that are available to us? Or can we do better than this?

Félix Guattari opens his essay, *The Three Ecologies*, with a quote taken from Gregory Bateson's *Steps to an Ecology of Mind*: 'There is an ecology of bad ideas, just as there is an ecology of weeds.' Another way of stating this is that 'now more than ever, nature cannot be separated from culture',¹⁸ and bad ideas can have a devastating impact on both natural and artefactual systems. It is clear that Bateson has had a profound impact on Guattari's argument in *The Three Ecologies*. It is also from Bateson that Gilles Deleuze and Guattari borrow the concept of the plateau for their book, *A Thousand Plateaus*. Following Bateson's argument, what Guattari points out is that where Charles Darwin's theory of natural selection pinpoints the family line, species or subspecies as the fundamental unit of survival, Bateson argues that the unit of survival should be understood as 'organism plus environment' and that, in turn, it is only through bitter experience that the organism learns that if it destroys its environment it also destroys itself.¹⁹ It seems, though, that the habits of thought that plague us are even more ingrained than Bateson himself believed. Bateson, anthropologist and second order cyberneticist, includes in his definition of ecology not just the natural world, nor even just a combination of constructed and natural worlds, but also the world of ideas, or 'Mind'. In his collection of essays entitled, *Steps to an Ecology of Mind* where he insists that '[t]here is an ecology of bad ideas, just as there is an ecology of weeds'²⁰ Bateson is making what might at first seem a self-evident point, but it is one we habitually forget. That is to say, the systems with which we think, or do not think critically, cannot be separated out from the environmental system that we inhabit. In fact, the very act of thinking is part and parcel with what I have called atmospheric ecologies, and poor thinking impacts on muddled acting, which concatenates through serial atmospheric effects. Importantly, Bateson's definition of Mind, which draws on cybernetic theory, is an immanent Mind, not a god-like mind that is transcendent or separated out from environment worlds. Bateson argues strenuously that you cannot separate Mind out from the structure in which it is immanent without that structure falling into crisis. Further to Bateson's expanded definition of ecology is his insistence that the unit of survival must be considered as a combination of 'organism plus environment'.²¹ This is a sentiment that resembles Uexküll's understanding of the inextricability of creature and world. A Mind is an aggregate of ideas that thinks beyond the human individual by whom we habitually circumscribe thought. An aggregate, or ecology of ideas includes, for instance, organism plus computer plus environment, and the interaction between these parts. What's more,

drawing definitive lines between where one component begins and another ends is of limited abstract use in better understanding the ecology in which they work.

Bateson's essays in *Steps to an Ecology of Mind* are a collection of papers that cut across the disciplines of anthropology, psychiatry, biological evolution and genetics, as well as venture into the then new discipline of cybernetics, which finally allows him to make many fruitful transdisciplinary observations. In the preface he explains that these essays offer a nearly exhaustive account of his research engagements from the mid 1930's through to the early 1970's. Although we might object that his work is now nearly forty years old, he is nevertheless still offering us lessons on how to rethink ecologies, lessons that we do not yet appear to have got. He discusses the risks of global warming, rampant and unchecked technological progress, and he offers inventive and creative expansions on the definition of how ecological systems may be understood through cybernetic explanation. Ecology in the widest sense, he explains 'turns out to be the study of the interaction and the survival of ideas and programmes (i.e., differences, complexes of differences) in circuits'.²² If you place one bad idea in the circuit it is likely to proliferate. For example, 'When you narrow down your epistemology and act on the premise 'What interests me is my organization, or my species', you chop off consideration of other loops of the loop structure.'²³ Bateson uses the example of Lake Erie: 'You decide that you want to get rid of the by-products of human life and that Lake Erie will be a good place to put them. You forget that the eco-mental system called Lake Erie is part of *your* wider eco-mental system – and that if Lake Erie is driven insane, its insanity is incorporated into the larger system of *your* thought and experience'.²⁴ Here we see ecology, society, '*your*' subjective position, and psychiatry being articulated by way of a cybernetic system or circuit both in terms of the ideas being circulated and the very real material *responses* that are forthcoming (Bateson is keen to point out that Cybernetic theory deals not with 'cause-and-effect', but with 'stimulus-and-response').²⁵

Readers of Dr Seuss's children's book *The Lorax*, a tale of environmental woes born out of greed and rampant consumption, may be familiar with the figure of Lake Erie. The Lorax, a short tempered environmentalist and spokesperson for his environment-world, which is getting all plugged-up with the pollutants produced from the harvesting of the lovely Truffula trees, makes reference to this exemplary site by exclaiming, 'I hear things are just as bad up in Lake Erie'.²⁶ Lake Erie, one of the five Great Lakes of North America, was an infamous example in the 1960's and 1970's of an environment befouled by heavy industrial pollutants. I do not spuriously mention this children's tale, for the stories we tell children, and what they show us of ourselves, play a considerable role in this argument. It is worth noting in the most recent edition of Bateson's *Steps to an Ecology of Mind* (2000), which is introduced by his own daughter, Mary Catherine Bateson, there have been included a series of what are called 'Metalogues'.²⁷ These are dialogues between a father and a daughter about all the muddled things that happen when we try to sort out questions and problems about our environment-worlds or the places and situations in which we find ourselves. The metalogue entitled, 'Why do Things Have Outlines?' is of particular use here, as it in part asks

the question of how do we delimit an interior, and how do we modulate the forces that continue to insist from the exterior, that is, how best do we think about and manage an interior atmospheric ecology? Part of the point is that problems can be grappled with exactly through an open dialogue, and sometimes it is worth asking what might at first appear to be simplistic questions. What's more, such conversations can also be undertaken as a process, even an evolutionary process of learning, as Bateson himself insists, between human organisms and nature. Between father and daughter, the two interlocutors consider whether or not discernible outlines are valuable, and these outlines of which they speak can be ascribed to all kinds of things (beyond the task of a child's colouring-in book), such as conversations, flocks of sheep, minority groups, and even machines. On the one hand an outline helps us recognise something clearly and distinctly, on the other hand, an outline sometimes fixes on things too early, and does not allow them to develop. The outline also tells us what is inside and what is outside the system in question, what belongs to the group, and what does not, but only in the given context, and at the current moment: tomorrow things could have rearranged themselves again. As children know, this is how bubbles work too, all too fleetingly.

We wanted to talk to the Bubble Man and ask him about his strange and wonderful inventions, but his performance was self-enclosing, and he seemed to barely notice the imminence of destruction that invariably followed each act of creation. Except sometimes for a small, brief smile that would quietly emerge on his face. The Bubble Man was not just technically adept at choreographing his ballet of bubbles, but was also held in his own bubble of existence, his unit of survival composed of organism plus environment. His sphere, it has to be stressed, was itself embedded in the larger sphere of the public place that is Kathe Kolwitz Platz, Berlin, and also in the midst of the particular set of activities that take place there on market day. As Uexküll has shown, to see the world from his point of view, we would have had to take a stroll into his atmospheric ecology or sphere of existence. Or else we might have quite simply ventured to begin a dialogue with him, in order to better grasp how his atmospheric ecology worked alongside ours. We might have asked him, based on his observations, why is it that we are so good at the hell-bent destruction of our own bubble-worlds?

NOTES

1. Peter Sloterdijk in conversation with Jean Christophe Royoux, "Peter Sloterdijk: Foreword to the Theory of Spheres" in Melik Ohanian and Jean-Christophe Royoux, *Cosmograms*, (New York: Lukas and Sternberg, 2005) :225.
2. Manuel De Landa, "Immanence and Transcendence in the Genesis of Form" in Ian Buchanan, ed. *A Deleuzian Century*, (London: Duke University Press, 1999):499-500.
3. De Landa, "Materiality: Anexact and Intense" in Lars Spuybroek, ed. *Nox*, (London: Thames and Hudson, 2002): 374.
4. De Landa, "Materiality: Anexact and Intense", 375.
5. See Sloterdijk's Spheres trilogy: Sloterdijk, *Sphären-Blasen*, *Mikrosphärologie* [Spheres I-Bubbles, microspherology] (Frankfurt am Main: Suhrkamp, 1998); Sloterdijk, *Sphären II: Globen*, *Makrosphärologie* [Spheres II: Globes, macrospherology] (Frankfurt am Main: Suhrkamp, 1999) Sloterdijk, *Sphären III-Schäume*, *Plurale Sphärologie* [Spheres III-Bubbles, plural-spherology] (Frankfurt am Main: Suhrkamp, 2004). See also Sloterdijk in conversation with Jean Christophe Royoux,

- "Peter Sloterdijk: Foreword to the Theory of Spheres" in *Cosmograms*, pp. 237-238; Sloterdijk, "Cell Block, Egospheres, Self-Container" in *Log 10*, Summer/Fall 2007, pp. 89-108; Sloterdijk, "Foam-City", in *Log 9*, Winter/Spring 2007, pp. 63-76, p. 63; Sloterdijk, "Airquakes" in *Environment and Planning D: Society and Space*, vol. 27, 2009, pp. 41-57.
6. Sloterdijk and Funcke, "Against Gravity: Bettina Funcke talks with Peter Sloterdijk", in *Bookforum*, February/March 2005. http://www.bookforum.com/archive/feb_05/funcke.html
 7. Peter Sloterdijk and Bettina Funcke, "Against Gravity: Bettina Funcke talks with Peter Sloterdijk".
 8. Peter Sloterdijk in conversation with Jean Christophe Royoux, "Peter Sloterdijk: Foreword to the Theory of Spheres" in Melik Ohanian and Jean-Christophe Royoux, *Cosmograms*, New York: Lukas and Sternberg, 2005, pp. 237-238, p. 237.
 9. Sloterdijk, "Foam City" in Cynthia C. Davidson ed., *Log 9*, Winter/Spring 2007, 63-76; 63.
 10. Sloterdijk, "Foam City", 63-76; 64.
 11. Sloterdijk, 'Atmospheric Politics', in Bruno Latour and Peter Weibel, eds. *Making Things Public: Atmospheres of Democracy*, MIT Press, (Cambridge, Massachusetts, 2005): 944-951; Sloterdijk, "Airquakes" in *Environment and Planning D: Society and Space*, vol. 27, 2009, pp. 41-57.
 12. Sloterdijk and Royoux, "Peter Sloterdijk: Foreword to the Theory of Spheres", 231.
 13. Jakob von Uexküll, "A Stroll Through the Worlds of Animals and Men", in Claire H. Schiller, ed. and trans., *Instinctive Behaviour: The Development of a Modern Concept*, (New York: International Universities Press, 1957).
 14. Uexküll, "A Stroll Through the Worlds of Animals and Men", 5.
 15. For further readings of Uexküll's work both philosophical and architectural see: Gilles Deleuze, *Spinoza: Practical Philosophy*, trans. Robert Hurley, (San Francisco: City Lights Books, 1988) ; Giorgio Agamben, *The Open: Man and Animal*, trans. Kevin Attell, (Stanford, Cal.: Stanford University Press, 2004); Catherine Ingraham, *Architecture, Animal, Human: The Asymmetrical Condition*, (London: Routledge, 2006); Michael Hensel and Achim Menges, eds. *Morpho-Ecologies*, London: AA Publications, 2006.
 16. Uexküll, "A Stroll Through the Worlds of Animals and Men", 28-29.
 17. Sloterdijk, "Foam City", 63.
 18. Guattari, *The Three Ecologies*, trans. Ian Pindar and Paul Sutton, (London: Athlone Press, 2000): 43.
 19. Félix Guattari, *The Three Ecologies*, note 1, p. 70.
 20. Gregory Bateson, *Steps to an Ecology of Mind*, London: Granada Publishing, 1978, pp. 459, 460.
 21. Bateson, *Steps to an Ecology of Mind*, 1978: 459.
 22. Bateson, *Steps to an Ecology of Mind*, 1978: 459.
 23. Bateson, *Steps to an Ecology of Mind*, 1978: 460.
 24. Bateson, *Steps to an Ecology of Mind*, 1978: 460.
 25. Bateson, *Steps to an Ecology of Mind*, p. 379. In 2008 a book of collected essays was published that returned specifically to the ongoing currency of Bateson's research, especially in relation to biosemiotics. See Jesper Hoffmeyer, ed., *A Legacy for Living Systems: Gregory Bateson as a precursor to Biosemiotics*, (New York: Springer, 2008).
 26. Dr Seuss, *The Lorax*, (London: WM Collins Sons and Co Ltd, 1973).
 27. Gregory Bateson, *Steps to an Ecology of Mind*, (Chicago: The University of Chicago Press, 2000): 3-60.