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Liquid Crystals: A Roundtable

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Abstract
This Roundtable began life as a public event on the subject of liquid crystals in our visual, material, media, scientific and artistic cultures. The event's premise was that liquid crystals are the ur-form that constitute and govern Modernity and its after-shocks. For sure this is because the dialectic of liquidity and crystallization, of flow and refraction, is key to the advent of screen-based media (LCD TVs, computers and mobile devices) and thus how we perceive, image and imagine the world. As such, liquid crystals as a 'phase of matter' are epochal. But more than this because, while the emergence of such a brave new world is manifestly contemporary and their 'discovery' is comparatively recent (1888), the very fact of liquid crystals goes back at least 4.5 billion years: water, for instance, is crystalline and thus our planet, our ecology and we ourselves are always already liquid crystal. Such a self-evident but under-acknowledged fact, discerned and foregrounded superbly by Esther Leslie in her recent book *Liquid Crystals: The Science and Art of a Fluid Form* (2016), becomes an occasion to bring together historians, theorists and practitioners of the convergences of design-science, media-ecology, political-aesthetics, and graphic-technologies. Using Leslie's book as a springboard, each of the five contributors, including Leslie herself, were invited to deliver a 10-minute presentation, an opening statement to set the scene, and raise fundamental questions to be considered further in the ensuing discussion. This structure is retained here, along with some of the informality that live conversation affords.

Keywords
DNA • earth minerals • life • liquid crystals • media ecologies • screen-based media • tactile vision • X-ray crystallography

Emily Candela (EC): The experience of reading *Liquid Crystals* mirrors the dialectics of the fluid and crystalline that characterize the 'liquid crystal epoch' described in Esther Leslie's book: the narrative flows unfettered by the limitations of discipline boundaries such as those between the histories of science, art, technology and design. As in an animated film, however, this flow unfolds as a series of pauses. A constellation of distinct moments and images generates Leslie's dialectics of liquidity and crystallinity: from Caspar David Friedrich's 1824 painting *The Sea of Ice* and early images of liquid crystals produced in the 19th-century German physicist Otto Lehmann's laboratory, to the looting of flat-screen TVs during the 2011 London riots and the 'slosh' of data between the little screens in our pockets.

A central thread developed by this liquid-crystal dynamic is the question 'what is life?' and its pursuit in the period covered in the text, from the early 19th century until today. This is, in one sense, a scientific question. The complexity of determining what falls on either side of the boundary between the living and non-living becomes apparent through the history of reflections on crystals, which have at various moments in the history of science teetered on the edge of this boundary. This is in part due to early observations of crystals' life-like attributes – their capacity to grow, self-assemble or even to become 'wounded' (Leslie, 2016: 37, 38).

The science of crystals acquired new entanglements with the investigation of the nature of life in the 20th century with the introduction of X-ray imaging technologies that meant scientists could probe the internal structures of crystals. The 'what is life' question animated the work of many mid-20th-century X-ray crystallographers, who visualized the sub-microscopic structures of matter, from minerals to proteins and viruses.

The techniques of X-ray crystallography, which developed in the early 20th century, allowed scientists to generate data about matter at the scale of structures of atoms and molecules. By beaming X-rays through a crystal, which diffract off the atoms inside, crystallographers are left with a coded pattern etched by the diffracted X-rays, which – when de-coded – reveal a crystal's internal atomic structure. While the field of X-ray crystallography began with investigations of substances more conventionally thought of as crystals, such as salt, crystallographic techniques were soon applied to the materials of life. The most well-known example of this is Rosalind Franklin's X-ray crystallographic analysis of DNA that led to the elucidation of its double-helix structure in 1953.
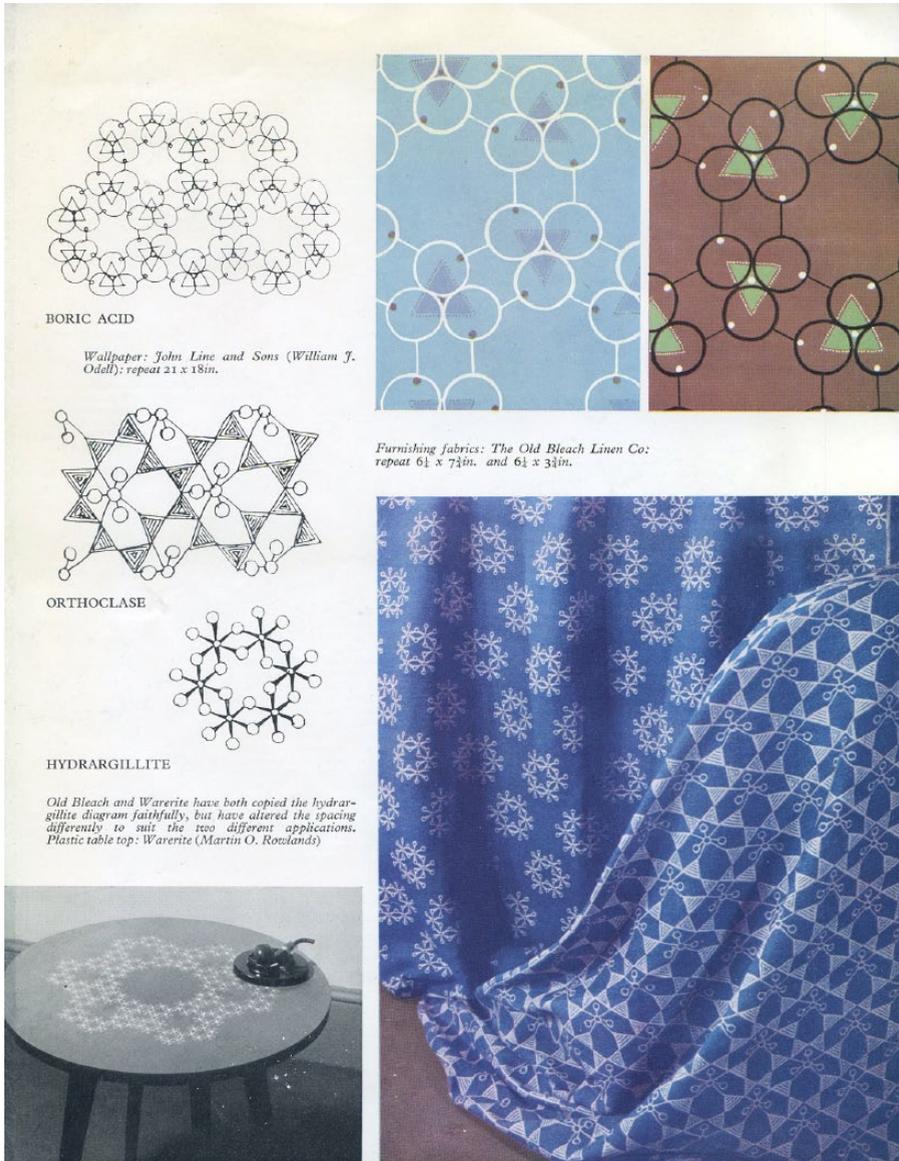
X-ray crystallography's uses in the growing field of molecular biology produced conceptions of life understood through molecular and atomic structure. Models and diagrams of organic matter, such as Francis Crick and James Watson's DNA model constructed of hard metal plates, clamps and rods, see biological subjects frozen in time. Such models broadcast new materialities for the invisible underpinnings of life, which took on abstract forms decipherable only by the expert (Figure 1). Some of these forms were nevertheless exhibited in 1951 at the Festival of Britain in the context of products for the home. The Festival Pattern Group, a consortium of manufacturers, designers and a scientist, the crystallographer Helen Megaw, showed a series of objects

Figure 1 Watson and Crick's reconstruction of the double helix model of DNA (1953), which is on display in the Science Museum. Science Museum Group Collection © The Board of Trustees of the Science Museum.

bearing so-called 'crystal designs' (Hartland Thomas, 1951) (Figure 2). Their surface patterns for wares such as carpets, wallpaper, glass and metal were derived from crystal structure diagrams of both inorganic and organic substances, such as insulin and haemoglobin (Figure 3).

It was the crystallographer JD Bernal's interest in life – particularly the function of water in living things – that led him outside the territory of ordered periodic crystal structure in his attempt to model the configuration of a liquid. In the late 1950s, he devised a very unconventional process to do so, one that was designed to ensure the production of a ball-and-spoke model with as random an arrangement of atoms (or balls in this case) as possible. He built the model in his office at Birkbeck College where he knew he would be interrupted, as he later explained, 'every five minutes or so', after which he would return to work each time 'not remembering what I had done before the interruption', thus achieving a disordered arrangement of balls and spokes (Bernal, 1964[1962]: 301–302; Brown, 2005). Bernal's process resembled a choreographed chance operation dependent upon the disruption of the scientist's flow. It resulted in a physical structure for liquid's essential randomness, part of Bernal's

BORIC ACID

Wallpaper: John Line and Sons (William J. Odell): repeat 21 x 18in.

ORTHOCLASE

Furnishing fabrics: The Old Bleach Linen Co: repeat 6¼ x 7¾in. and 6¼ x 3⅜in.

HYDRARGILLITE

Old Bleach and Warerite have both copied the hydrargillite diagram faithfully, but have altered the spacing differently to suit the two different applications. Plastic table top: Warerite (Martin O. Rowlands)

Figure 2 Selected Festival Pattern Group products and the crystallographic diagrams from which they were derived, featured in Mark Hartland Thomas, *The Souvenir Book of Crystal Designs* (London: Council of Industrial Design, 1951), p. 9 © Design Council Archives.

work, ultimately, towards the notion of water as a 'random network' and a representation of a vital element of the flow of life arrested (Brown, 2005; Finney, 2007: 40) (Figure 4).

Bernal's model overlays two visions at once: the crystallographic impulse towards structural understandings of life, on one hand, and the impossibility
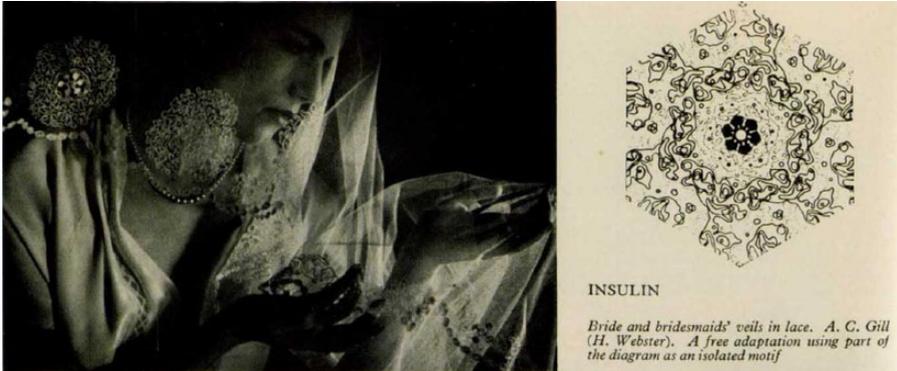
Figure 3 Crystallographic diagram of insulin (right) and lace pattern derived from it (left) as part of the Festival Pattern Group project. Mark Hartland Thomas, *The Souvenir Book of Crystal Designs* (London: Council of Industrial Design, 1951), p. 4 (detail) © Design Council Archives.
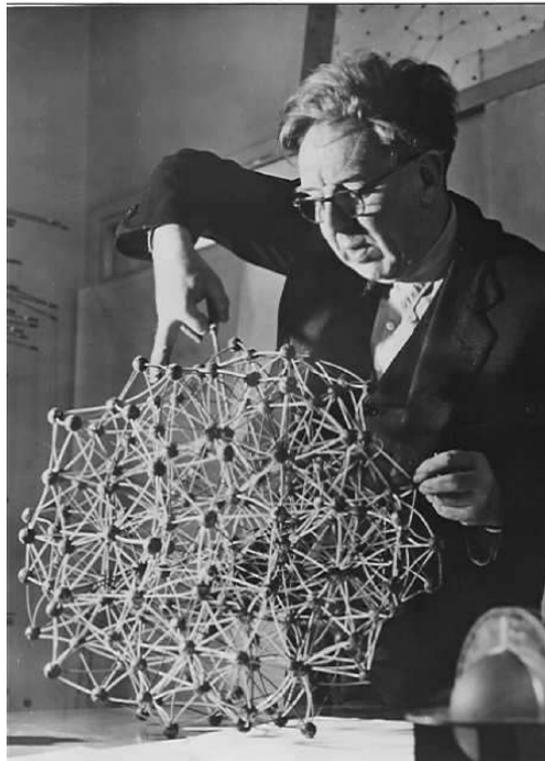

Figure 4 Bernal building a model of a liquid in his office. © John Finney.

of ordered structure in liquid matter, on the other. This, alongside Bernal's flow/freeze/flow/freeze pattern of working that generated his model, mirrors some of the relationships between the frozen and fluid in Leslie's 'liquid crystal epoch'. The crystal and the liquid are constantly overlaid: in animation's freeze-frame flux, or money's dual mobility ('a lubricant that makes life slippery', she writes, Leslie, 2016: 14) and fixed value.

As such, the question 'what is life?' is not only about biology in the book (nor was it for Bernal, whose work also encompassed political activities, future speculation on human civilization and forging links between his scientific research and the work of artists and architects). Leslie's liquid crystal dialectics reflect on *life* in the sense of both biology and lived human experience, addressing the social and economic structures of time, for instance, and contemporary mergings of screen, body and consumption in the liquid crystal display. In exploring the liquid crystal as a scientific concept, a phase of matter and of social life, a technological affordance and a worldview, Leslie exhibits a fluid form of interdisciplinarity. The resulting dialectics of the fluid and crystalline cut new slices through the histories traversed in the book, including, perhaps most significantly, the conditions of the technological history of now. *Liquid Crystal* thus reveals the possibilities for critical work that crosses boundaries between 'art and science', not for the sake of uniting disciplines in itself but because the paths traced by a material, object, metaphor or state lead us across them.

Esher Leslie (EL): The poet–botanist Johann Wolfgang von Goethe was keen to undertake optical experiments. He reports results on a series of observations relating to what he calls 'epoptical colours', also known as interference colours, which appear intensely when there is a crack in crystal, if lenses or other hard transparent bodies are pressed together, is spied in the bubbles of liquid, chocolate, wine or glass, in heated metal or decaying glass, or in breath on glass. Goethe reported on the last of these conditions. He narrowed his eyes and stared at the sun in order to make prismatic patterns of light play on the inside of his eyelids. At other times, he breathed on cool surfaces, producing a film of condensation on which optical effects took place. His description of one such test reads like a sketch of animation, as both process and product:

> If after breathing on a plate of glass, the breath is merely wiped away with the finger, and if we then again immediately breathe on the glass, we see very vivid colours gliding through each other; these, as the moisture evaporates, change their place, and at last vanish altogether. If this operation is repeated, the colours are more vivid and beautiful, and remain longer than they did the first time. (Goethe, 1840, para. 455: 189)

Goethe here evokes things that are pertinent to animation: reiteration, movement, fleetingness and transformation. There exists a maker, who, in this case, quite literally breathes the life – if we can call it that – into the vibrancy produced of breath and glass. This maker then abrades the deposit on the glass with a finger dab and finds thereby that the hues and

tints are fortified. These colours too have their own life – they glide and slide, evaporate, rearrange and dissolve. The materials, breath on glass, in their combination, seem to have a life, possess their own life. In another experiment, or perhaps a result of just an everyday journey on a frosty day, Goethe detected how his breath misted the window inside the carriage. On this window, there appeared 'the most vivid play of colours', intensified by the external darkness (para 458: 190–191). A kaleidoscope on black. These screens onto which Goethe exhaled were panes of glass with twirling colours and figures, so evanescent they could not be captured.

In a cycle of 24 erotic poems titled *Roman Elegies*, from some 20 years earlier, in 1788–1790, Goethe wrote the following, as he recalled tapping on his lover's back: 'See with a hand that can feel, feel with a hand that can see' ('*Sehe mit fühlendem Aug, fühle mit sehender Hand*', Goethe, 1994[1788–1790]: 106). The line was occasioned by his reflection on how caressing a woman's skin made him see marble anew. Paul Klee rephrased this sentiment in 1911: 'one eye sees, the other feels' (Klee, 1964[1898–1918]: 310). An artist–lover's consideration of form and life merges and confuses the senses. But is there an ur-form at work in Goethe's drumming on skin, a form of seeing and a form of touching that has the future coiled within it? Is this a flash-forward to the contemporary seeing that is feeling, the tactile vision of the scanning electron microscope, or the touch screen, which collapses seeing and touching onto one surface?

Goethe's glass panes onto which he breathed, anticipate – but pervert too, and address more tenderly than may be possible for us – a contemporary object, an iPhone, an iPad, a tablet. They look forward to any glass surface on which lively colourful, twinkling events take place, an enlivened surface, in the shape of the touch screen, in relation to which humans become something like an object of the subject that is not us but rather the glassy surface. The touch screen user becomes an object of marketing and surveillance, with every click and every touch of the screen, or in other words, an object, or function, for it. The touch screen loops visual entertainment back to its machine-driven origins, when a glut of apparatuses stimulated the haptic–optic mode of experience, each viewer fiddling with a crank, a handle, a drum, flicking small rigid pages or peering through a window, while rotating an arm. Contemporary touch screens, in their various types, resistive ones, capacitive ones, surface wave ones, have various modes of operation, which all involve an incorporation of the human body to spark off touch events. The resistive screens respond to any hard object bearing down and producing a connection between two layers, in order to change the electrical field. Other screen types deploy the human (or any other conductor) and its electrical charges, and partaking in electrical fields, operate by discharging electricity in the user or marshalling that user to complete electrical circuits or to disturb the run of waves. From the user, electricity is extracted. The screen is intimate with the body, whose force of pressure can be read and options presented in response. The hand-held machine waits for inputs, desirous of contact. The user's body is legible: fingertip, nail, knuckle. Angled towards the devices, our hands as multiple instruments, our fingers see as they touch. Our eyes touch as we see. Our body is refigured. Of course this was not what Goethe

imagined. But it is a capability imagined in the seeing–touching fingers of the lover, which finds an instrumental form some 200 years later.

The other side of the screen, the side that awaits the touch and monitors the changes in electric state on the screen, is composed of rare earth minerals and metals, highly conductive ones, ones easy to deposit on the glass as a film and optically transparent. The landscape's minerals are splintered into tiny parts and distributed on the surfaces and inside the box that is supposed never to be opened, at least not until its life's end and even then not. From under the ground, from immense cavernous holes in the earth, from brown rock and mud, smashed and grabbed from the crust, elements take up residence inside the glossy pebbles, the black boxes, the smooth white slabs, the rose-gold gewgaws. In Baotou, Inner Mongolia, where masses of these minerals are mined, in environments prepared to accept the hazardous and toxic processing required, the rainwater turns murky from the interminable coal dust of the power stations that operate day and night, and processes compounds for polishing touch screens or colouring glass. This world of light and polish is an elemental one, binding chemical elements for its affects. At Baotou, there is a vast toxic lake, a 'tailings pond' for discarding industrial waste, and it is comprised of a constant flow of sludge, a radioactive clay that has been shed by the city's factories. Perhaps under a certain light this black mire might exude a lustre akin to the plastic of a smart phone's casing.

In this liquid crystal world, a world in which liquid crystal movements are gazed at more often than a lover's eyes, there is no stillness, except for when we command it or when it, the technology, fails. The screen makes all history flow, apparently. At any moment, the screen may freeze a single moment and tumble its viewers into a deep space where nothing is happening and this lurch might be accompanied by a feeling of panic. Space is overcome in composite scenes, multiple tabs and constantly changing contexts. Time is time redoubled, accelerated, so that capitalism can communicate with us, constantly and from every angle. It is time for the whole world to be remodelled, or augmented, through liquid crystals, even three-dimensionally. The cities glow. The city is something we log onto. And the screens will become conveyors of time, in its deepest sense, in the mode that makes sense to us: we will calculate our age in iPhone generations.

When the artist Eduardo Kac seemingly used biotechnologies to create a white rabbit called Alba who glowed in the dark, shock and horror were to be incited at his tinkering with nature. But Alba arrived in a world in which transgenic GloFish© from Singapore, via Yorktown Technologies of Texas, and the TK-1 rice fish, from Taikong Corporation, Taiwan, are a weird but readily domesticated reality. These fish come in trademarked colour lines as Starfire Red, Electric Green, Sunburst Orange. Our second nature, our artificial selves and environments are nothing new, but they promise to develop further. Pets made from our own DNA beckon with our own eyes from a near future.[1] Not only are there screens. We are screened. And we turn ourselves inside out and find liquid crystals. For they are to be found in the body: DNA and cell membranes have liquid crystal phases, muscles contain liquid crystals and our brains are 70 percent liquid crystal. Life

scientists have found them to be the stuff of DNA, which can assemble into liquid crystal phases and self-select, self-orient, self-replicate and chain-up.

If the age of advertising stuff to the masses in the last half of the 20th century spawned an ice-cream dream of consumerism, with all its melt and mess and excess, we now seem, in the age of liquid crystal, to subsist within infinite form, colourful confection and animated rainbow possibility, at every fingertip. The i-Screen is the surface through which everything passes, and the past is conveyed into the present as a resource, endlessly plunderable. Through it, individuals are persistently animated by electronic signals, exploited by the technological machine, but they also learn to become adept at inhabiting various modalities, epochs, experiences, spaces, types of attention, all coursing through the one entryway – where love, commerce, work, play, crime occur sequentially or simultaneously. There is nothing but the screen and the contacts file in the networked society. The screen's diversity of inputs translates into diversity of outputs and each subject 'flexibilizes' himself or herself in response. The artist too – like any other fully flexibilized post-post-modern neoliberal self – will reproduce himself or herself multiple times, as trinket maker, lecturer, showman, shop keeper, TV station boss, comics writer, DJ, record producer, engaging in multiple performance tests … How might this be visualized – through contortions perhaps – twisting a body round so that it can peer up its own anus where the screen is located, as Jana Euler's 'Form Follows Information Exchange 1, 2 & 3' (2010) so explicitly portrays, its mannequin staring at iPad screens located on their backsides …?

And here in the rectal voids of the i-Screen, we find novel times, novel pile-ups and breakdowns, like that of post-continuity editing in newer action cinema and pop videos, a site of flows, of controlled chaos, in which the camera makes no sense of action, but renders only affect, something felt, in staccato snippets of time, hand-held and composited footage randomly segued, a compression, which is felt as a ripping, wounding, violent muddling. These hyperactive worlds of mingling, layering, intertwining, generate new forms of attention, perhaps a 'continuous partial attention' (Stone, 1998). If the viewer – or for that matter the artist – has only half an eye on any one thing, then its registration is made fully elsewhere, in becoming data. Information is produced, even if only as explosive ejaculations of nonsense. Never has more information been so constantly produced and monitored and analysed. The capacity to informationalize even enters into the body, grafted onto our own information centres, in order to be articulated on screens. And where the mid-century quivered in the shadow of the atom bomb, the new century fashions a data bomb. And the human body too is data. It is conceived as a location of tiny happenings that are constant and yet accessed only by machineries – after the stethoscope, MRI, and then bio-feedback processes, whereby the body receives through electrical sensors information about its processes. The body is quantified, voluntarily and as play, in gamification events that measure steps, calorific consumption and the like. In such a world might one configure new life forms, including techno-bodies, something like the psychedelic outputs of Google's 'Deep Dream' artificial neural network, which tends to pepper everything with eyes.

These days animation is not the distorted image of the self rotoscoped into rubbery shapes; animation itself proposes modes of being, is the mode of the liquid crystal working away inside us, as inside our screens, invisibly, visibly. Animation fabricates second lives. It calculates our risks and conveys or mitigates violence. Always intimate with the commodity through advertising, animation now sells future lives, as developers use it to visualize the enclaves they plan to build. Animation has found in art not a rival but a home, as artists gravitate towards this seductive, endlessly re-inventable form. Animation is part of our pasts, even as it models our futures. Animation is the patina that will coat these futures with projections in liquid crystal of enlivened surfaces through Oculus Rift, Project Morpheus, Magic Leap, augmented and virtual reality technologies, which merge data with real world environments, immersing the viewer–participant. Animation in some form or other might train us in these new landscapes of 'second nature', these second lives, this new ontology of data that is mined, grown and harvested. And there is the other landscape, the one that exists in liquid crystal and augments the liquid crystals of the seas, combining with GPS data to guide ships. This one is a virtual trade wind that speeds things along and, as is the capacity of any technology, might be harnessed for other ends, disruptive ones. In the animation project by Will Gowland, titled *Here Be Dragons: The Unstable Landscapes of GPS by _ Unknown Fields Department of Landscape Glitches_Winter 2011_Far North Alaska 71°17'23.2"N 156°46'38.7"W*, digital icebergs, 'protest icebergs', interfere with the paths of oil tankers, which find their way through reliance on the data provided by GPS.[2]

The crystal first and then the liquid crystal were associated with life, or – more starkly – were and are seen as life forms. But the crystal, in its rigidity and in its precision, is also an emblem of death. Liquid is a force of fertility, of dissolving the old and the rotten. But its fatal powers and its affinities to capitalist circulation and the market are not to be ignored. The liquid crystal form was understood by many who saw it first, under the microscope or in drawings, photographs and animations, to be some sort of life form. It is captured in time, incarcerated inside the liquid crystal display, where it is abstracted and works on behalf of representation, illusion-generation, the culture industry. In installing scenes of colourful life, it mingles with, and perhaps occludes – or negates – the lives that apprehend it. What lives might instead have been led in its absence? Are these any longer imaginable or only depictable in liquid crystal? To think liquid crystal, from the sea of ice to the melting poles, is to think against the power of their subsumption and to hold onto their antinomic nature, their presence in us and in the world, their straddling life and non-life, their fantastical nature and their actuality. They are the most familiar thing, yet unfamiliar. To evoke the liquid and the crystal is to oscillate between terror and ecstasy, the poetic possibilities of utopian alleviation and sublime annihilation. Poetizing technology is a way of scooping under the economic and fatal relations in which it is entangled. But it is still a spectator sport, a dream, a wish, a hope that springs up between what is also a fight to the death.
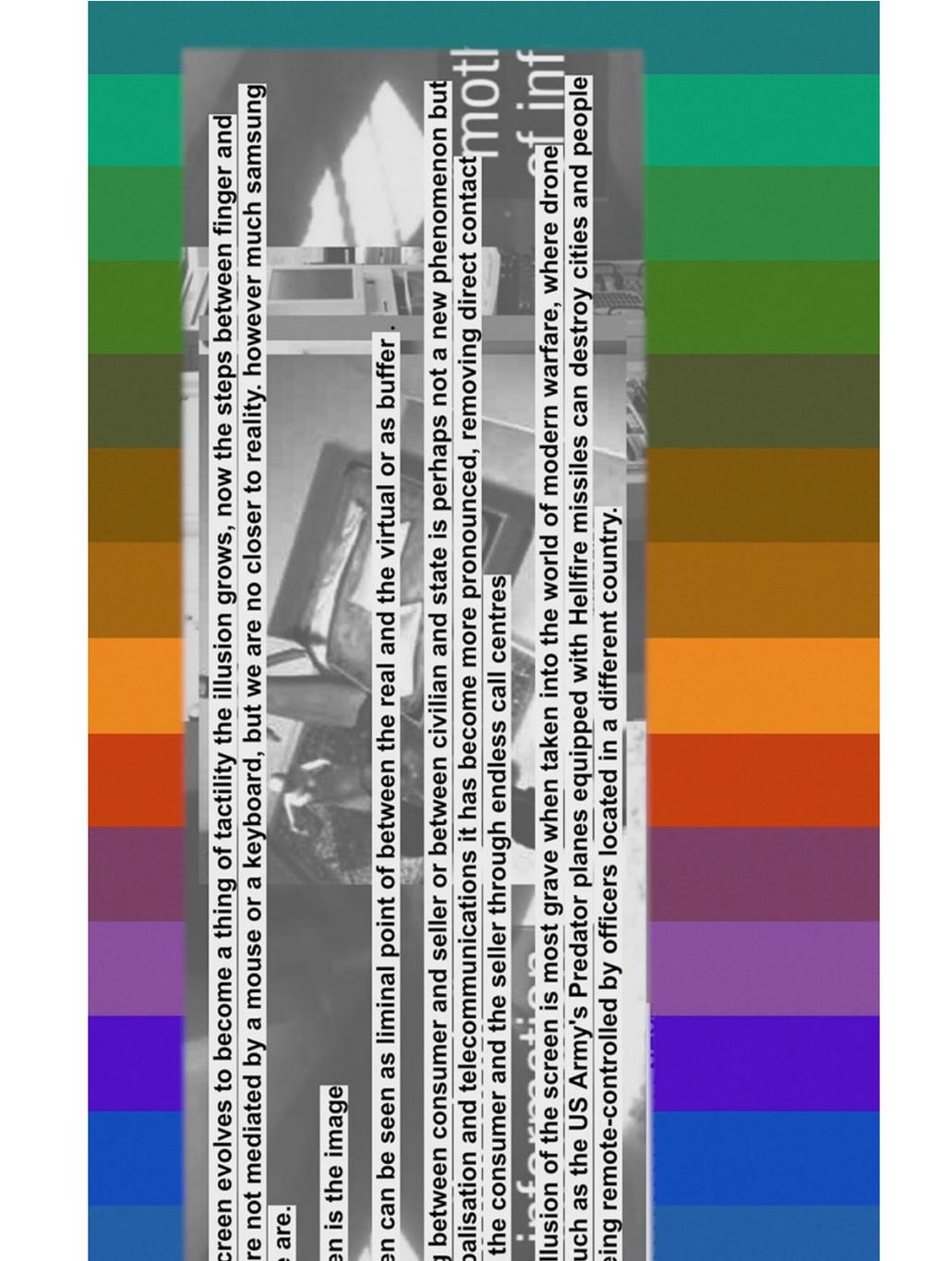
As the screen evolves to become a thing of tactility the illusion grows, now the steps between finger and screen are not mediated by a mouse or a keyboard, but we are no closer to reality. however much samsung insist we are.

the screen is the image

the screen can be seen as liminal point of between the real and the virtual or as buffer .

buffering between consumer and seller or between civilian and state is perhaps not a new phenomenon but with globalisation and telecommunications it has become more pronounced, removing direct contact between the consumer and the seller through endless call centres

But the illusion of the screen is most grave when taken into the world of modern warfare, where drone planes such as the US Army's Predator planes equipped with Hellfire missiles can destroy cities and people whilst being remote-controlled by officers located in a different country.
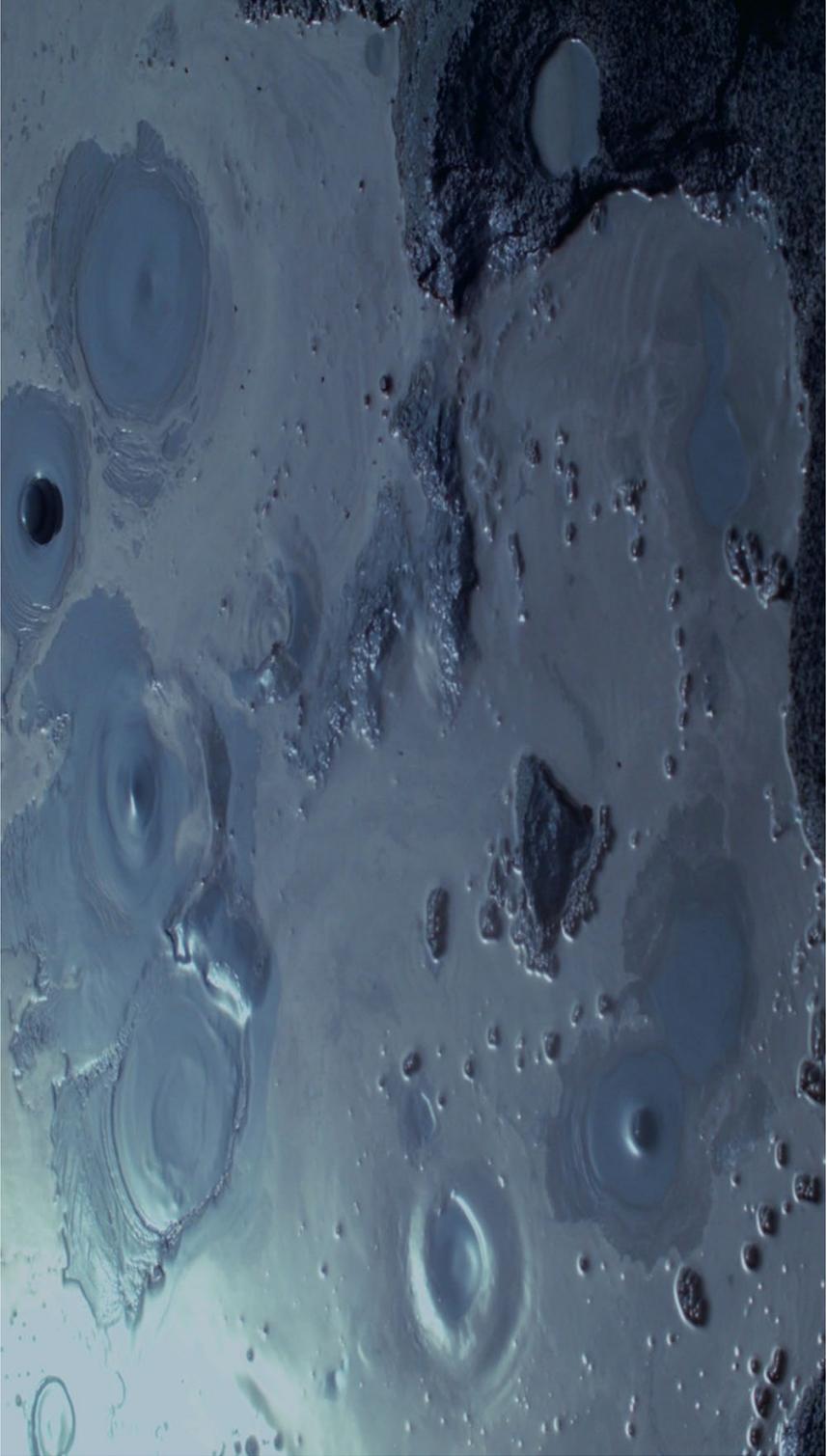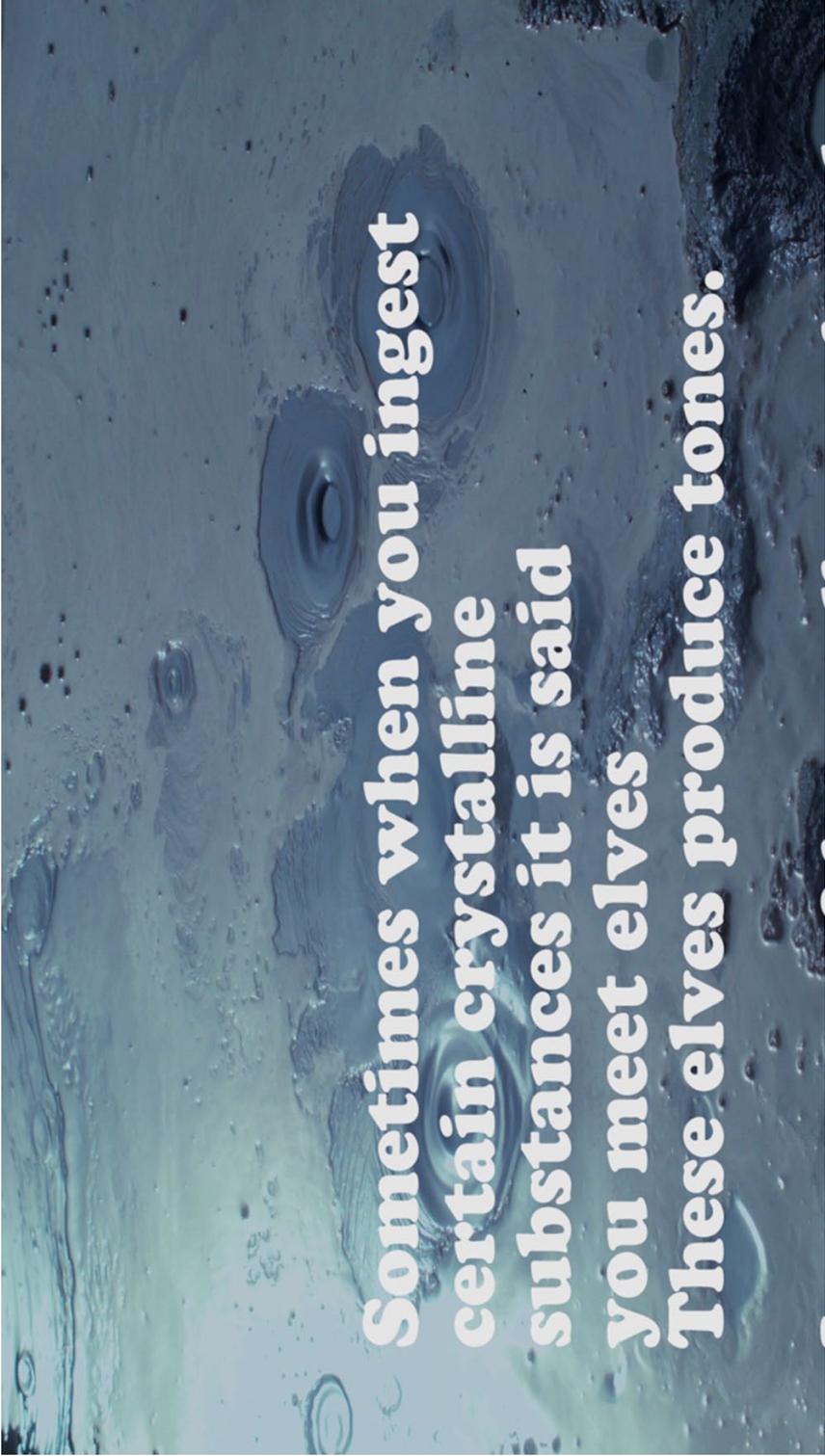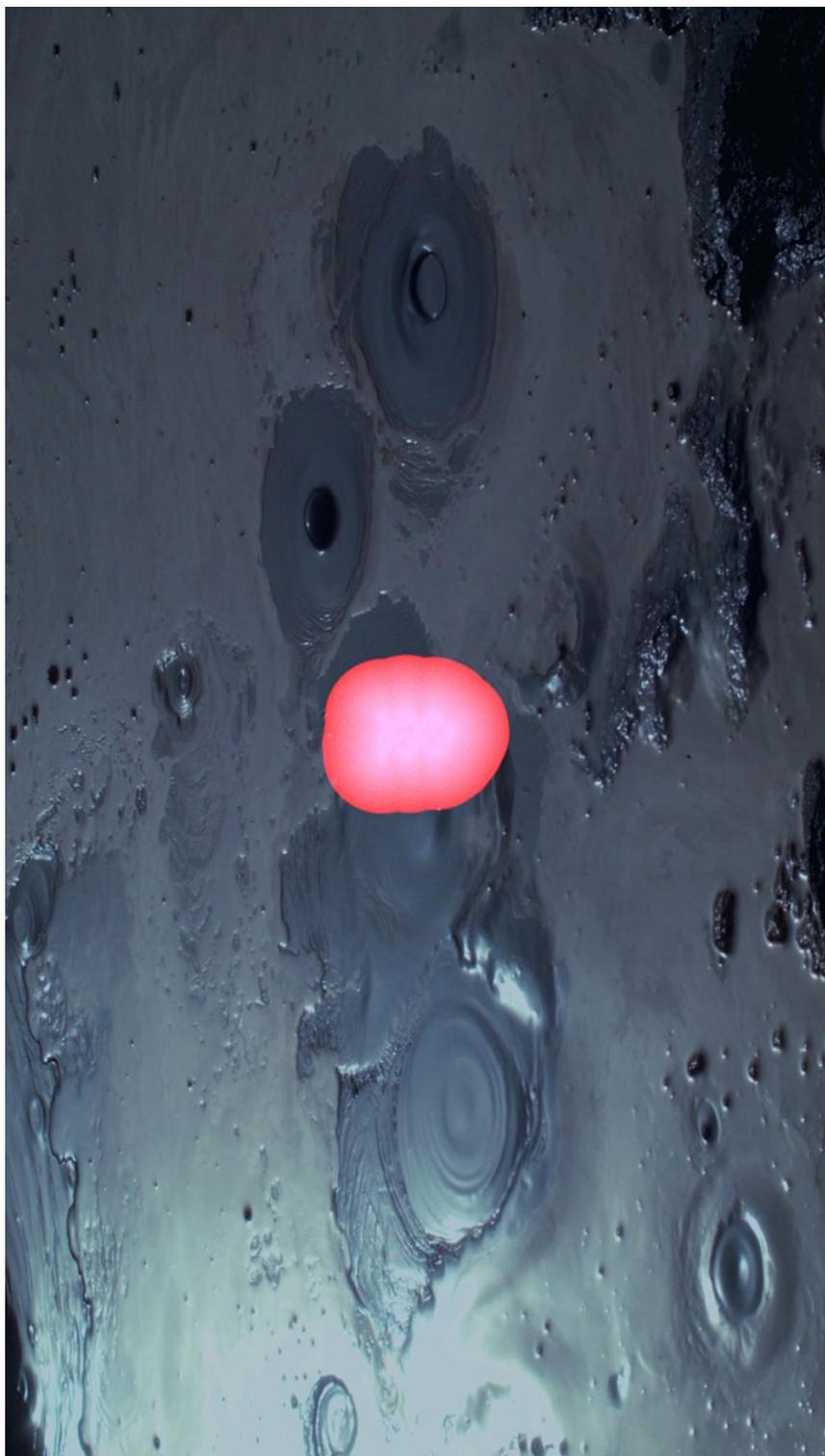
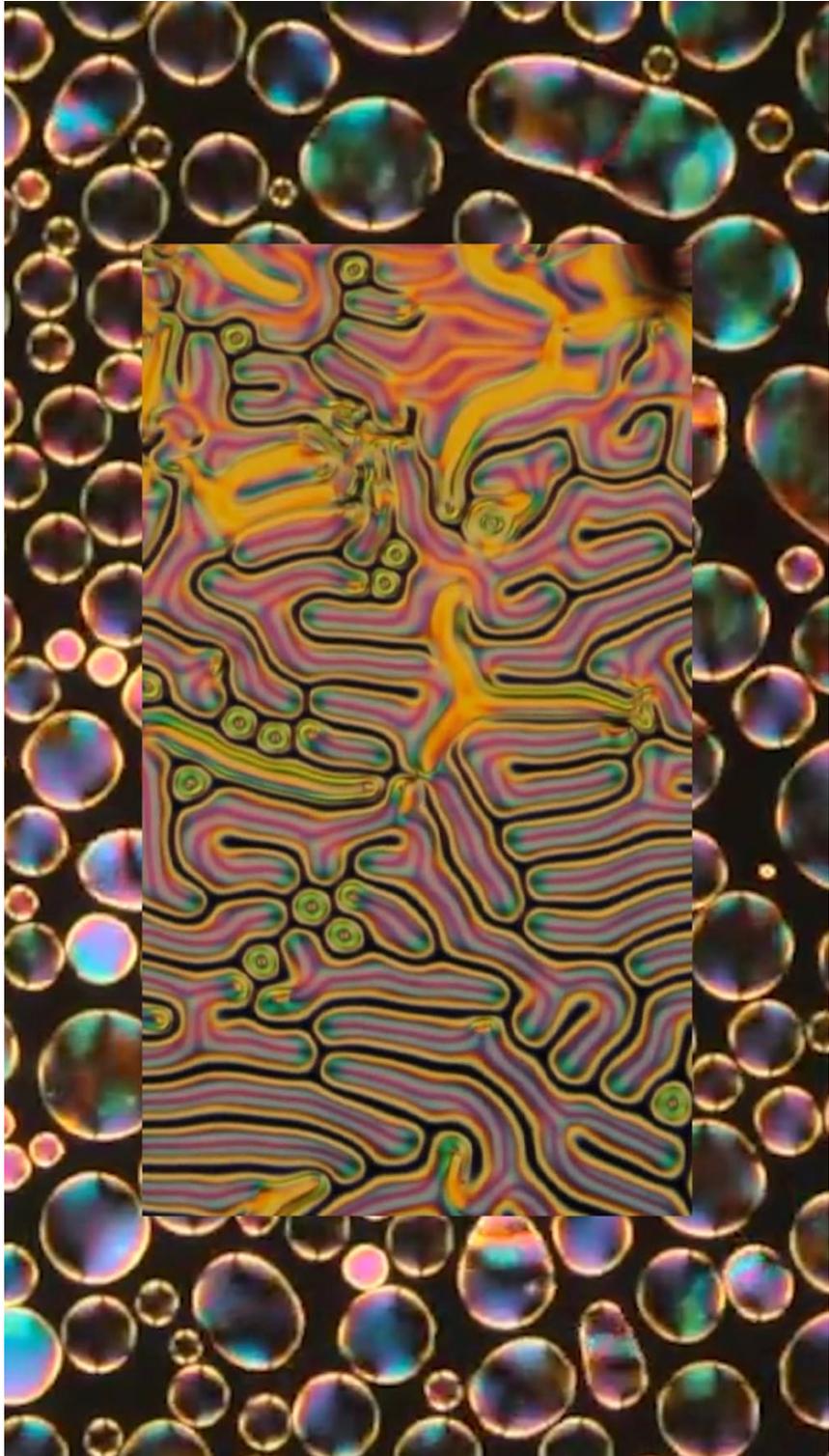Sometimes when you ingest certain crystalline substances it is said you meet elves These elves produce tones.
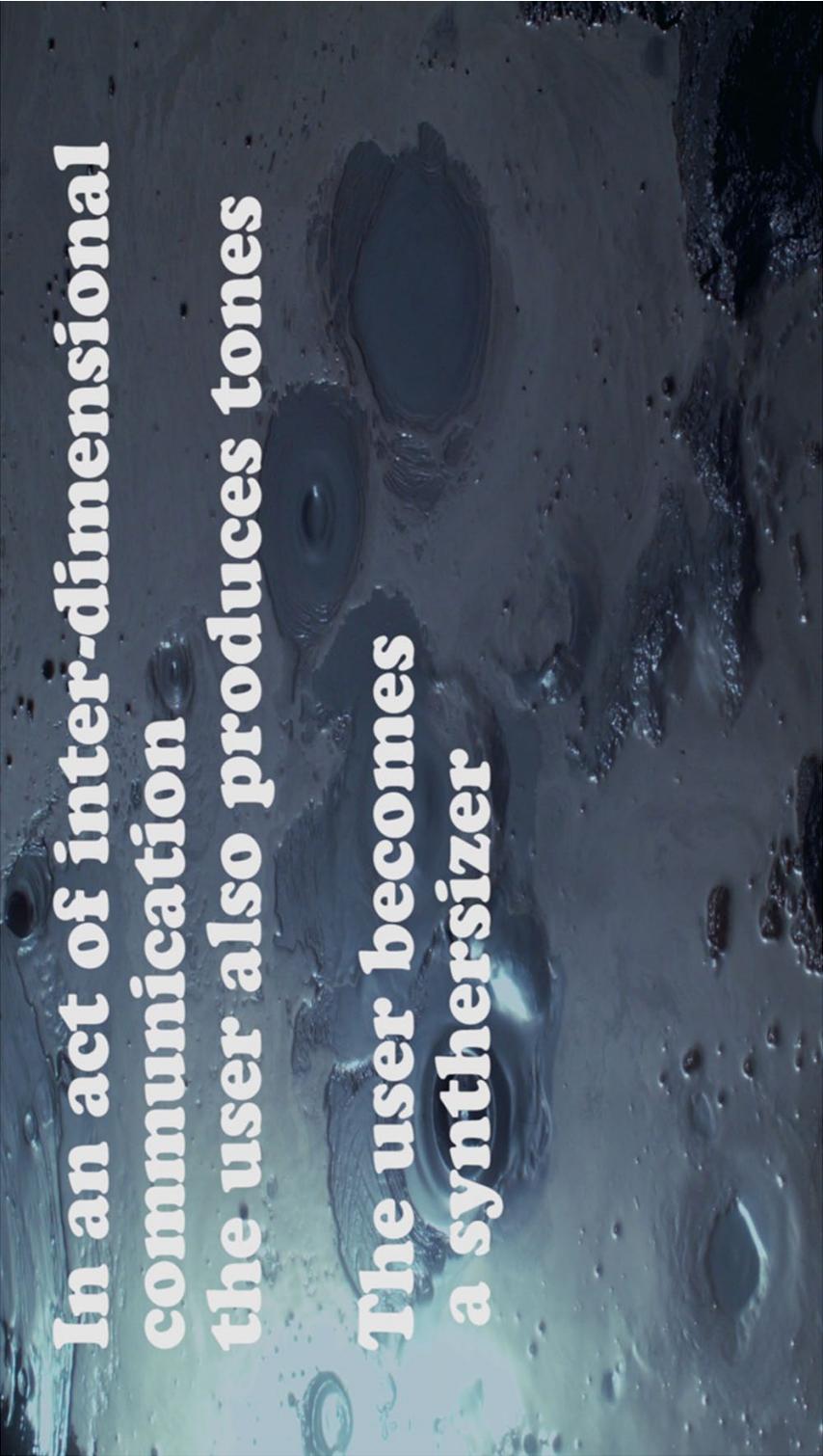
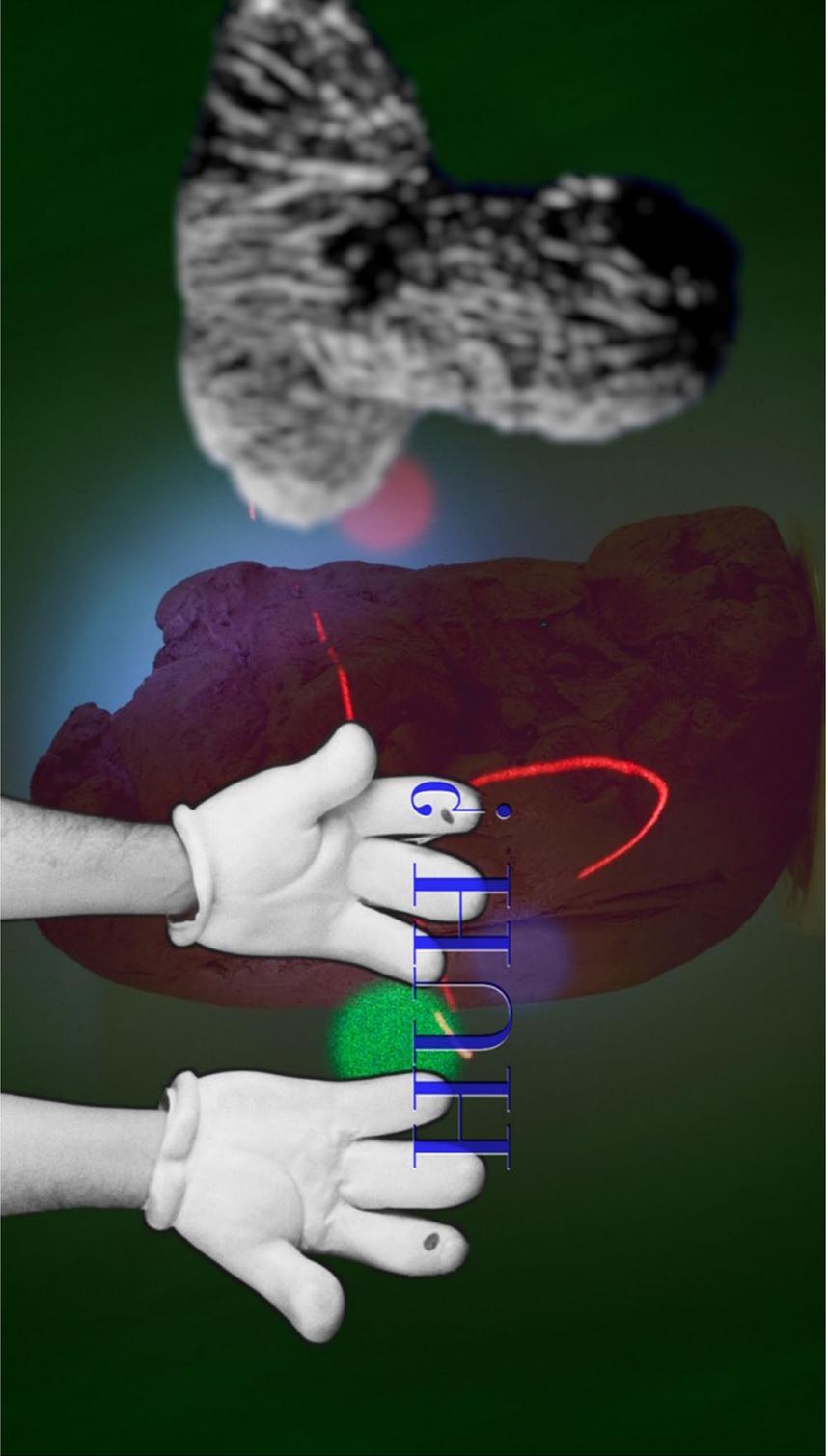In an act of inter-dimensional communication the user also produces tones

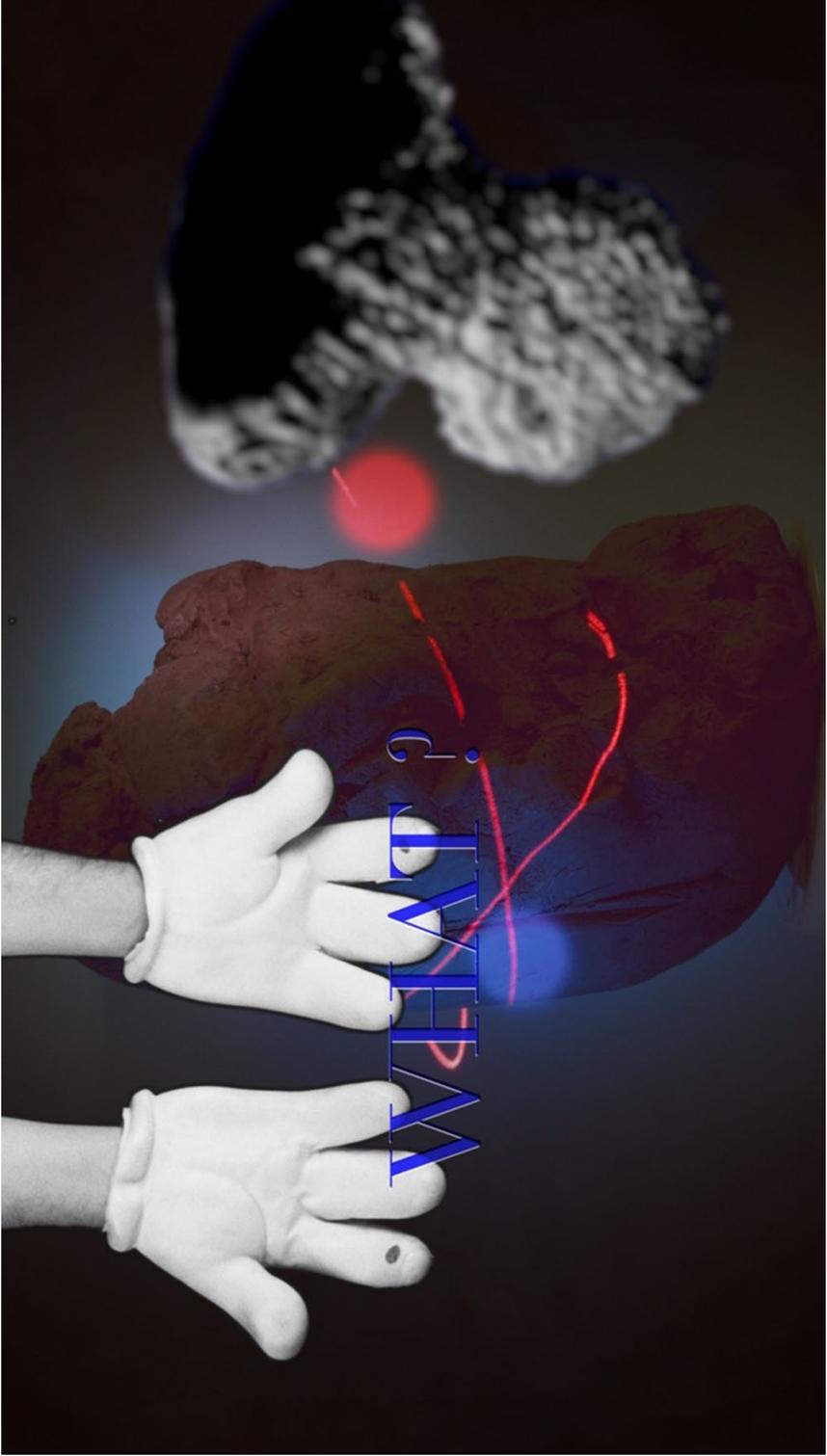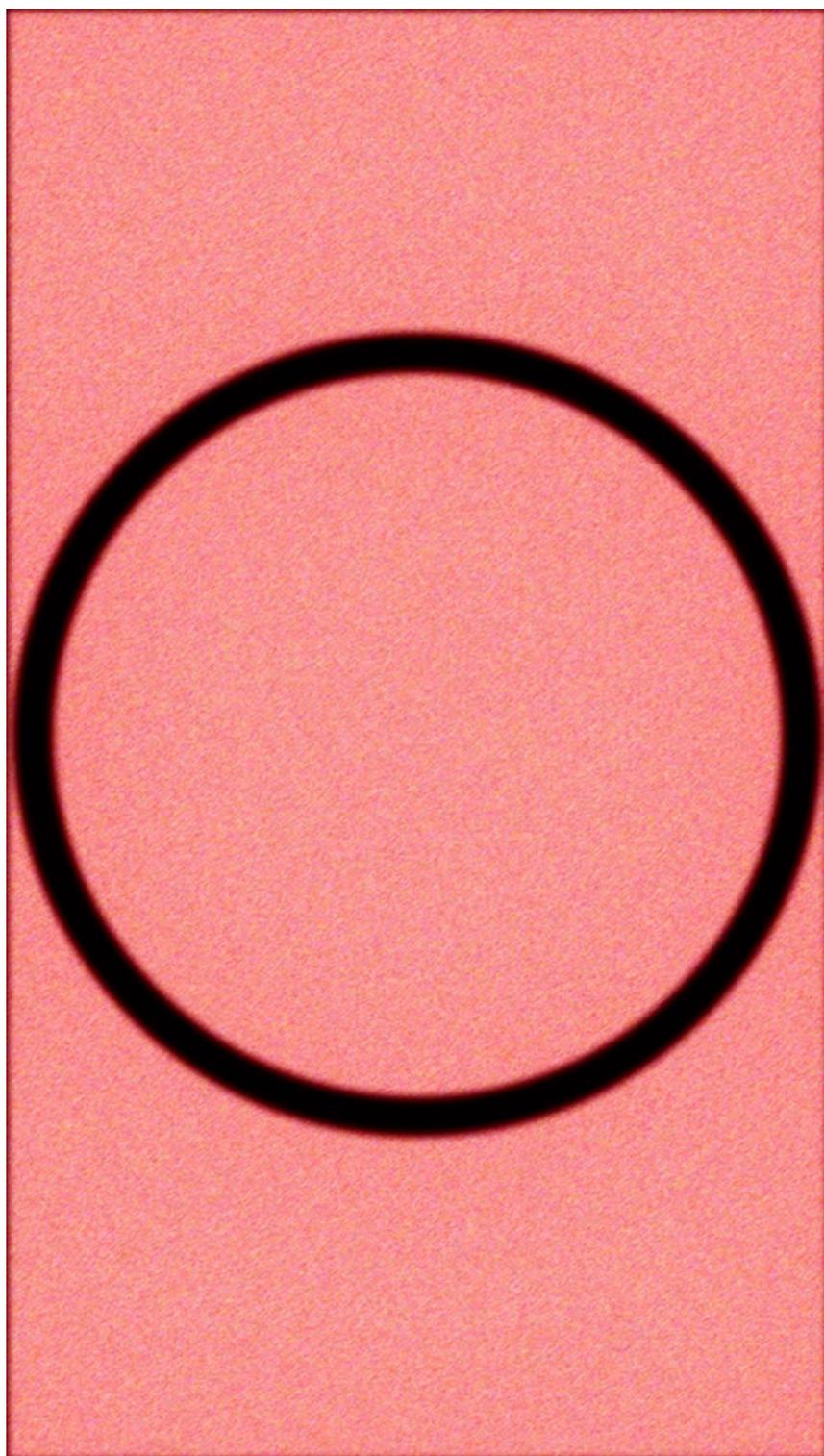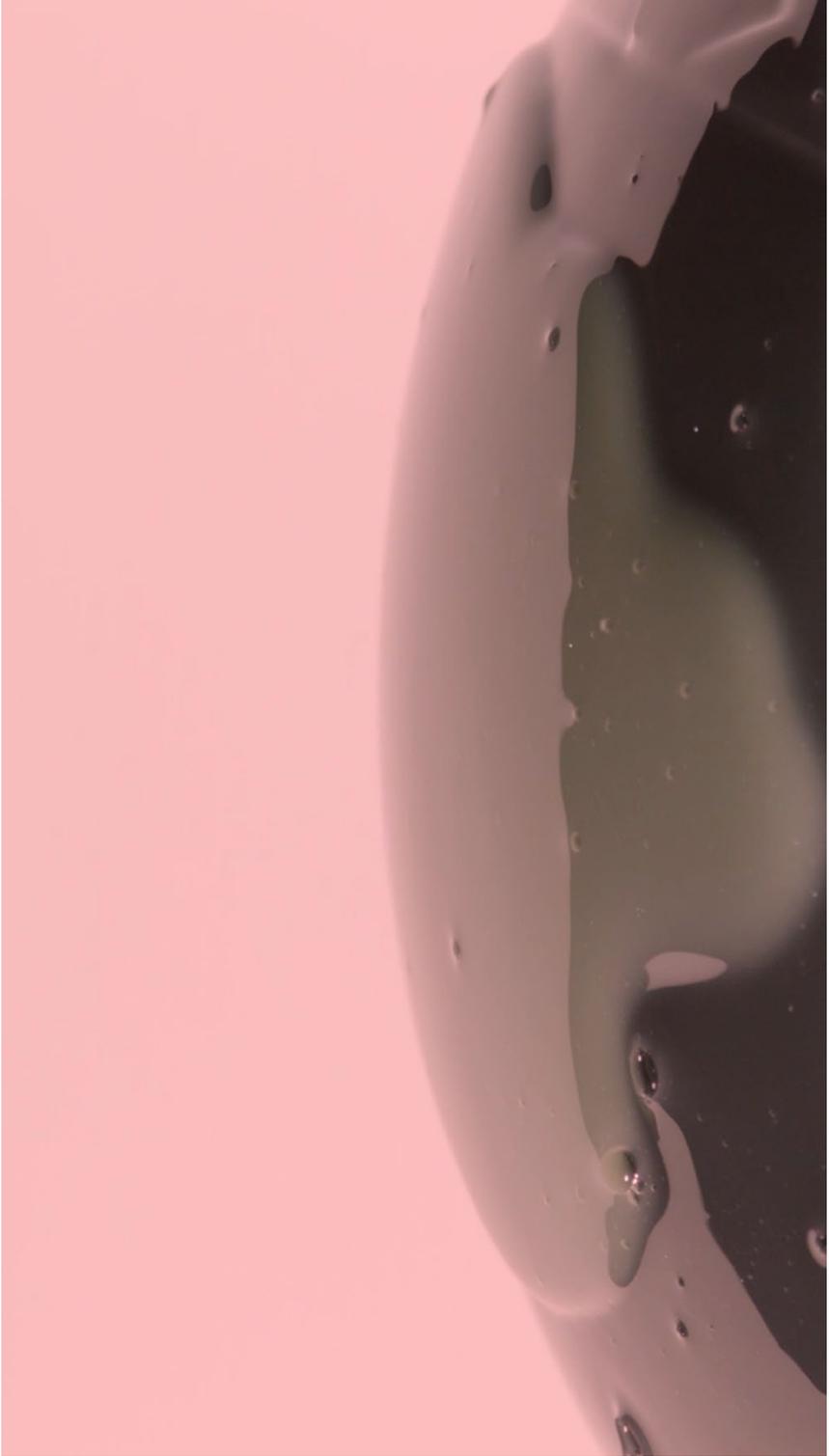The user becomes a synthersizer

¿HUH?

"A Signifier With A Vague, Highly Variable, Unspecifiable Or Non-Existent Signified"
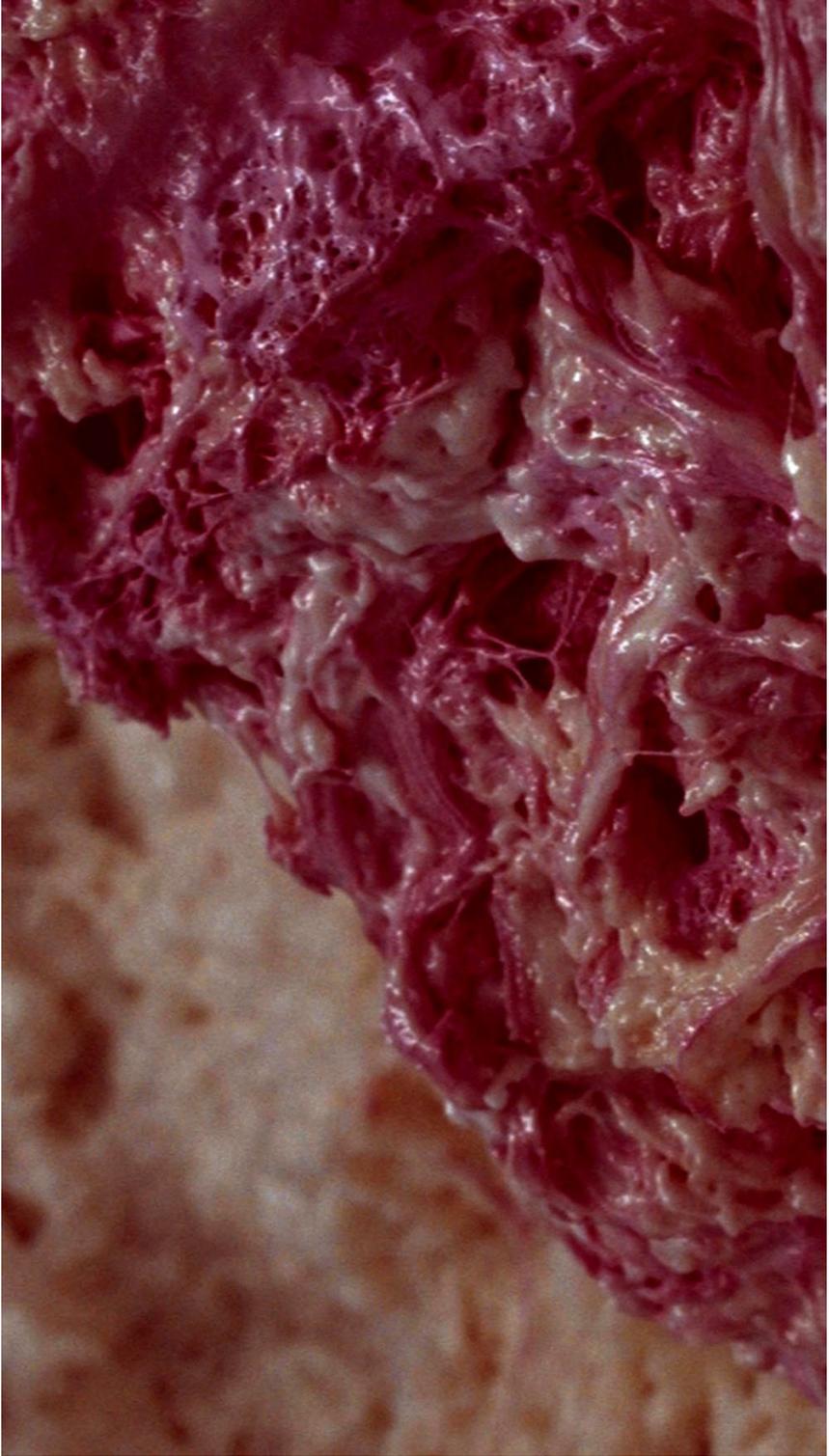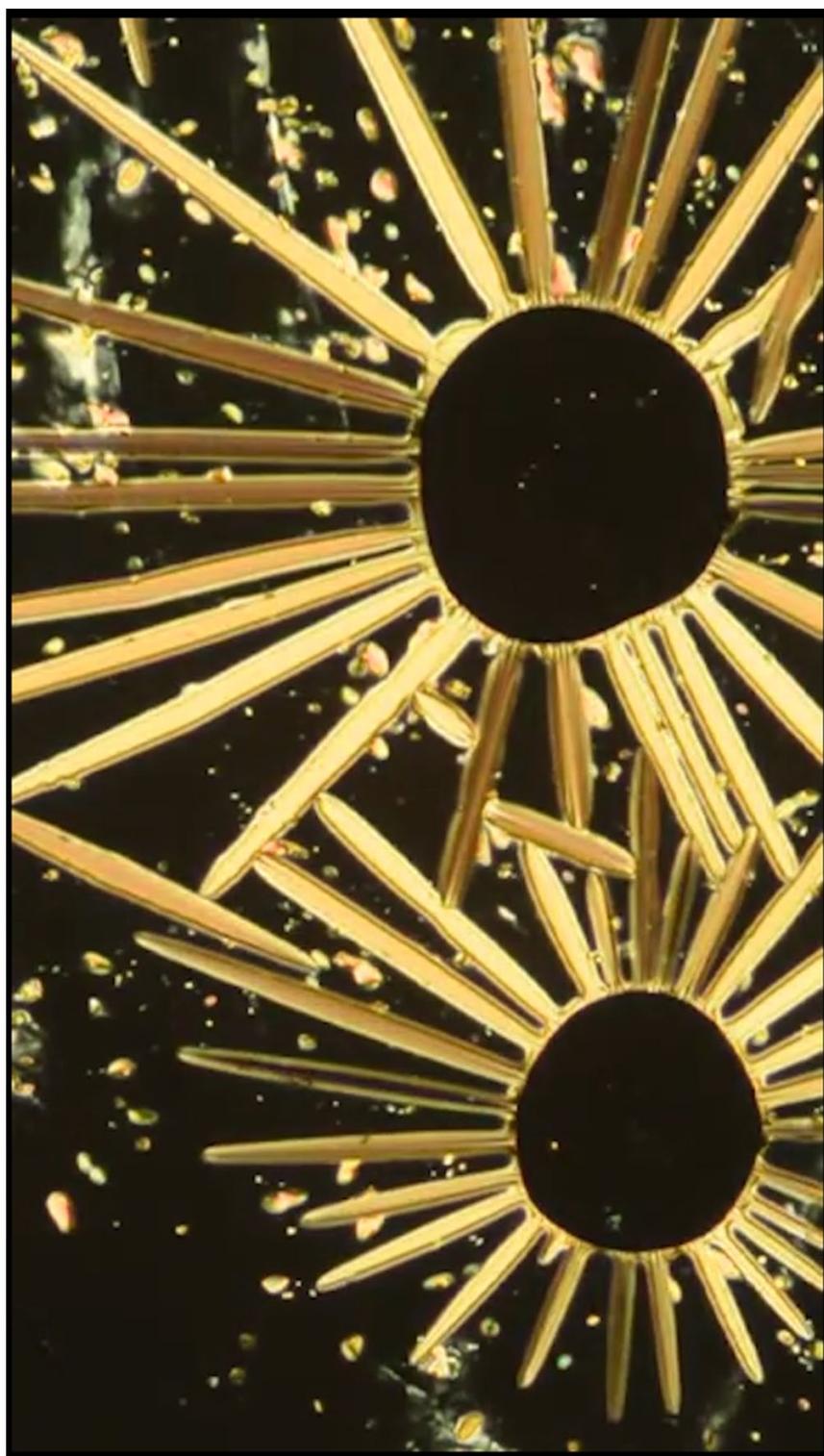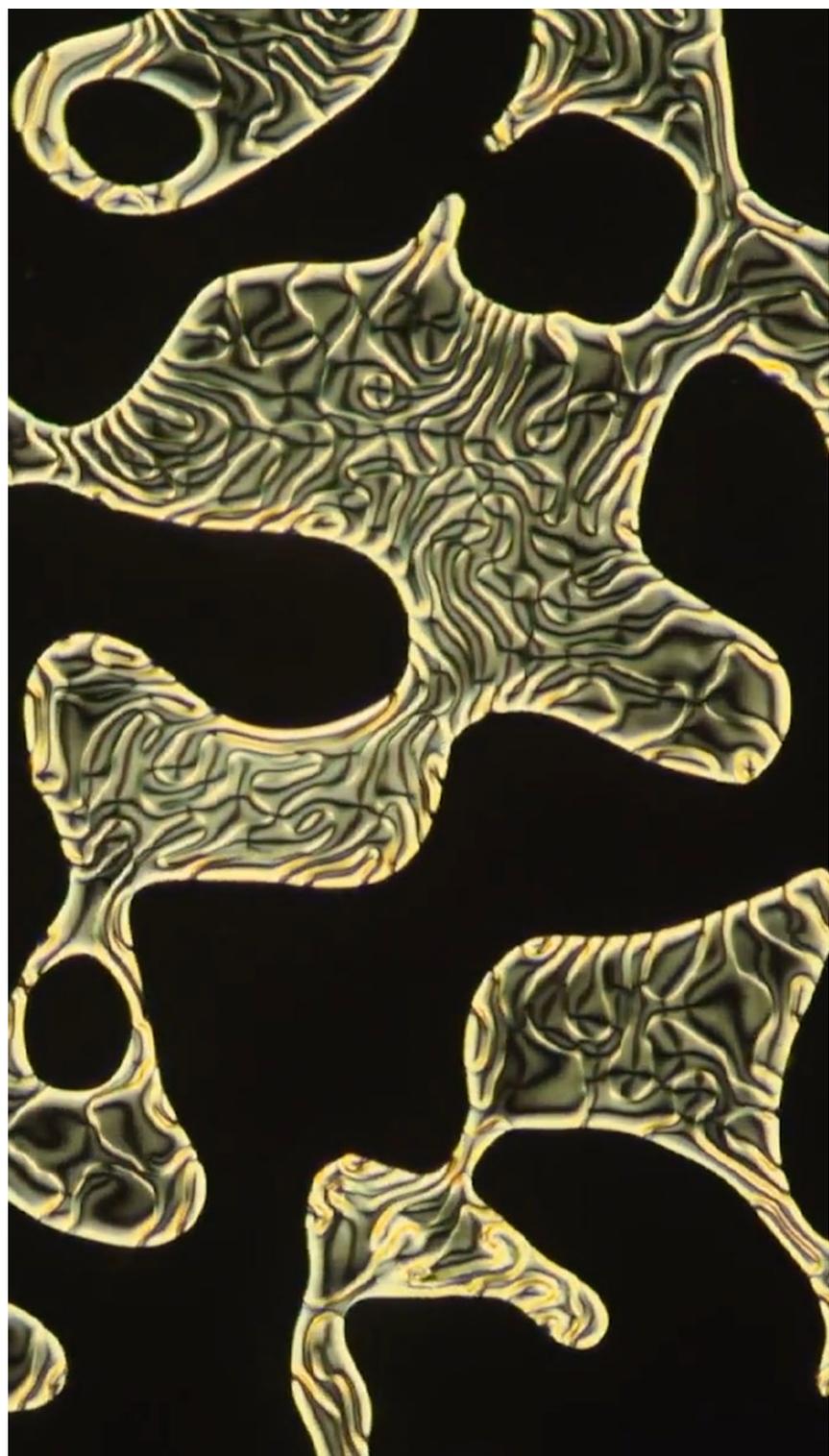
WHAT?

Barnaby Dicker (BD): I have some notes about animation in response to Esther's *Liquid Crystals*. At times there will be some convergence between what we've seen from Benedict and what Emily and Esther talked about too. A key thing that came out of the book for me was the idea that the liquid crystal is a worldview (Leslie, 2016: 21). And that, as has already been mentioned, 'the liquid and the crystal may be thought dialectically or they may be thought in their separation' (p. 22). I felt that the book keeps coming back to a tension between media culture and the discourses that we use, relate to, or connect with that are communicated through and/or explicate said media culture. So I was wondering whether we might take these artefacts and discourses as different elements that combine in varying and novel ways to create 'fluid/crystalline' forms. From this perspective, when reading Esther's book, I found myself asking – in relation to my topic of animation – what 'fluid/crystalline forms' are we, as practitioners, critics, theorists, historians, consumers, social agents, or producers, animating? Processes of solidification or liquefaction, i.e. are we moving towards solidification? Or are we moving towards liquefaction? Are we animating natural forms, or are we animating cultural forms, or even something like social relations?

Those are the questions that span and guide my thoughts here. I think the issue of scale and point of view is also very important; scale in the sense of necessarily taking up positions on the spectrum between macro and micro points of view that are then coloured or skewed, as it were, *laterally*, by specific concerns and allegiances. Particularly important is the idea of recognition, of what we see and what we don't see. One of the quotations from the German physicist Otto Lehmann in Esther's book really stood out for me in this regard. In his 1901 lecture 'Physics and Politics', he states: 'observation and making discoveries is an art, which must be learned like many others … we have to learn to see' (p. 29; see also Lehmann, 1901: 49). This stood out for me because at the moment I'm very interested in Louis Althusser's work. In his reading of Karl Marx, Althusser has some interesting ideas around the visible and the non-visible. Here is a statement from the mid-1960s:

> The invisible is the theoretical problematic's non-vision of its non-objects, the invisible is the darkness, the blinded eye of the theoretical problematic's self-reflection when it scans its non-objects, its non-problems without seeing them, *in order not to look at them* … The invisible is not therefore simply what is outside the visible … the outer darkness of exclusion – but the *inner darkness of exclusion*, inside the visible itself because defined by its structure. (Althusser, 1979[1965]: 27, emphases in original)

So, like Lehmann, Althusser insists that we have to learn to see the things that we may or may not want to see. In some ways, the discovery of cinematography required new ways of looking and new experiments to make explicit and concrete something that had always been an implicit possibility

– in the sense that we could have, in theory, invented cinematography thousands and thousands of years ago. In other words, the potential of the cinematographic arrangement or *dispositif* had to be recognized. I define cinematography as the rapid intermittent presentation of intensely grouped images. Understood in this way, cinematography's animation of discrete frames can be seen to entertain a productive tension between principles of regularity and difference that chime with Austrian physicist Erwin Schrödinger's definition of periodic and aperiodic crystals (discussed by Leslie, 2016: 176–177; see also Schrödinger, 2012[1944]: 5). (In a nutshell: the periodic being regular and simple, the aperiodic, irregular and complex.)

In *Liquid Crystals*, Esther dedicates some space to discussing proto-cinematography, that is to say, the earliest forms of cinematography.[3] The history of proto-cinematography shows us the process by which the moving image came to visibility – both cognitively and culturally. Its evolution since the almost simultaneous publication of devices developed by Joseph Plateau in Belgium and Simon Stampfer in Austria in 1833 has been quite rapid. In terms of proto-cinematography, Esther focuses on Émile Reynaud's Praxinoscope; a device that went through several different versions (spanning the late 1870s and the early 1900s), most of which are recognizable for their central column of mirrors.

Some time ago, art historian and curator Margit Rowell noted the suggestive evidence that the Czech-born, Paris-based artist František Kupka (1871–1957) – a pioneer of the current of abstraction known as 'Orphism' – had an interest in Reynaud (Rowell, 1975a, 1975b: 48–51).[4] Rowell, and before her, Denise Fédit (1966: 54), see this influence manifesting most directly in a sketch called *Les Cavaliers* (1900–1902); seeing in its composition a reference to – or interpretation of – the layout of the Praxinoscope which presents animations, multiplied in the central column of mirrors, flanked by the images swirling around the inside of the drum. If we accept this interpretation of Kupka's *Les Cavaliers* – and I do – this exposes the interesting proposition that proto-cinematography did not just provide experimental tests or proof of perceptual or cognitive faculties, on the one hand, and parlour amusements, on the other; it also created new objects *for* perception, which could be looked at in a variety of ways, and started to shape other forms of visual culture. In the Kupka case, this relates to the evolution of abstract art. Orphism developed in close proximity to Cubism. In his recent book of poems, entitled *Crystallography* (2013), Christian Bök writes, 'a crystal makes a lens through which the cubist painter might see the world as it really is' (p. 37). Combining all of these threads, we can ascribe a pivotal fluid/crystalline structure to the Praxinoscope and its animation; one that was beneficial to the evolution of abstract art. If, from here, we move towards conceptualizing all cinematography as both fluid and crystalline, we see that Esther offers us a materialist approach quite different to that of Gilles Deleuze's 'crystal-image' (Deleuze, 1989: 68–97), which eschews technology, favours a Bergson-derived 'virtuality', emphasizes cinema's narrative thematics and excludes animation.

Esther's discussion of Tim Macmillan's 'Time-Slice' technique as 'playing with or inside the binary of the fluid and the frozen … [which constitutes] the heart of film and most specifically animation' (Leslie, 2016: 217) provides a welcome route to considering experimental film in relation to the liquid/crystal. Connecting with Benedict's work and presentation we encounter so-called structural film. Here, I want to single out the practice of creating 'film scores', as used by experimental filmmakers such as Paul Sharits. I think these scores chart the process by which we see some kind of crystallization take shape. I see the relationship between the score and the film as you experience it on-screen embodying the parallel I mentioned earlier between media culture and its surrounding discourses. Writing about his film, *N:O:T:H:I:N:G* (1968), Sharits (1969: 15) claims to have been working with 'virtual shapes' generated through precise use of cinematographic flicker effects. He offers a quotation from the Indian Upanishads: 'As you practise meditation you may see in visions forms resembling snow, crystals, smoke, fire, lightning, fireflies, the sun, the moon.' To which he responds, 'I'm not at all interested in the mystical symbolism of Buddhism, only in its strong, intuitively developed imagistic power.'

So, here again, I think we see some kind of (non-exclusive) commitment to building films that have a fluid/crystalline structure and that actually engage their viewers in this way directly. Pertinent once more is Schrödinger's distinction between periodic and aperiodic crystals. To conclude, I return to my opening question – 'what "fluid/crystalline forms" are we animating?' – and give it a new spin: 'what are the "fluid/crystalline" *structure*s that are being animated?' Are they periodic or aperiodic? Do they tend towards regularity or irregularity? Simplicity or complexity? Thinking about such questions might help us to recognize, *to see*, new or hidden formations in our media environment.

Sean Cubitt (SC): On my way to the celebratory seminar for Esther Leslie's fine monograph *Liquid Crystals* (2016) I toyed with a turgid academic pun by way of a title: 'Liquidditas and Haecceitice', hanging 'haecceity', the principle of 'thisness', of the unique presence of a singular phenomenon to perception, with the crystalline; and 'quiddity', 'thatness' or 'whatness', the retreat of the object from perception into an essence unavailable to the senses, with the fluid. The pun failed, I felt, because quiddity is surely the more fixed of the two Scholastic categories; and haecceitas, even though its instant of conjuncture is of crystalline clarity in, say, Gerard Manley Hopkins' employment of the idea he drew from Scotus Erigena, the more fleeting.

Leslie's book is valuable not just for its novel taxonomy, nor for the gems of research material she teases to the surface, but for its method, fundamentally ideogrammic in the mode of Ezra Pound (Fenellosa and Pound, 2008): a compounding of complex patterns from tesserae like the poet JH Prynne she often quotes (eclecticism is little prized today; Leslie, like Prynne, is a mistress of it). And so because I began with a Scholastic play on words, it seemed inevitable, if not legitimate, to turn to the idea of *panpsychia* which

inhabits Leslie's work. The universal mind of *panpsychia* seems to have been coined by the 16th-century Croatian philosopher Francesco Patrizi. In his *Nova de universis philosophia* of 1591, Patrizi treats of light emanating from God (a thought he may have gleaned from the 14th-century divine Robert Grosseteste, Bishop of Lincoln, whose *De Luce* proposed that God's light, in the first words of Genesis, gave form to – in-formed – the *tohu-va-bohu*, the world 'without form and void' that preceded Creation). For Patrizi, a convinced Platonist, hurrying to critique the Aristoteleanism of the Scholastics, this light was Soul, a universal Soul, an idea that would in time shape the thought of Giordano Bruno and, much later, glide, with equally mystic insinuation, through Quine and Whitehead towards the 'immanence' of Bergson and Deleuze.

Striding through leafy Bloomsbury on a May evening it is not hard to believe that light is indeed the visible form of God as various Mediaeval and Renaissance neo-Platonists and heirs of Trismegistus held, and that the visible world comprises the glittering facets of a universal intelligence. Yet our condition is otherwise. It is true, as Leslie demonstrates so deftly, that the infrastructure of our digital world is caught in the dichotomy between flows and lattices, and that our interfaces are ubiquitously liquid crystal displays flickering between the two states. But the light that proliferates through our networks is no longer God's spendthrift suns but organized light, fruit of the engineered agitation of atoms and the meticulously guided and accounted passage of photons. If this is the state of the universal soul in the 21st century, we have a problem.

During the weeks leading up to this event, I had been preoccupied with the fate of images in social media. I hypothesized, on the back of Flusser's (2000) dialectical phenomenology of photography, that images no longer have the unique referential and affective properties that Barthes (1980) ascribed to them but rather, from the standpoint of the systems they circulate through, exist as interchangeable units composing a vast, composite, mass image. I had come already to the conclusion that my preferred method, that of singling out one by one each image from the mass for the kind of attention that brings an image to crisis and therefore to criticism, might in fact be an act not of liberation but a purely nostalgic recapitulation of precisely that Cartesian ego-object relation which all my training had set me against.

It was a case of being careful what you wish for. If the goal of post-structural thought from Barthes and Lacan to contemporary neo-materialisms had been to liberate the self from subject–object relations and, at its best, to socialize in the most profound way the workings of the psyche, then the mass image has indeed realized that ambition. Yet what has resulted is not liberation but a new thralldom, this time of an ionized plasma of behaviours, mined as ruthlessly by contemporary capital as the ego was in earlier phases.

Methodologically, this poses a new problem: how to confront the flow of images through social media and other networks (the immense archives of X-rays and CCTV for example)? What mode of attention can bring to

crisis (and therefore criticism) a flow whose scale far exceeds not only what any individual can attend to but the sum of all the attention of all the human population added together? The only attention with the scale and speed required for the job is the very one that brought this state of the image about; the collective algorithm of EdgeRank and the other tools of Facebook, Google, Instagram and the rest. These tools exist exclusively for the extraction of profit. Is it possible to use the master's tools not only to dismantle the master's house but to build a new one with no trace of mastery?

My interest in the mass image had begun from a larger enquiry into the aesthetics of truth, which Aquinas defined as *adequatio rei et intellectus*, the adequation of thing and intellect (though I have seen it mistranslated to the effect that 'only an adequate intellect can know a thing' – a statement which has its own validity, and is perhaps germinative of capital allocating knowledge of the mass image to machine intelligence). Truth in Aquinas and under God who alone is and knows Truth, human truth therefore, is adequate and no more. It is an act of knowing but not necessarily of speaking: I 'knew' the dappled sunlight of those Bloomsbury squares down to the pigeon nesting in the branches but could not articulate it in writing in less than a short lifetime. Equally I can state with some certainty things that I do not know in any adequate sense, such as the laws of thermodynamics operating on the evening around me. The excellence of the universe is that it is never adequately knowable. The fine tunings that compose it escape, leaving nothing but fundamental laws. Not only do the laws not describe the games of light and leaves in an urban square; they are themselves taken on faith and, like faith, with limited understanding. We have had to invent closed systems in which they can operate in their pure form, with little evidence that the senses can descry of any such closure. A syllogism does not release us from this paradox, unless we derive from the mismatch of laws and perceptions that truth is either paradoxical or unknowable or the ogee of an asymptotic adequation.

Commenting on the opening line of Wittgenstein's *Tractatus* (1961[1921]), Adorno (2000[1963]: 196) observed that what is significant about a state of affairs is not what is the case but what in it is incomplete or cannot be contained. Negation, void, structural absence would be some names for the non-identity of a state of affairs with itself, the motors that allow, indeed force, it to change: the potential within its actuality. The failure entirely to exist is the engine of becoming. The adequacy of truth is then its saving grace: it cannot treat the world as given (*datum*) or posit it, with an easy conscience, as possessing in whole or in its parts the solidity of being. There are two implications: firstly, that becoming is not the ontological state of the world but a result of its failure to Be; and secondly, that truth, as adequation of thing and mind, is momentary, a *haecceitas* whose dependence on the shifter 'here' illuminates its once-and-for-all ephemerality, such that truth inheres neither in the image nor in its perception but in their meeting.

The question then must be whether the databases of the mass image can participate in such an encounter. If, as Marx argued in the *Grundrisse*, technology is 'dead labour', then a demarcation distinguishing machine and human intelligence is not going to help us here: the intelligence of the ancestors congealed into the black boxes of information capital's databases, even though enslaved much as light has been in our fibre optics and LCDs, is of a kind with our own and indeed that of any living thing, and potentially of the panpsychic intelligence of the universe as a whole. Facial recognition, the semantic web, GPS, range-finding and mass analysis of metatags, plus all the panoply of scientific instruments making 'images' from supra-sensible wavelengths and scales all indicate that there is, if anything, a greater adequacy of the machine intellect to things than anything human minds can achieve. That, however, is not the point to be prised out from Aquinas' formula. Nor is it simply that the world is not data, since data are secondary statements about states of affairs, not states of affairs themselves or knowledge of them derived from the encounter. The critique of data is an extension of familiar critiques of representation, valuable as such but not itself the instrument we need to drive data into crisis.

The mythos of the image – for example in Barthes' later, melancholic writing – is of a discrete entity apart from the world, even the world it once recorded. In an earlier pamphlet answering attacks on his literary criticism, Barthes suggests a more useful approach for us:

> … a term may be formulated only once in the whole work, and yet, as a result of a certain number of transformations which, precisely, define structural phenomena, be present in the work '*everywhere*' and '*always*'. (Barthes, 1987[1966]: 34, emphases in original)

Until the advent of the mass image, the turn of phrase 'The Image' was a misnomer: there was no single quidditas shared by every child's crayoning, scientific observation and discarded postcard. That is no longer quite the case: today all images are gathered together under the structured unity of database logic. Whether one agrees that an image is a structure or not, the database most surely is; and therefore Barthes' observation is the more precious for the new circumstance. What is most valuable about the mass image is not its aggregation but the exceptions to its generality, not because they escape but because they indicate the structural operation itself, just as a single poetic image may be the secret fulcrum on which the literary work levers a world into existence. I doubt this new method can hinge on an individual image; but should appear as structural to the massification of images, in the taxonomic principles governing the tesserae, or in the contradictions of their internal logic, in the manner of Marx's unpicking of the emporium of commodities.

And so I returned to that stuffy joke. Is it not the case that just as the dissolution of the Cartesian subject became a new servitude, so the philosophy of flux foretold what now we inhabit: frictionless capital and the

market as ocean of intensities? Liquidity – which in economics means the ability of cash and other forms of funds to shift values at the highest speed – is indeed the quidditas of the contemporary world; and the crystalline form of haecceity that instantaneous extraction of non-identity from the flow. The liquid/crystal dialectic Esther Leslie has brought us is a tool for creating crisis in the triumphal smooth spaces of financialization.

<div align="center">***</div>

Question: Benedict, I want to ask a question about screens … because you use the screen to make the film, and the screen is thus both the means and the medium by which …

Benedict Drew: I made the film last night while I was having dinner, with my phone, my laptop, and *Master Chef* on in the background, my partner was on her phone and our daughter was on her phone and …

EL: It's inescapable, isn't it? That's why I wanted to think about the liquid crystals in ourselves. If we're thinking about screens, we're also thinking about ourselves since we are liquid crystal devices. It's not that you can step away. We have to engage with the screen that's projected into and out of yourself because otherwise it would be some weird kind of 'Primitivism', so you can't side-step it.

Benedict Drew: It was originally a web essay, and it was originally about … It's curious, this addiction to screens, this being drawn, moth-like, towards the screen, and knowing it's totally banal. And how it's tied to a networked social media which is nothing more than a monetization of that banality. And that the device in your hands, that you're paying through the nose for, has so much value attached to it, and all this labour, and all this waste, and destruction of the natural world … And you just get distracted and think: 'Oh, I wonder what's happening on Instagram? Did anyone like my photo?' It's totally addictive. It's the allure.

EL: For me, its allure all concentrates in the jewel-like beauty, the crystallized beauty, combined with that flow of time. That there may always be another 'like', there may always be a new news event. It's that weird dialectic again between the frozen focus and the endless fluid movement, and it's totally compelling for many people, and maybe it is a kind of identification or recognition of something very internal to ourselves. That would bring us back to Emily's discussion of Bernal's amazing construction of the flow of life arrested, his notion of water as a 'random network'. And his mode of making it! *Wanting* those interruptions! His needing the knock on the door to divert the banality of the atomic model he is building is interesting, as if that loss of attention would make it build itself in a way more akin to liveliness.

EC: It's a very organized way to model disorder. It seemed to be very much grounded in his crystallographic practice, which is so based on elucidating and representing structures, yet at the same time in order to break out of that, he had to create a very well-structured plan to create randomness.

EL: It's not unfamiliar; it's like John Cage refracted into other areas.

EC: Bernal actually did similar experiments with steel ball bearings inside a balloon. Another way in which he set out to understand, in a very material way, the irregular structure of a liquid, was through a modelling experiment that involved filling a balloon with steel balls, then pouring paint inside the balloon, some of which would drain out, and when the paint dried, it would reveal the contact points between the steel balls. This was part of his exploration of 'heaps', or irregular arrangements of atoms like you find in a liquid, as opposed to the ordered arrangements of atoms into a 'pile' in solid crystalline materials. It was another kind of physical investigation using chance or indeterminacy. Bernal was involved in the worlds of art and design at the time, and had close friendships with several artists, so it's possible he was aware of John Cage, but I'm not aware of any evidence that he influenced Bernal's research.

Question: Thank you very much! I enjoyed all of your presentations. To go back to Esther's really interesting analysis of touch and seeing, and the relationship between those two. Anecdotally and banally, recently I took students to the National Gallery to look at John Constable's great big landscapes. Stood in front of the canvases, I asked them to download images of the paintings onto their mobile phones, and then I asked them a really easy question: which do you prefer? There was a shuffling, and embarrassment, and a feeling that they shouldn't really be allowed to say this, but 60 percent or 70 percent of the students said they preferred the image on the phone even though they were sitting in front of the actual painting. When I asked them *why*, they shuffled again, and said that it is because they could touch the screen and move the image. It had to do with their possession of touch and sight, as opposed to *merely* looking at the six footers – that completely immerse you, of course, because if you are close enough to them, you can't see outside them, but that didn't compel them as much as the image on their phones, even though they were embarrassed, which I found interesting: that they were embarrassed to tell me they preferred the touch of the screen, the seduction of the screen, that amalgamation of looking and touching that wasn't possible with the actual paintings. Had we been able to touch the six footers without being thrown out of the National Gallery, that would have been an interesting experiment, but I wasn't prepared to go that far.

EL: I wonder if it's more about the *facility* the student had over it, to be able to enlarge, glide around it, to become … Ken Morse, the rostrum camera operator of *Ways of Seeing*! It comes back to Barney's point about making new ways of seeing, new visualities; this seeing–touching is just what they're comfortable with. Does it relate to a possessive individualism, or is it more utopian than that, or is it more about Goethean intimacy? What I find alienating or odd about touch screens is that you're not touching it; you're always touching glass, you're always touching the same smoothness. There's a barrier that leads to the desire, as Hito Steyerl has it (in her films *STRIKE*, 2010, and *STRIKE II*, 2012), to smash to get underneath it.

Attributing liveliness to it, she also remarks on her imagination of the screen's liquid crystals 'turning into stone in an instant'. She asks us to imagine them fossilizing, 'as if in a flash, and breaking all screens open from within' (Steyerl, 2017: 386) But we are stuck on the surface, even if it feels as if we are taking into ourselves or projecting ourselves into it, and that simply becomes … preferable.

BD: I very much like Esther's comment that the smart phone is the new pebble because that made me think of the Makapansgat pebble, which is one of my favourite things, which I would love to hold. I think it's about two and a half million years old and it's a little face, just two eyes and a mouth, and it's naturally formed, and it was carried by our ancient hominid ancestors from a river bed in South Africa, some distance back to their camp. Apparently, the hominids were not anatomically able to fashion that object, the face, but they clearly recognized the symbolic potential of it. So I like this idea that the *new* pebble, just like that old pebble, returns us to this same issue of being allowed to handle some thing, or seem to own it or pass it around and interrogate it. This is perhaps an issue that chimes more with craft and handiwork than with high or fine art.

EL: In a way, the smartphone could provide a re-affirmation of object-hood. It could be the object that has reintroduced the desire for our hands to hold something, to have a gadget between our fingers, on our palms, always close, also drawing our touch and eyes to it. This weekend I've been introduced to 'the craze that's sweeping the nation': the fidget spinner! We're now the proud possessors of two in our household. It's a plastic or metal item whose sole function is for you to spin it around and round and round and look at it. And now every child in the land has them. Originally it was developed for ADHD and autism, as toys for sensory feedback, the pleasures of repetitive behaviour, and so on. And then they became executive stress relief toys, and now all the children have them. What is that about? That sense of physicality, of having the object in the hand, and of having control over it, what is that about?

Benedict Drew: The ADHD thing, and the social media thing about checking your smart phone all the time, they're linked. Mark Leckey talks about the huge percentage of coders and programmers that could be on the autistic spectrum and, by ever increasing our online life, we're entering into that vision. That kind of way of looking at the world overtakes us.

SC: The beautiful repetition. And the other thing about the smart screen's navigability is that it smashes up that tyranny of perspective that has occupied us for so long, especially in lens-based technologies, which are less perspectival than, let's say, famous examples from Caravaggio like *The Supper at Emmaus*(1601), where the arms reach the canvas and the basket of fruit is leaning beyond the picture plane into the real world. There's a sense of the limitations of an older pictorial regime that Constable is an absolute master of, but he never comes forward before the picture frame. In Constable, everything is retreating and you're going

into it. Caravaggio's *Supper* shows a way of bringing that world forward, which is interesting. But then the other problem is the screen, the glass screen, because that does a whole bundle of things. One of them that Esther points out in the book is about indium tin oxide, widely used in display technologies and LEDs. It *ought* to make us more magically – and ecologically – engaged with both the represented and the object that we are physically holding, but in actuality it gives the impression of doing that while at the same time removing the object from the experience because of the transparency that makes it valuable in the first place, and because it depends on an utterly un-ecological action, which is to pile all the indium in the world into very small portable gadgets – and incidentally on the silvering of DVDs and optical media – to the extent that there is now more indium in waste piles by a considerable majority than there is left in the ground. So what we tend to do is to take the living rocks and not only rip them out but crush them, take out the bits we want, discard the rest with wild abandon, and then we have these intensely reconfigured quantities of tin that was once very common; it isn't anymore. And it's scary, it leaves all sorts of scars, like Cornish tin mines and their still toxic tailings, abiotic even after they have been abandoned for at least a century, and were poor picking for a century before that. So there's a weird mix of an ecological and an un-ecological process, which is precisely where that liquid crystal dialectic operates. If, on the one hand, I'm wary of flows, because they have been appropriated as metaphor in the finance sector, on the other hand, the crystalline is equally an emblem of a deeply frightening ecological process of extraction and concentration, which is, in the end, extravagantly wasteful.

EC: On the topic of the screen interface, I found the Goethe quote about the finger that can see incredibly compelling: that bodily interaction also affects what we expect back *after* we touch the screen. One of my students, Lucy Hardcastle, in the Information Experience Design MA at the RCA has been doing research on YouTube ASMR videos. ASMR is a condition in which certain sounds (usually), like whispering or small movements of materials close to the ear, can trigger a certain kind of tingly feeling on the viewer or listener's scalp or in the brain, almost like an electrical sort of feeling. There isn't a lot of research about ASMR, but it's probably the case that it existed before the internet! That said, ASMR as a phenomenon and a culture has grown up online, in part because it sits very well in that space. Now the videos themselves are incredibly material: a lot of ASMR videos show hands moulding or tapping on some kind of sonorous substance like glass beads or slime. Grooming, and the materials associated with the act, are a prominent feature too; quiet processes like hair brushing, or of scissors snipping hair around the neck are amplified in the videos.

Benedict Drew: It's so interesting to consider this through the prism of structural/material film and also avant-garde music, and the history of sound art; because it's all about a really close listening.

EC: It's like being touched back by the screen!

Benedict Drew: Yes, it's like expanded cinema and also pure affect. It's not about content; it's about what it makes you feel, and your physical response to that.

EL: The work by structuralist filmmaker Paul Sharits, with its intense blasting with a rainbow of different colours, produces something bodily. It has retinal effect, but also a bodily one. His 1968 film *T,O,U,C,H,I,N,G* seems to know this. It has a static image of a man's bare shoulders and head countered by flickers of colours, flash frames and the word 'destroy' repeated over and over until it becomes nothing. But it touches something, touches a nerve, maybe. In a statement prepared for the Fourth International Experimental Film Festival in Knokke-le-Zoute, Belgium, in 1967, he wrote of this 'mandala' work:

> I wish to abandon imitation and illusion and enter directly into the higher drama of: celluloid, two-dimensional strips; individual rectangular frames; the nature of sprockets and emulsion; projector operations; the three-dimensional light beam; environmental illumination; the two-dimensional reflective screen surface; the retinal screen, optic nerve and individual psycho-physical subjectivities of consciousness. (Sharits, cited in *Art Forum*, 2015)

That 'higher drama of celluloid' is its physicality that acts on us – and us on it – through the varied combinations of light, reflection, volume, nervous apprehension, the capacities of our eyes, brains and minds.

EC: The thing about ASMR is that the physical relationship goes the other way too, and there's an expected reciprocity, like you'd expect with another human being.

Benedict Drew: What's interesting about the ASMR phenomenon is that it's kind of soaked in self-help. It's all about – and this goes back to what Sean was saying – feeling good; it's full of positive affirmation, delivered in dulcet tones. It's like: 'you're an amazing person, and I'm going to crinkle some paper for half an hour, because you deserve it.'

EC: The effect is meant to be so physical; it's not only for a sense of mental well-being; there's an actual physical sensation.

Benedict Drew: There's a lot to talk about how it's pornographic too, and I don't think that can be ignored. I think it's interesting that it might be a new kind of pornography, which is probably what we need. It lacks violence, and it's not gender specific …

SC: That's as maybe, but polyurethane crinkling does have a terrible environmental reputation!

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Notes

1. As imagined in Alexey Marfin's 7-minute film *Blue-Eyed Me* (2014).
2. See William Gowland, *Here Be Dragons*: williamgowland.co.uk (2012).
3. For source texts and commentary regarding proto-cinematography, see Dicker (2016).
4. Among Kupka's possessions was an 1896 or 1897 prospectus for Reynaud's *Pantomimes Lumineuses*, which had been projected at the Musée Grévin since 1892.

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