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Living Ashes: Associated milieus and distributed agencies

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> 21 May 2016, 18:16: Three people in white coverall defenders and gas masks stand in front of an audience in Helsingør, Denmark. They transmute 'inert' matter into animation; they hack, tear and burn—ashes, fats and oils appear. Assemblages of chemistries, oil and lye. They form a droplet, which immediately fragments into three. It lies still for three seconds, jitters and starts its slow clamber following invisible, chemical waves. For a few seconds, here, protocells dance.

Living Ashes II is a performance, first staged at the 2016 CLICK Festival in Helsingør,[{note}]1 where we create protocells in a live performance. Protocells—precursors, or models of living cells formed by the innate, complex chemistry of molecules existing at the interface between oil and lye—while being induced by theatrical human performers are, however, animated by their own membranes: they are formed by an alkali solution released on a fatty milieu. The chemical variations create an interface at the edges, thickening and weakening the membrane as it pushes the protocell to move along the chemical gradient outside. We use the trope of the 'membrane' as a tool to explore the conceptual and technical hurdles we encounter as we attempt to bring the processes of microscopic semi-living matter to the larger-scale 'bubble' of a human audience. As the chemical variations animate the membranes of protocells, we likewise explore both the material and conceptual boundaries that this stage performance challenges and temporarily dissolves.

[{figure1}]

Here we follow an auto-ethnographic approach to understand how membranes—both material and metaphorical—challenge how human performers engage with and understand living systems on stage. We take the materiality of protocell membranes to explore our performance and discuss issues of agency 'liveliness'. There are two membranes that animate our understanding of protocells as non-human agents and 'performers': the negotiation of porosity and transference in protocells' membranes;

and the boundary between living and non-living matter. Our strategy in this piece is to mirror the liveliness of the material boundary animating protocells to reflect on the way that we approach protocells as 'performers' on stage. Living Ashes II is also a reflection on our own individual practices. We come together as a group with a medley of backgrounds and interests—collectively, we are artists, designers, architects, researchers, academics. Our work crosses disciplines, themes and methodologies. We believe that practice and discourse are material processes and here we attempt to thread both in advancing a critical reading of synthetic biology and biotechnologies, using Living Ashes II to situate ourselves in the contemporary discourse articulated around living matter.

Materiality of protocells: The membrane

Protocells are conceptually animated by (their) boundaries. Epistemologically speaking, they are an experimental model of life and a challenge to vitalism, a system of thought that creates a stark boundary between living and non-living matter. Earlier forms of vitalism imagined a 'force' that animated matter with life. Ancient Greek anatomist Galen, for example, thought that a vital spirit was necessary for life. Later vitalists thought that life was a consequence of matter assuming distinct configurations. Henri Bergson spoke of a vital impetus, an élan vital, in his Creative Evolution (Bergson 1911: 42). Advances in chemistry in the nineteenth century challenged the boundary separating living and non-living matter and, in 1828, Frederic Wöhler synthesized urea in the laboratory, thus demonstrating that a living kidney is not needed for its production and that organic molecules could be derived from inorganic ones (Hanczyc 2008).

Wöhler's research served as inspiration for the first models of artificial cells and, in 1867, Moritz Traube created the first known model of a protocell by releasing a drop of copper sulphate solution in potassium ferrocyanide, a process that results in a red-tinted boundary that acts as a barrier preventing exchange between exterior and interior (Ling 2001). Later, Otto Bütschli (1894) developed a protocol to produce an artificial model of protists, eukaryotic organisms capable of moulding their membrane to produce an arm-like projection, by releasing small amounts of potash in an olive

oil medium, which generates droplets that mimic the behaviour of amoebas due to chemical imbalances at either side of its membrane (Hanczyc 2008).

In the Bütschli model, protocells are materially animated by their membrane. When mixed, potash and olive oil trigger a chemical reaction in which the chemical bonds of triglyceride molecules that make up the olive oil are ruptured by the potassium hydroxide molecules in the lye. The reaction, known as saponification, produces glycerol and the fatty acid salt of soap. When released as droplets, potassium hydroxide triggers a saponification process at the interface between the droplet compartment and the medium surrounding it. The energy produced by the rupturing of the chemical bonds produces interfacial tensions between both liquids. The uneven distribution generates force fields that push and pull the membrane, deforming the body of the droplet and producing the behaviour that Bütschli described as amoeba-like: droplets breaking into smaller ones, migrating and engulfing others to become a large unit again. The forces generated in its interior 'animate' the droplet, thickening and weakening the membrane as it pushes the protocell to move.

[{figure2}]

The Petri dish as fourth wall

We arrived in Helsingør six days before the performance, using the time to set up our stage at the festival, collect local materials and install an improvised lab. Once settled and with a 'kitchen-workshop' operational, we began reproducing the Bütschli protocol. Our initial attempts, however, were highly erratic—we weren't sure the droplets we were producing were, indeed, protocells. The following days became an exploration of the membrane. We realized that fluctuations in temperature and alkalinity of the base media created differences in the thickness and quality of the membrane, producing different forms of 'animation' in the protocells that emerged—sometimes animated and 'amoeba-like', sometimes completely static. With time running out, and the day of the performance looming larger in the horizon, we reverted back to the Bütschli protocol we had used in a previous edition of Living Ashes, following the implementation of our collaborator Martin Hanczyc (2008,

2014). While preparing for the performance, we relied on our experience to replicate the processes but without being fastidious about validating concentrations, mass and molarity of the solutions. As our initial attempts at creating protocells failed to yield the results we expected, we reverted to a strict implementation of the protocol, a tactic that shifted our attention to the Petri dish.

[{figure3}]

The dish generates a physical boundary to control conditions—temperature, humidity, density, molarity—and delineates other strategies and contingencies.[{note}]2 Our use of Petri dishes articulates our performance around the boundaries of scientific practice but, by placing the performance on stage, it creates an overlapping of boundaries and membranes. In Western, contemporary drama, the stage exists as an enclosed environment bounded by the so-called 'fourth wall' where actors and props are disconnected from the audience, who remain as observers. Although the 'fourth wall' does not exist physically, it sets a boundary between the actors and the audience and it has been the site of exploration in contemporary theatre practices to negotiate the transference between performers and audience (Benjamin and Bostock 2003; Reinelt 1996). The way that our performance overlaps boundaries can be interpreted as a similar strategy that creates sites of transference between the inside and the outside of the fourth wall. The vibrancy—or in scientific terms, the reactions—of protocells happen as transference across their membrane. The second boundary—the Petri dish—remains comparatively sterile whereas the third boundary—the microscopic projection—occasionally reveals and is bounded by the edge of the Petri dish, which makes the audience aware of the interaction between inside and outside.

[{figure4}]

Our tactics consist of creating sites of transference that raise fundamental questions about the status of performance in our research. Considering the Petri dish as the initial boundary assumes protocells to be performers, on a par to ourselves as we develop our actions and project their live images. In preparing Living Ashes II, we were motivated by the question of how and who decides the threshold of aliveness.

Reflecting on our individual work on biotechnologies and synthetic biology, the definition of what counts as living matter seemed crucial—the notion of what is living matter animates much of the discourse around biotechnologies, as well as motivating the development of ever more sophisticated tools and practices. The performance raises questions about our role as conductors of proceedings.

Aliveness and the gradience of animation

Our actions on stage are organized along a symbolic gradient of 'animation'. We imagined the performance following a 'production line' that narrated a gradual transformation of matter. Banana husks and tree trunks are chopped, hacked, crushed, pulverized, torched and burned, reduced to ashes; pork meat boiled, fat rendered and sieved. Ashes soaked in water and turned into potash. Droplets released into fatty acid; liquid compartments breaking up, membranes trembling and clambering up an invisible gradient. Matter is transformed gradually, animated for a few seconds—an animation that ends when a temporary balance with the milieu is achieved. The chemical bonds in the membrane rupture and small lumps of soap are created, leaving a trace of glycerol.

[{figure5}]
[{figure6}]

The performance follows matter through its journey from a 'lower' level to animation to the few seconds in which it would climb the 'animation ladder', inspired by the notion of 'vibrant matter' introduced by Jane Bennett (2001, 2009) that seeks to destabilize the notion of life, arguing that much of our political systems and ways of socializing are organized by what she calls 'a partition of the sensible' (vii): a scale of values that privileges entities that are capable of thought and self-reflection. This framework, according to Bennett, justifies a consumerist society, which sees so-called inanimate matter just as a mere resource that can be used and chucked away. The notion of vibrancy invites a different understanding of matter, one that challenges the divide between living and non-living and encourages a different way of organizing ourselves as society. Feeling some attachment to 'stuff', contemplating in awe their different levels of vibrancy, would make us less inclined to throw it away.

[{figure7}]

For us, the notion of vibrancy was crucial in understanding our performance as a reflection and critique of biotechnologies, in general, and synthetic biology, in particular. In 1911 Stéphane Leduc introduced the term ‘synthetic biology’ to describe an analytical tool to understand biological morphology. For Leduc, all scientific disciplines start by observing, classifying and deriving principles—an analytical phase. It is only until the discipline has matured enough that it is able to validate its claim to knowledge by synthesizing, using principles to produce minimal units of study. The modern synthetic biology takes this proposition to its logical consequence and builds on principles of standardization, control and predictability (Campos 2009). Underlying the discipline is the partition of the sensible: living matter becomes a new resource to be harnessed and marketed, a ‘premium’ form of matter. As Oron Catts and Ionat Zurr astutely observe, the mindset of synthetic biology reveals a living world that ‘provides a seemingly rich yet largely unexplored medium for controlling and processing information, materials, and energy’ (2014: 28). Life is, indeed, the final frontier.

The notion of vibrancy enables a reframing of our understanding of matter and, crucially, allows for proposing a flat ontology. There is no living and non-living matter (with the forced inclusion of a semi-living category). Instead, in such an understanding, matter is capable of different levels of ‘liveliness’. A dissolution of boundaries, however, has consequences on the way we conceptualize performativity and how we organize ourselves on stage.

Protocells as performers

Locating matter across a gradient of vibrancy suggests a capacity to perform. Jens Hauser (2006, 2017) describes how art practices have historically used symbols and signs to represent ‘life’. Biotechnological art implies a shift to biotechnological procedures that take life not as a thematic point of departure, but as a medium of expression. Representation, simulation, metaphor and image production give way to re-materialization based on principles of authenticity and presence. Paralleling

philologist Hans Ulrich Gumbrecht's writing on the 'production of presence' (2004), Hauser argues that biotechnological art forms are essentially preoccupied with a 'production of presence' that, in many cases, emphasizes multiple non-human agencies, described as 'microperformativity'—a term that describes the focus on the microscopic to produce 'an interplay of non-human actors that carry out a dazzling spectacle' (Hauser 2017: 267), turning the spotlight onto the complex interaction of 'bacteria, microbiomes, phytoplankton, and extremophiles' and their 'agencies and potentials to synthesise' (263).

In Living Ashes II, it was important for us that our audience felt the serrated knife cutting through a tree trunk, the warmth as banana husks are burnt and the crackle of fat as it is rendered off a piece of hock. We believe that our argument for a dissolution of the categories of living and non-living matter lies in drawing our audience's attention to the aliveness and vibrancy of protocells as they climb the ladder of animation for a few seconds, just before the chemical bonds in the triglyceride molecule rupture and the interfacial tensions halt.

[{figure8}]

However, there are two elements in our performance that are seemingly at odds with the notion of vibrancy. For example, we stand in front of each table wearing white coveralls and mask respirators and devised a sign language to communicate on stage, expanding the range of actions beyond those involved in manipulating matter to produce protocells. We used these tactics to create sites of transference and porosity across the membranes in our performance. As suggested by Hauser, biotechnical art forms often require strategies to contextualize such transformational processes, directing the audience's attention towards the 'presence' of organisms. While some practitioners chose to use a 'lecture setup' and provide a talk to the audience, we were keen to communicate with our audience in non-linguistic ways.

The choice of costume was influenced by our collaboration with biologist Martin Hanczyc (2008) and the way his research locates protocells as a model to understand the conditions that allowed inorganic matter to organize into a primitive form of life. We reinterpreted protocells in the context of a primeval life production

into a contemporary ‘assembly line’, an allusion reinforced by the factory aesthetics lend by the setting of the CLICK Festival in the old shipyard of Helsingør and the use of work-wear that reinforced these symbolic elements. Our choice of work-wear, however, also invokes the debate of the laboratory aesthetics and the ‘problem of absorption’. Simoniti (2017) describes how artistic practices that draw on biotechnologies often risk being absorbed by them and, as a result, interpreted as a subsidiary practice. In our performance the colour of the coveralls is evocative of white lab-coats and, on a symbolic level, strongly suggests that everything on our tables might be read through the interpretative framework of science.

[{figure9}]

A similar slippage is at play in our use of a sign language. While preparing for the performance, we created a sign language to communicate when we needed to manipulate the microscope to amplify the image and move across the microscopic stage. The click of the objective lenses as they revolve and snap into place, the friction of the coarse adjustment knob and the texture of the diaphragm ring produce a bodily experience as the image gets closer to the protocells. The same experience, however, is not shared by the audience. There are cues in the image—objects become bigger, parts disappear out of the borders, motion blurs as the stage is moved—but the visual vocabulary of our audience hasn’t been built up to link these to the awareness of their position in a microscopic stage. We decided to create a system of gestures and mime actions to communicate on stage—a palm moving down to increase magnification, a rotating ‘claw’ to adjust focus, a palm facing down and moving horizontally to move the stage—hoping that these actions would also allow the audience to understand their situation in the microscopic image.

The choice of aesthetics and our sign language suggest difficulties in conceiving of the agency of microscopic life in its own right. To think of the capacity of matter to perform supposes a level of non-human agency: the ability to produce a somewhat independent action and have an effect in their environment. There is, however, a long-standing tradition of understanding matter instrumentally. As Barbara Bolt reminds us:

> In the theory of means and ends that dominates our contemporary understanding of the artistic process, we tend to focus on the instrumental use of tools and materials to make an artwork. According to this view, the artist and craftsperson is the one who exercises mastery over his/her tools and materials to produce an artwork. In harnessing means to ends, the artist justifiably can sign her/his name as the one who has made or caused a work of art to come into being. (Bolt 2007: 1)

Although our performance was articulated around the notion of re-conceptualizing matter as having fluctuating levels of vibrancy, a more traditional frame of reference locates matter as being subject to the mastery and agency of the artist. On a symbolic level, the audience might struggle to follow the actions performed by the protocells, even if they are magnified by microscope. To appear convincing, the agency of microscopic life needs to be complemented by human action. Once these referents are in place, we can suggest a different narrative and destabilize assumptions of what is alive, and what counts as performer on stage.

[{figure10}]

Conclusion

There are chemical boundaries that allow for vibrancy and performativity, as suggested by our exploration of protocells and the way that their locomotion is fuelled by the rupturing of chemical bonds that thicken and thin their membrane. Other boundaries are produced by the way that biotechnologies have absorbed creative practices around living matter, creating numerous sites of exchange and contamination that make it harder to create a narrative wholly independent of scientific referents. But as our exploration here suggests, perhaps the most challenging boundary to negotiate is that between the symbolic and the processual.

Although bioart can be understood through its progression from a symbolic to a material engagement with life, the membrane dividing both is highly porous, resulting in myriad combinations of human and non-human performativity. One crucial

challenge is in understanding the tactics that allow an audience to understand the transformational processes that take place in front of them. Here we have described a few, drawing on strategies of epic theatre that, we believe, contributed in the production of presence. These tactics, however, are always entangled in a dense matrix of symbolic associations, generating conflicting messages that can undermine our express ethos of dissolving the divide between living and non-living matter.

It is also important to remember that agency of microscopic life is a notion in flux, constantly reconfigured by the cultural context in which it operates. The creation of presence—and the willingness of the audience to believe our account of the transformational processes on stage—will inevitably change as claims to truth shift (Baggini 2017). In a 'post-truth' reality defined by deep fakes, it will become increasingly difficult for audiences to suspend disbelief and engage with mediated performances at the microscopic scale.

These challenges compound the technical difficulties that we already face as performers—working with living matter often involves setting up contingency tactics for when things simply won't work. In our performance, these tactics took the form of pre-recorded clips. Despite our efforts to make sure the audience was aware of the change of modality, we also opened the possibility for confusion and to make our claim to co-corporeality harder to communicate and validate. We believe, however, that these new challenges will push us, as a field, to explore new tactics to create sites of exchange between inside and outside so that our audiences engage with microscopic life.

Notes

1 CLICK is an annual festival in Denmark that explores the intersection between contemporary art, science and technology. The 2016 performance and art programme was dedicated to 'microperformativity' and curated by Jens Hauser. See: clickfestival.dk

2 Knowing that it was difficult to replicate the exact same conditions of our kitchen-workshop on stage, we recorded the performance of protocells as we tested the protocol. We kept the footage in case we failed to produce protocells on stage and although we did succeed, we incorporated some of the clips, switching modalities from live action to recording at the end of our performance using sound and light to signal the shift.

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Captions

Figure 1. Living Ashes II at the CLICK Festival in Helsingør, Denmark.

Figure 2. Protocells with green colorant and ash traces.

Figure 3. Working on our improvised lab days before the performance. We began by testing different combinations of lye and oil in an attempt to understand the performance of the ‘membrane’

Figure 4. Exchange between three protocells as they merge and break apart.

Figure 5. Members of the audience look at the stage minutes before the performance.

Figure 6. Central stage. The digital microscope is used to capture the performance of protocells, which is then projected in the screen at the back.

Figure 7. We organized the performance as a series of actions or ‘stations’ that enact the material transformations that lead to protocells.

Figure 8. Key events in the emergence of protocells. A lye solution is dropped in oily media resulting in a droplet that fragments and jitters.

Figure 9. Performing alongside protocells. Carolina (left) delivers and mixes chemistries in the Petri dish; Luis (centre) manipulates the digital microscope, communicating with the other performers through a sign language; Pei (right) mixes sound and phrases that are projected on top of the video feed (shown at the back).

Figure 10. Protocells projected. As the performance ended, we dimmed the lights in the hall and showed a few additional seconds of protocell footage.