**Living Ashes: Associated Milieus and Distributed Agencies**

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Abstract

We document and reflect on Living Ashes II, a performance with protocells developed as part of the 2016 *Click* Festival in Helsingør. Protocells are animated by their membrane; they are formed by an alkali solution that is 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 membrane as a tool to explore the conceptual and technical hurdles we encountered as we attempted to bring the microprocesses of semi-living matter to the mesoscopic bubble of a human audience. As the chemical variations animate the membrane of protocells, we propose to use these difficulties to explore the material and conceptual boundaries the performance animates and temporarily dissolves. We follow an autoethnographic approach to understand the way that membranes influence the way we understand microperformativity, and the challenges faced by performers in working with living systems on stage.

Preface

At 18:16 on the 21st of May 2016, a group of protocells performed in front of an audience in Helsingør, Denmark. An assemblage of chemistries, oil and lye, come together and form a droplet which immediately fragments into three. It lies still for three seconds, jitters and starts its slow clamber following invisible, chemical waves. Three people stand in white coverall defenders and gas masks. They transmute ‘inert’ matter into animation; they hack, torn and burn; ashes, fats, and oils appear. For a few seconds, protocells dance.

1. Introduction

Living Ashes II emerged out of a desire to stage the chemical processes involved in extracting the raw ingredients of protocells, and to explore the moment where inert matter 'performs' a brief chemical dance. In a previous edition of the project we had explored the creation of protocells, documenting the process through short films and ephemera in the form of soap. Producing the short films enabled us to reflect on the sense of situatedness within the microscopic stage -- as operators of the microscope, we were aware of the instrument operations involved in changing magnification and moving across the microscope's stage. Understood in the context of micro-performativity, a *co-corporeality* with the instrument allows the human performer to develop a microscopic *proprioception*: a sense of awareness of how each operation affects their situation within the boundaries of the observed world. An audience, however, hasn't developed this awareness and struggles to understand how each magnification and pan movements change their 'situation' in the microscopic image, which makes it challenging to communicate these shifts in a short film. Living Ashes II started as an exploration of co-corporeality and proprioception in staging protocells.

The notion of vibrancy and matter are crucial in understanding the performance as a reflection of our own practices. We come together as a group with a medley of backgrounds and interests -- collectively, we are artists, designers, architects, researchers, academics. Our work follows a creative practice approach and, influenced by the work of Karen Barad (2001) and Dona Haraway (2013), we cross disciplines, themes and methodologies ranging from biodesign to bioart to materials to digital computation. 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.

2. Materiality of protocells: the membrane

Protocells are conceptually animated by boundaries. 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* (1998). Advances in chemistry in the 19th century challenged the boundary separating living and non-living matter and in 1828, Frederic Wöhler synthesised urea in the laboratory without the use of a living kidney, demonstrating that organic molecules could be derived from inorganic ones (Hanczyc, 2013).

The work of Wöhler would serve as inspiration for the first models of artificial cells. In 1867 Moritz Traube reported that releasing a drop of copper sulphate solution in potassium ferrocyanide generates a thin layer of copper-ferrocyanide precipitate. The resulting red boundary acts as a barrier between the precipitate and the potassium ferrocyanide medium, preventing any further 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. Bütschli managed to generate a primitive form of amoebas 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, 2009).

The Bütschli model of protocell are materially animated by their membrane. When mixed together, 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 in a droplet, potassium hydroxide triggers a saponification process at the interface between the two liquids, the one contained in the droplet compartment and the medium surrounding it. The energy produced by the chemical bonds in the triglyceride molecule rupturing 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 other 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.

We take the materiality of protocell membranes to explore our performance and discuss issues of micro-performativity and ‘liveliness’. There are two conceptual membranes that animate our understanding of protocells and the way we can frame it as a form of non-human agency and ‘performer’: the negotiation of porosity and transference in scientific and ‘performative’ membranes; and the boundary between living and non-living matter. We mirror the liveliness of the material boundary animating protocells to reflect our way through the implications of this performance.

3. Petri dishes and the fourth wall

We arrived in Helsingør six days before the performance took place, using the time to setup our stage at the festival and collect some local materials. The organisers had helped us to order a few instruments in advance and found an accommodation where we could set up 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 as described in the original protocol and the ones that were closer would not last long enough to capture in the microscope. The following days became an exploration of the membrane. We realised 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 protocol. We had first used the Bütschli protocol during the first edition of Living Ashes, following the implementation of our collaborator Martin Hanczyc (2013; 2014; 2007). While preparing for the performance, we relied on our experience to replicate the processes but without being fastidious about validating weights 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, controlling and registering environmental, any modifications had to be slight variations on the original protocol. This change of tactic, from operating within a creative appropriation of the protocol to being articulated by the protocol itself, generates a shift in our practice. Instead of imagining our performance as an exploration of the membrane of the protocells and its potentiality to ‘animate’ matter, we restructured our performance around the edge of the petri dish. The dish generates a boundary of isolation which allows us to control conditions -- temperature, humidity, density, molarity -- and delineates other strategies and contingencies. 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. 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.

The boundary articulated by the wall of the petri dish also constrains our practice to the workings of laboratory work, where boundaries are intentionally drawn to favour the happenings of specific experiments. Sandra Kaji-O’Grady and Chris L. Smith (2016) have written of the importance of membranes in articulating the space of scientific laboratories. These boundaries are topologically dynamic, initiated and extended by the sealed containers that are used to carry out experiments and introduce new substances, such as the petri dish in which protocells are made possible. And although they are primary designed to contain contaminants, membranes also carry potentialities: they are articulated in thick assemblages of instruments, policies and people that make them porous sites of transference between organisms and contaminants. Membranes are designed to contain and to negotiate transference between the exterior and the interior: they are dynamic and animated.

Our use of petri dishes articulates our practice around the boundaries of scientific. By placing the performance on stage however, we extend the formal mechanism of porosity that are used in the laboratory to negotiate transference between the inside and the outside. Living Ashes II was a production based on the existing installation and video recordings of Living Ashes I but, unlike its predecessor, it borrows the

form of theatre performance with an urge to invite the audience to witness the animation of artificial life oblivious of its scientific explanation. Living Ashes II borrows the language of theatre in hoping that the boundaries of ‘stage’ will gain an adequate distance for the audience from scientific protocols to be emotionally immersed. The thick assemblage making up the membrane in a laboratory is rearticulated in our stage.

In western modern drama, the stage exists as an enclosed environment bounded by the ‘fourth wall’ where the actors and props has their own dimension and the audience merely 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. In Brecht’s epic theatre, actors intentionally speak to the audience as a method of alienation to facilitate reflections. In films and TV, actors talk towards the camera as a way to ‘break the fourth wall’ (Benjamin and Bostock, 2003; Reinelt, 1996). The overlapping of boundaries in our performance create an equivalent to produce sites of transference between the inside and the outside. Projecting live imagery of the microscope creates a stage within a stage. The vibrancy - or in scientific terms, the reactions - of protocells happen between the membrane between fat and lye, which marks the minimum scale of boundaries exists in Living Ashes II settings. The second boundary -- the petri dish -- remains comparatively sterile. Whereas the third boundary - the microscopic projection manipulated by the performers live, constantly adjusting at different magnification scales and positions, occasionally make aware the edge of petri dish hinting the interaction across the inside and outside.

4. Microperformativity, when a prop becomes a performer

Our tactics to create sites of transference 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 generated 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.

4.1 Aliveness and the gradience of animation

The actions on stage are organised 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, pulverised; torched and burned, reduced to ashes. Pork meat boiled, fat rendered and sieved. Ashes soaked in water and turned into potash. Droplets released in fatty acid; liquid compartments breaking up, membranes trembling and clambering up an invisible gradient. Matter is transformed gradually, animated for a few seconds that end 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.

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 notion of vibrant matter. Jane Bennet (2009, 2001) looks to destabilise the notion of life, arguing that much of our political systems and ways of socialising are organised by what she calls ‘a partition of the sensible’: a scale of values that privileges entities which are capable of thought and self-reflection. The framework justifies a consumerist society which sees so-called inanimate matter as a resource that can be used and chucked away. For Bennet, the notion of vibrancy allows a different understanding of matter, one that interrogates the divide between living and non-living and gives way to a different way of organising ourselves as society. Feeling some attachment to ‘stuff’, contemplating in awe their different levels of vibrancy, would make us less inclined to throw them away.

The notion of vibrancy was crucial in understanding the performance as a reflection and critique on Synthetic Biology and biotechnologies. The ‘old’ Synthetic Biology is one of contemplation. In La Biologie Synthétique Stéphane Leduc (1911) describes

synthetic biology as understanding biological morphology through experiments carried outside biological systems. 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 synthesising, using principles to produce minimal units of study. The modern Synthetic Biology takes this proposition to its logical consequence and builds on principles of standardisation, 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 which 'provides a seemingly rich yet largely unexplored medium for controlling and processing information, materials, and energy' (Catts and Zurr, 2014: 28). Life is, indeed, the final frontier.

The notion of vibrancy allowed us to reframe our understanding of matter and, crucially, propose a flattening of categories. There is no living and non-living matter (with the forced inclusion of a semi-living category). Instead, we have matter capable of different levels of 'liveliness'. A dissolution of boundaries however has consequences on the way we conceptualise performativity and how we organise ourselves on stage.

### 4.2 Microperformativity

Locating matter across a gradient of vibrancy suggests a capacity to *perform*. Jens Hauser (2017, 2006) describes how art practices have historically used symbols and signs to represent life. Bioart implies a shift, using life not as a theme but a medium of expression. Representation, simulation, metaphor and image production give way to a process of re-materialisation based on principles of authenticity and presence. Life is not only represented and alluded to, as it is often the case in other art practices, but instead presented on stage with a range of strategies to transfer knowledge to the audience to acquaint themselves with the 'transformational processes' taking place. Borrowing the term of philologist Hans Ulrich Gumbrecht (2004), Hauser argues that bioart is essentially preoccupied with the 'production of

presence' (2006). Bioart seeks to create an impact on the body, to appeal to the senses rather than to transmit meaning.

One important concept in Hauser's reading of bioart is microperformativity, a term describes the shift from the symbolic to the processual while signalling the focus on the microscopic to produce 'an interplay of non-human actors that carry out a dazzling spectacle' (2017: 267). For Hauser, Art has historically shown an interest in 'aliveness', expressed in the imagination, representation and mimicking of living phenomena. The interest takes a turn in media art, where life can be simulated and staged, imitated mechanically and electronically. Bioart transforms this interest and reinterprets it in the direct manipulation of life, bringing the spotlight to the complexity of 'bacteria, microbiomes, phytoplankton, and extremophiles' (p. 263) and their 'agencies and potentials to synthesise' (*Idem*)

Although we would contest Living Ashes II inclusion in bioart, we coincide in the interest of presence and materiality. For us, it is important that our audience *feels* the serrated knife cutting through a tree trunk, the warmth as banana husks are burnt and the crackle of fat as it's rendered off a piece of hock. We believe that our capacity to argue 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.

There are two elements of our performance that are seemingly at odds with the privileging of the processual and the notion of vibrancy. In the performance, we stand in front of each table wearing white coverall and mask respirators. Moreover, we devised a sign language to communicate on stage, expanding the range of actions beyond those involved in manipulating matter to produce protocells. These tactics are part of the tactics we've used in creating sites of transference and porosity in the membranes enacted by our performance. As suggested by Hauser, bioart often requires strategies to contextualise the transformational processes taking place, making the audience aware of the 'presence' of life. While some practitioners do this using a 'lecture' setup, where they provide a talk to the audience to explain the operation of an installation for example, we were keen to communicate

with our audience in non-linguistic ways. The workwear and sign language draw on a network of symbolic meaning which enable us to situate the audience within the broader discourse of our practice. As it is often the case with symbols, however, the notions we want to invoke are entangled with others that operate against our discourse of dissolving the boundary between living and non-living matter.

The choice of costume was influenced by our collaboration with Martin Hanczyc and the way his research locates protocells as a model to understand the conditions that allowed inorganic matter to organise into a primitive form of life (Hanczyc, 2013, 2009). The context of a primeval earth suggested the organisation of the performance in a 'production line', reinforced by the factory aesthetics lend by the setting of the Click Festival in the old shipyard of Helsingør and the use of workwear that reinforced these symbolic elements. Our choice of workwear, however, also invokes the debate of the laboratory aesthetics in bioart and the 'problem of absorption' that bioart has developed as a result of its proximity to biotechnologies (Simoniti, 2017). The colour of the coveralls is evocative of laboratory white coats and, on a symbolic level, strongly suggest that everything in our tables is read through the interpretative framework of science. The reading is further reinforced by our use of labware. Although we tried to keep the use of laboratory glassware to a minimum, the use of heat on stage and the alkalinity of the solutions we were using required borosilicate glass and the form factors of beakers, petri dishes, conical flasks and funnels.

A similar process of slippage is at play in our use of a sign language. While preparing for the performance, we created a sign-language to communicate manipulation of the microscope. As described in the introduction, we were interested in exploring the proprioception and co-corporeality that develops when manipulating a microscope to shift magnification power and navigate the 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 blur 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 in 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 microperformativity 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-conceptualising matter as having fluctuating levels of vibrancy, the frame of reference of our audience locates matter as being subject to the mastery and agency of the artist. On a symbolic level, the audience would struggle to follow the actions performed by the protocells, even if they are magnified by microscope. To appear convincing, microperformativity needs to be complemented by human action and allusion to the ‘authority’ of science. Once these referents are in place, we can suggest a different narrative and destabilise assumptions of what is alive, and what counts as performer or as a prop on stage.

5. Conclusion

Bioart is animated by its membranes. 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 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, there membrane dividing both is highly porous, resulting in myriad combinations of human and nonhuman performativity. One crucial challenge to practitioner 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 dense matrix of symbolic associations, generating conflicting messages that can undermine our express ethos of dissolving the divide between living and non-living matter. We hope to implement other tactics in future editions of Living Ashes, for example, allowing audiences to produce their own protocells in satellite stages.

It is also important to remember that microperformativity 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 take place in stage -- will inevitably change as notions of indexicality and 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 microperformativity.

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