Semiconductor,
Magnetic Movie
(2007). Courtesy of
the artists.

Moving Image Review & Art Journal · Volume 2 · Number 2
© 2013 Intellect Ltd Article. English language. doi: 10.1386/miraj.2.2.198_1

The meta-physics of data: Philosophical science in Semiconductor's animated videos

Lilly Husbands
Kings College London

ABSTRACT

This article examines video and animation works by the artist-duo Ruth Jarman and Joe Gerhardt, known together as Semiconductor. Over the course of the last decade, their works have come to occupy a unique position in the world of artist's film and video with projects that blend – in philosophically compelling ways – experimental video art techniques, scientific research and digital technology. In works like All The Time In The World *(2005),* Brilliant Noise *(2006),* Black Rain *(2009) and* Magnetic Movie *(2007), they approach some of the grandest subjects in the physical sciences (geomorphology and astrophysics) in ways that engage with the metaphysical implications of aesthetically mediating natural forces whose magnitude and actual nature far exceed any capacity for normal perception. For these projects, Jarman and Gerhardt have immersed themselves in rigorous research at prestigious scientific institutions such as the NASA Space Sciences Laboratories (SSL) and the Mineral Sciences Department at the Smithsonian National Museum of Natural History. Here they were given privileged access to scientific research technologies as well as personal instruction by some of the foremost scientists in their fields. However, as artists exhibiting their work in gallery contexts, Semiconductor's creative freedoms have been largely unimpeded by obligations to conform to strict scientific accuracy or to the narrative codes of traditional science documentary. Indeed, the single and multi-channel installations that have resulted from their research are hybrid experimental artworks that engage with their subject matter on a number of different levels, with varying degrees and manifestations of scientific 'truth'. In this article I argue that, in spite of their blurring of discipline boundaries, many of their works enact and*

KEYWORDS

experimental digital animation
philosophy of science
Semiconductor
science and art
data visualization
science documentary

embody a philosophy of science that is engaged with technological investigation and its ability to expressively reveal the material nature of our universe.

> Concepts like hidden dimensions of reality (string theory) or hidden infinite possible parallel universes (the multiverse) are radical revisions of the very concept of reality. Since detailed contact with experimental data might be decades away, theorists have relied mainly on mathematical consistency and 'aesthetics' to guide their explorations. In light of these developments, it seems absurd to dismiss philosophy as having nothing to do with their endeavors. (Frank 2012)

Since the late 1990s, Semiconductor's Ruth Jarman and Joe Gerhardt have been forging relationships between digital imaging technologies, statistical and scientific datasets, and contemporary concepts in the natural sciences to create innovative digital artworks. Their aim is to examine 'how science mediates our experience of the physical world' and how it 'position[s] man as an observer of the shifting world' (Jarman and Gerhardt 2011:1).[1] Their multi-channel installations mix live action film and video with time-lapse and data-led digital animation designed to explore some of physical science's foundational subjects, such as geomorphology, astrophysics and volcanology. Their installations, situated in various hybrid art/science/technology exhibition spaces, reframe representations of scientific procedures, methodologies and discoveries in ways that step outside scientific discourse altogether. Thus they draw attention to the philosophical significance of the conjunction of aesthetics and technology that is manifested in their work. The processes they adopt convey, in visual terms, abstract and theoretically complex scientific discoveries about the world and the universe.[2] It is my contention that despite the obvious enthusiasm Semiconductor's works display for the revelatory capacities of modern science and technology, they simultaneously invite viewers to consider the philosophical problems posed by such technologically mediated observations of suprasensible phenomena (in the forms of what I am calling the *ancestral*[3] and the *invisible*). This combination of enthusiasm for science and philosophical criticality carves out new artistic spaces of enquiry and aesthetic experience.[4]

Semiconductor's work offers a significant contribution to the combined traditions of science film-making and experimental cinema. As James Leo Cahill has noted, the science film and experimental film forms have both used 'the cinematograph as a machine for research, revelation and discovery, endowing spectators with a means of perception […] *quite* different from commonsense experience' (Cahill 2011: 69, original emphasis). Indeed, the notion that cinema (and perhaps more specifically animation) is capable of offering viewers experiences of phenomena that would otherwise remain imperceptible is at the heart of many experimental films that take science as their subjects. Germaine Dulac saw the supra-human perception of certain cinematographic techniques as directly appealing to the avant-garde's desire for a 'visual cinema' that would privilege purely visual perception and the rhythms of form and movement over the literariness and theatricality of narrative film (Dulac 1978: 35).

Throughout experimental cinema's history there have been many film-makers (Jordan Belson, James Whitney, Jim Davis, Maya Deren, Daniel Reeves, Bill Viola, etc.) who were interested in approaching cosmological ideas in the form of mysticism, eastern philosophy and meditation. Some of their films and videos are obliquely evocative of astrophysics or astronomy (e.g. images that resemble star formations); however, their styles and methodologies generally reflect alternative belief systems that would be considered 'pseudo-science' in the western scientific tradition.[5] A number of experimental films were produced in the 1970s that approached issues of scale (from microscopic to astronomic)

1. Jarman and Gerhardt began working together in Brighton in 1997, and in 1999 they embarked on digital animations that they described as 'Sound Films', emphasizing their non-narrative, structural reliance on sound as an animating device (Jarman and Gerhardt 2009: 170). Many of these early Sound Films were created during live performances, where real-time processors of audio-visual data made it possible for the music and animated imagery to merge into one spectacle.

2. For many viewers, access to Semiconductor's work has been through screenings, festivals, DVD sales, television broadcasts and online exhibition platforms; however, most of Semiconductor's work is first exhibited in gallery and museum settings before being reformatted for various viewing platforms. Their most recent solo exhibition, 'Worlds in the Making', took place at the Foundation for Art and Creative Technology (FACT) in Liverpool, UK, in 2011. For a list of all their exhibitions, see: http://www.semiconductorfilms.com/root/Semi_cv.htm. Accessed 21 May 2013.

3. I am borrowing the term 'ancestral' from philosopher Quentin Meillassoux, as I explain below.

4. The enormous dimensions of many of Semiconductor's multi- and single-channel gallery works emphasize the supra-human spatial and temporal magnitude of the phenomena they are representing. Their installations

in more precise and systematic ways including John Latham's *Erth* (1971), Charles and Ray Eames's *Powers of Ten* (1977) and Al Jarnow's *Cosmic Clock* (1979) and *Comic Letter* (1979). Others have used time-lapse animation techniques to depict the earth's rotation around the sun. For instance, Chris Welsby's *Seven Days* (1974), John Smith's and Al Jarnow's films, both called *Celestial Navigation* (1980 and 1984) function like scientific experiments as they chart the passage of the sun over different stretches of time.[6] These films anticipate Semiconductor's three-screen installation *Heliocentric* (2010), in which Jarman and Gerhardt pay homage to a Galilean world-view by using time-lapse photography and astronomical tracking to plot the sun's trajectory across a series of landscapes, keeping the sun in the centre of the screen as the day progresses.[7]

A point of contact between experimental film and the science film is a shared fascination with the abstract, geometric shapes produced by crystal formations. Dutch amateur science film-maker J. C. Mol's *From the Domain of Crystals* (1928), Elwood Decker's *Crystals* (1951) and Jean Painlevé's *Liquid Crystals* (1978) all involve time-lapse micro-cinematographic footage of crystals in the process of forming. As Malin Wahlberg suggests with regard to Mol's films, these crystal films with their 'rhythmic unfolding of abstract patterns' are as conducive to a poetic or contemplative experience as to a pedagogical one (Wahlberg 2006: 288). Experimental film-maker Thorsten Fleisch has grown crystals directly on the celluloid substrate for his film *Kosmos* (2004) in order to investigate their purported magical and mystical qualities.[8] Similarly, in 2012, Semiconductor created a three-channel animation installation, *The Shaping Grows*, as part of the 'Digital Crystal: Swarovski at the Design Museum' exhibition in London. The work consists of several digital animations portraying a vast subterranean cave. The projected images cover the length of the exhibition space on opposite walls and depict innumerable crystal formations coming into being and changing over time.[9] The crystal animations are controlled by seismic data collected from recent earthquake activity around the world, and the evolving crystals represent the ever-changing geological events and processes that constitute the evolution of our planet. As in these earlier artists' films, Semiconductor's digital crystals dazzle, glisten and transform with chaotic, angular precision. However, there is a revealing difference between Semiconductor's crystal works and those of their predecessors. Although the spectacle offers an occasion for viewers to enter a state of enchantment similar to that experienced by Wahlberg, Semiconductor's digital crystals also point to a direct correlation between the precise geometric shapes that compose three-dimensional computer graphics and the similarly complex geometric patterns that characterize crystal formations on molecular and even atomic levels. They 'draw a parallel between these basic molecular structures and the building blocks of the digital world, which has become the prism through which we increasingly experience reality' (Jarman and Gerhardt 2011).

In 2002, Stephen Wilson observed that 'the art world seems relatively less interested in the physical world than it once was'.[10] He noted that 'even technologically oriented artists concentrate on image generation and communication technologies that help them explore issues of virtuality and representation rather than scientific and engineering research into the physical world' (Wilson 2002: 203). However, examples of contemporary experimental film and new media that address complex theoretical issues related to the physical sciences are on the increase. Semiconductor are among a growing number of artists who use technologies developed for scientific investigation and explore the philosophical underpinnings and cultural implications of scientific research.[11] Over the course of the last decade, Jarman and Gerhardt have immersed themselves in research projects at scientific institutions, and these have informed how they translate scientific concepts and discoveries into linguistic and visual forms that render them comprehensible to non-experts.[12] During their time at these institutions, they received personal instruction by some of the foremost scientists in their fields and were given privileged access to specialized research tools and scientific data.[13] Semiconductor often use these

often feature screens displaying HD animations and videos that surround viewers who are equally immersed in voluminous multi-channel audio soundtracks.

5. Many of Stan Brakhage's hand-painted films exhibit a visual analogy with images taken by satellites, an aesthetic similarity that his film *Stellar* (1993) seems to be directly referencing. Experimental film-maker Courtney Hoskins has created a series of handmade films called *The Galilean Satellites (Europa, Ganymede, Callisto, Io)* (2003), which she dedicates to Brakhage.

6. In Welsby's film, we follow the camera's shadow and thus the sun over the course of a week in the Welsh mountains, in Smith's, the shadow of a spade on a beach over the course of a day, and in Jarnow's, shadows crossing his studio over the course of a year.

7. In a contemporary context, Inger Lise Hansen and Emily Richardson each use time-lapse photography and animation in unique ways to convey relationships between celestial bodies and landscape.

8. Marina Abramović believes that crystals possess magical and healing properties. Mary Richards notes that Abramović associates particular crystals with certain parts of the body (Richards 2009: 24). Some of her investigations over the years have involved sleeping with crystals and recording her experiences.

9. In their 2011 exhibition 'Worlds in the Making',

technologies and techniques in ways that emphasize the dramatic difference between the world that science reveals to us and the world as we experience it; for instance, works like *Heliocentric* visualize scientific facts that are normally imperceptible to us, in this case, that the earth revolves around the sun. Perhaps one of the most important ways in which they use scientific techniques in their works is in data visualization in which various forms of data (audio, seismic, magnetic, etc.) literally shape their animated images.[14] In this way they infuse their works with the non-mimetic 'language' of science on a formal as well as a conceptual level. What is singular about Semiconductor's data visualization technique is that it enables them to explore the philosophical problem of translation identified by Michel Serres, as (mis)communication between physical phenomena and their inscription into scientific data by means of instruments and then, further, into words and images (Serres with Latour 1995: 70).

These themes are rehearsed in a number of Semiconductor's works, however, in this article I shall focus on *All The Time In The World* (2005), *Brilliant Noise* (2006), *Black Rain* (2009) and *Magnetic Movie* (2007), all of which resulted from research that Jarman and Gerhardt conducted at the British Geological Survey and at NASA's Space Sciences Laboratories (SSL). The fields of geomorphology and astrophysics are concerned in part with events and phenomena that can only be accessed via speculative induction, abstract mathematics and the mediation of complex technologies. These include processes such as the accretion and evolution of the earth's surface and the material nature of the universe. These disciplines make extensive use of advanced observation technologies including remote sensing, infrared radiometers, ultraviolet spectrometers, ground-penetrating radar, seismometers, and magnometers, and the majority of the information that they acquire has been deduced from data that originates in non-mimetic formats: algebraic equations, seismographic waveforms, spectroscopic images, etc. In this way, geomorphology and astrophysics pose distinct but related problems both for artists and for philosophers in that they produce information about times, spaces and phenomena that are incommensurable with our sensory experiences. For critical philosophy, the problem lies in reconciling the imperatives of empiricism (based on observable sense-data) with the extensive logical and technological mediation involved in their investigations.[15] For post-critical philosophers (like Latour and Serres), the lack of directly perceivable sense-data in modern physical science need not pose such a problem if the theories provide effective explanations and are achieved by means of valid deductive arguments. However, for Gerhardt and Jarman, who are attempting to communicate knowledge provided by complex theoretical science to non-experts, the difficulty remains empirically rooted, that is, in finding ways to accurately represent, in perceptible forms, what science knows about natural phenomena. The geomorphological and astrophysical phenomena that their works address manifest in two different, equally suprasensible earthly conditions: the history and dynamics of landforms as they evolve over millions of years prior to the existence of humanity – the ancestral – and phenomena that either exist outside the visible spectrum or whose size and distance from the earth surpasses any normal human powers of perception – the invisible. In the following sections, I first approach the ancestral as it manifests in *All The Time In The World* and then the invisible as it is invoked in *Brilliant Noise, Black Rain* and *Magnetic Movie*.

The problem of the ancestral

The ancestral, occurring before the appearance of life on earth, poses problems for contemporary philosophy because it produces information about times, spaces and phenomena that no human consciousness could possibly have witnessed. For Quentin

Semiconductor included several short animated works called *Crystallised* (2011), which took the form of a series of digital mineral crystal animations generated and animated by sound recordings of ice crystals.

10. In fact, since the mid-2000s, organizations such as the Wellcome Trust in the United Kingdom and Imagine Science Films in the United States have helped produce and exhibit dozens of collaborations between scientists and film-makers.

11. For instance, artists such as Angela Palmer, and Felix Luque and Iñigo Bilbao have used magnetic resonance imaging (MRI) and computerized tomography (CT) scans to create moving image works, while experimental animator Bärbel Neubauer uses complex algorithms to generate computer animations of fractal patterns. Still others concentrate on ecological and environmental sciences, such as film artist Lynette Wallworth, who has recently made an underwater film about coral reefs called *Coral: Rekindling Venus* (2012).

12. Semiconductor have collaborated at various times with the British Geological Survey in Edinburgh (2005), the NASA Space Sciences Laboratories (SSL) in Berkeley, California (2005), the Mineral Sciences Laboratory at the Smithsonian National Museum of Natural History in Washington, DC (2010) and the Charles Darwin Research Station in the Galapagos Islands (2010).

Meillassoux, the ancestral challenges a foundational premise of modern philosophy since Immanuel Kant, namely 'correlationism'. Correlationism is Meillassoux's term for the assertion that 'the sensible only exists as a relation, between the world and the living creature I am' (Meillassoux 2008: 2). That is, it is ultimately impossible to distinguish between the subjective and the truly objective, because the objective, the Kantian noumenon[16] or 'thing in itself', or what Meillassoux calls the 'great outdoors', can only be encountered through the subjective lens of the observing human (Meillassoux 2008: 7). The scientific discoveries that provide information about events that took place prior to humanity's existence can only ever exist in relation to living human consciousness. For Meillassoux (and indeed anyone who is not a correlationist philosopher), access to the great outdoors is now provided by science through mathematics, and importantly, through technology. Meillassoux writes, 'all those aspects of the object that can give rise to a mathematical thought (to a formula or to a digitalization) rather than a perception or sensation can be meaningfully turned into properties of the thing not only as it is with me, but also as it is without me' (Meillassoux 2008: 3).[17] Logic, mathematics and technology make it possible for science to obtain information about 'ancestral' events that took place prior to human existence through seismograms, stratification, a decaying isotope or the 'luminous emission of a star that informs us as to the date of its formation' (Meillassoux 2008: 10). However, mathematical data allows us to determine only the primary qualities of ancestral events. How such events might have appeared to the senses – its secondary qualities – remains mere speculation. There is a significant difference between the information that science is able to provide about these events and the ways in which we are (un)able to relate to them experientially via natural perception.

This problem is at the heart of Semiconductor's five-minute video *All The Time In The World*. It begins with a subtly animated shot of a cove along the craggy coastline of Saint Abb's Head beach, accompanied by the sounds of waves regularly crashing against the shore.[18] Suddenly, a thunderous boom resounds, and the image of the cove vibrates and trembles in time with the noise. Numerous digitally animated balls of sparkly white light then appear, bouncing around, in and out of the recesses of the shoreline, illuminating the cliffs as they move. They seem to give off a crackling, high frequency electronic sound as they fly about like giant insects, eventually gliding out to sea and disappearing into the air. At first, spectators might be struck by the strangeness of what seems like a supernatural event; however, in the notes that accompany the film, Semiconductor explain that these 'earth lights' are 'said to be the result of tectonic movement in the strata below us. Flashes of light and electricity are produced as movement squeezes mineral crystals together, displaying luminous objects whose motion coincides with the direction of ruptures within the earth' (Jarman and Gerhardt 2007: 15).[19] The lights give way to an image of the exposed striations of a large rock formation along the body of a partitioned hill at Cocklawburn beach, and the rumbling, seismic sounds heard briefly at the beginning return, causing the outlines of the rocks to jump and vibrate. The remainder of the video takes us from one heaving landscape to the next as the chugging, rumbling noise increases in speed and intensity, climaxing towards the end in an image of a green and golden expanse of the Cheviot Hills undulating like a water bed, transforming the horizon into wildly fluctuating sine waves. The work comes to a close as the sound recedes and the misty rolling hills return to stillness.

Semiconductor's use of scientific data as a sculptural animation tool takes on a philosophical significance in *All The Time In The World* because it represents the mathematization and technological mediation of nature through which we can access the deeper secrets of Meillassoux's 'great outdoors' (2008: 7). It was during a fellowship at Berwick Gymnasium Gallery in Berwick-Upon-Tweed that Jarman and Gerhardt converted into sound the data recordings of local seismic disturbances acquired from the archives at the British Geological survey in Edinburgh. They used the resulting

13. For instance, they used digitally transmitted imagery from the Heliospheric Imager satellite features in their time-lapse animations *Brilliant Noise* (2006) and *Black Rain* (2009).

14. They first started working with this process in the late 1990s by manipulating paths between software programs in order to translate a piece of audio into visual data and vice versa. They began applying a similar process to the data's waveform patterns, transforming them into sound waves and visual data that they then used to generate and control their animations through programming and audio amplitude (Jarman and Gerhardt 2012).

15. Critical philosophy, associated with the later philosophical writings of Immanuel Kant and his followers, suggests that the primary task of philosophy lies in the critique of rather than the justification of knowledge. It claims that we cannot make substantive epistemological claims about the world independently of our cognitive and perceptive apparatus, which is fundamentally based on experience.

16. In *The Critique of Pure Reason* (1781), Immanuel Kant distinguishes between what he calls *phenomena*, or objects as they are interpreted and understood by human sensibility, and *noumena*, or objects as things-in-themselves, which humans cannot experience directly. While Kant asserts that the thing-in-itself is unknowable, he maintains that it is thinkable, and thus Meillassoux calls this 'weak' correlation.

sound to digitally reanimate both still photos and video footage shot at various locations along the Scottish border, choosing places that offered visible evidence of volcanic and sedimentary rocks created from 300 to 400 million years ago.[20] Semiconductor's animation technique maps the data onto movements of the image so as 'to suggest the motion that had gone into shaping the land, as if we were watching hundreds of thousands of years condensed into the length of a few minutes' (Jarman and Gerhardt 2009: 171). For them, digital animation can 'reveal and bring to life the constantly shifting geography around us' (Jarman and Gerhardt 2007). Indeed, the quaking rock formations in the work convey a dramatic sense of the power under the earth's surface, a force that can shift huge masses of land. However, by manipulating *contemporary* images of these locations from an accessible human viewpoint, the work also encourages viewers to contemplate their privileged yet illusory positions as witnesses to a history that in reality was observed by no living creature. Semiconductor have not used animation to imaginatively re-enact the physical transformations that have taken place over millions of years. They have not created a simulation of the rocks' shifting geology with a reassuringly teleological voice-over leading viewers through the evolutionary stages of transition, culminating triumphantly in the contemporary landscape. Instead, through their data-based animation technique they signal the abstract language of the seismic data that scientists use to help them understand the geological history of the area, and which as Meillassoux argues, is the only means of gaining access to the ancestral beyond the reach of subjective perceptions. In the work itself, the geometric shapes created by one form of scientific documentation (the seismological graph) in turn manipulate the remaining visual clues left in the contemporary landscape, thereby visually conceptualizing the history that the graph symbolically represents.

There is a paradox at the centre of the work's ostensible project, whereby the bringing into the visual field of natural forces that far exceed any capacity for normal human perception is achieved by means of computer-generated data that itself testifies to the limitations of empirical observation based on the senses. This, however, points precisely to the contradiction inherent in Semiconductor's artistic representation of suprasensible phenomena: while Jarman and Gerhardt's position is anti-correlationist in the sense that they believe that scientific data provides access to the great outdoors, as visual artists, they adopt an anthropocentric point of view that reaffirms the correlationist dilemma (it would be virtually impossible not to do so).

The problem of the invisible

The philosopher Alex Rosenberg observes, 'while the official epistemology of science is empiricism – the thesis that our knowledge is justified only by experience, that is, experiment and observation – its explanatory function is fulfilled by just those sorts of things that creatures like us can have no direct experience of' (Rosenberg 2005:84). Although empirical science is still founded upon experimental observation, the exact nature of that observation has changed dramatically due to modern technological innovation. Technology has always played an important part in scientific discovery: science as we know it would not have come to be without the invention of the telescope and the microscope in the sixteenth and seventeenth centuries. However, beginning in the latter part of the nineteenth century, powerful new technologies instigated a profound paradigm shift from the observable laws of Newtonian physics to the abstractly theoretical ones of modern quantum physics. Ernst Mach's wave theory, the discovery of X-rays by Wilhelm Röntgen in 1895, Einstein's theory of relativity, and the testing of atomic theory in bubble chambers all served to change the way

17. Meillassoux is following Galileo's epistemological distinction between primary and secondary qualities, where primary qualities are those that an object possesses independent of any observer and where secondary qualities are those properties that produce sensation in observers.

18. Saint Abb's Head beach is a National Nature Reserve and the home of more than 60,000 seabirds, whose calls are audible on the soundtrack.

19. These incandescent orbs, or 'earth lights', are often responsible for UFO sightings, and witnesses around the world and throughout history have attributed to them multifarious supernatural causes. In the 1980s, British scientist Paul Devereux coined the term 'earth lights' (which helps distinguish the phenomenon from ball lightning or earthquake lights), and they are said to occur near fault lines and places where the earth's crust is particularly active. Despite Devereux's and others' efforts, there is still very little understood about this natural occurrence; they remain a marvellous and mysterious phenomenon that eludes science's full understanding. Paul Devereux, 'Abstracted from a presentation given by Paul at the Dana Centre, Science Museum, on 9 December, 2003'. http://www.pauldevereux.co.uk/html/body_earthlights.html. Accessed 21 May 2013.

20. These rock formations lie about 60 miles from those that inspired Scottish geologist James Hutton's theory of

scientists understand the previously invisible landscape of the material world. Indeed, technologies that can detect and render visible hidden aspects of the universe are mostly responsible for what contemporary science has come to understand about the material nature of our universe (Ihde 1991: 45). These discoveries have indicated a shift in theoretical science 'from the *perceptual* to the *conceptual*', creating an ever-greater distance from the old understanding of reality achieved by means of direct sensory experience (Wolf 1999: 286).

Philosophers of science have, in part, dealt with this shift away from scientific investigation based on direct observation, the foundational idea of positivism, by amending the epistemological claims of positivism to accommodate the conjectural nature of their theories and by concentrating instead on the pragmatic use of scientific instruments as means to an end. Contemporary post-positivist and instrumentalist philosophies believe that 'scientific theories should be treated as heuristic devices, tools for organizing our experiences and making predictions about them' (Rosenberg 2005: 197). The emphasis is not so much on how accurately scientific theory describes objective reality, but on how effectively they explain and predict phenomena. Nevertheless, these philosophical approaches have not fully resolved the tensions between technologically mediated observation and direct experience. Jésus Mosterín is one of the few philosophers to have tackled the philosophical quandaries that arise with the recognition that technologically mediated observation in modern science is largely impersonal and indirect.[21] He asserts:

> None of the proposed accounts does justice to the essential role played by any computer processing of data, or by computational management of the whole experiment, its parts and its stages. From the detection of signals to the collection, analysis, selection and recording of data and the interpretation of results, computers as artificial extensions of our brains interact with the detectors as artificial extensions of our senses in myriads of scarcely analyzed ways. (Mosterín 1998: 78)

Mosterín emphasizes the significant level of remove that exists between astrophysicists' observational experiences and the extra-terrestrial phenomena that they observe. He points out that most modern super power telescopes do not even have eyepieces for direct observation and instead receive stimuli on nitrogen or helium refrigerated charge-coupled devices (CCDs). Astronomers view the images on a computer screen (often in another room altogether).[22] He continues:

> Most of the time the astronomer does not even see pictures of the observed object on the screen, but only graphics representing the computer-generated spectral analysis of its light as detected by the CCD. What the astronomer sees on the screen has gone through multiple transductions of photons into electric charges and currents, and electronic transformations inside the computer, till finally the last electrons are transduced back to photons in the cathode ray tube of the computer screen. Those are the photons that reach the astronomer's eye […] not the photons of the astronomical source. […] But observation nevertheless it is. The whole process has been triggered by photons coming from the source. (Mosterín 1998: 70–71)

Not only does this demonstrate the high degree of removal between the initial stimuli and sense-experience in astrophysical investigations, it also provides evidence for the constitutive role that visualization (mostly by means of computer animation) plays in such incidences of remote observation (van Dijk 2006: 14). Since the Scientific Revolution, researchers have used maps, models and schematic diagrams to communicate

the immense antiquity of the earth's surface in the late eighteenth century, known as 'deep time', which disproved the biblically inspired 'diluvial' explanation of the landscape's formation that was accepted at the time, and which paved the way for contemporary geomorphology.

21. This might also be described in terms of what G. Deleuze and F. Guattari called 'machinic vision' (1987: 88–91), which John Johnston suggests 'presupposes not only an environment of interacting machines and human-machine systems but a field of decoded perceptions that, whether or not produced by or issuing from these machines, assume their full intelligibility only in relation to them' (Johnston 1999: 27).

22. Phenomenologist Don Ihde comes to a similar conclusion when he suggests that the interfaces, or visual displays, of these technologies must always cater to an embodied human perspective and inevitably entail degrees of translation for hermeneutic purposes (Idhe 2012: 141).

complex theoretical ideas and to assist in their own understanding of these ideas.[23] Nowadays, computer simulations, derived from underlying mathematical and algorithmic calculations and data input, present scientists with information in the form of mimetic moving images generated from the data itself. Indeed, computer-generated animation is playing an ever-increasing role in how scientists visually relate to and conceive of the findings of their instruments. However, an important distinction must be made here between the imaging techniques that scientists use to supplement their mathematical and statistical data and the kinds of visual representations that are often used to communicate scientific information to non-expert audiences. Astrophysicist E. P. Szuszczewicz makes an important point when he notes that modern scientific visualization has nothing to do with being a 'pretty picture' but is the result of a combination of intensive training and expert knowledge of certain technological tools (Szuszczewicz 1995: 5). However, the imagery that is most often presented to the general public gives very little indication of the degree of complexity involved in the reading of scientific images. Digital imagery of phenomena that fall outside the spectrum of visible light (captured using various spectroscopic technologies) first has to be transduced into the visible portion of the spectrum in order to be human-accessible. These images are most often conveyed to the general public cleaned up and coloured in ways that conform more closely to our preconceptions of what they *should* look like (red, orange and yellow for the sun, etc.). Martin Kemp has observed that 'in keeping with the perceptual practices of those who first looked through optical devices, the topographies of the unfamiliar worlds are certified by analogy to morphological features visible within the normal compass of our unaided vision. The metaphorical language of science often speaks of this mode of seeing and describing' (Kemp 2000:140). Moreover, Kemp offers potential explanations for this anthropocentric tendency by stating that it is a response to 'the voracious public need for pictures of new discoveries within a culture which ceaselessly demands cascades of visual novelty'. In addition, 'the huge budgets for space exploration need to be justified. Some kind of spectacular public output is required if the enterprises are to continue' (Kemp 2000: 139).

This process of image familiarization is precisely what Semiconductor refuse to do in *Brilliant Noise* and *Black Rain*. The time-lapse animations are composed of digitally transmitted images sent by satellite, with the former focusing on the dynamic behaviours of the solar surface and the latter depicting the Heliospheric Imager satellite's journey tracking the earth's orbit around the sun. Jarman and Gerhardt learned how to access the Solar and Heliospheric Observatory (SOHO) space satellite's image archive and to use programming languages such as Interactive Data Language (IDL) to extract thousands of still images from stored data archives. In conjunction with images from the SOHO archive, they used images from the Heliospheric Imager on the NASA STEREO satellite to create the animations. The notes that accompany the work tell viewers that

> these images have been kept in their most raw form, revealing the energetic particles and solar wind as a rain of white noise. This grainy black-and-white quality is routinely cleaned up by NASA, hiding the processes and mechanics in action behind the capturing procedure. (Jarman and Gerhardt 2007: 9)

The animations are composed of unadulterated black and white coronagraph images, without the colourization that normally renders these images more 'naturalized'.[24] The works were exhibited as enormous multi-screen installations that surrounded and towered over the viewer, conveying the expansive otherworldliness of their subjects. In their various screening formats, these animations offer experiences that are inflected with a sense of disorientation, and it is impressive how little concrete information

23. The Scientific Revolution began in Europe in the sixteenth century with Nikolaus Copernicus's discovery of the heliocentric universe and continued until the late eighteenth century. It was an era characterized by developments in mathematics, physics, astronomy, biology, medicine and chemistry that transformed ideas about society and nature, eventually giving rise to modern science.

24. A coronagraph is a telescopic attachment that uses a disk to block out the direct light from the sun (functioning like an eclipse) so that nearby objects and solar emissions – which otherwise would be hidden by the sun's glare – are made visible.

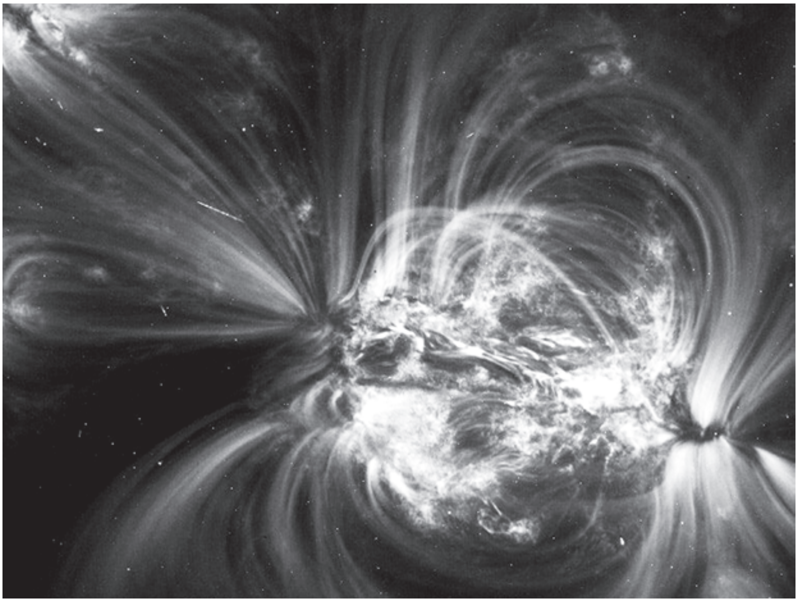
can be gleaned solely from the images in their unadulterated state. Indeed, it is largely through the contextualization of the accompanying notes that the animations are rendered intelligible, an effect that in turn calls attention to how much our understanding of the universe is mediated through scientific explanation. Despite their interest in the indefinable qualities of these phenomena, Jarman and Gerhardt are compelled to explain the works and the different stages of transformation that, as artists, they have had to enact in order to create them. In this way, the full complexity of the works' philosophical significance can be made apparent. However, they still maintain, at the level of the image and its staging, a sense of inexpressibility, one that acknowledges the limitations of visual representation when the creative ambition is to embody the scale and power of solar activity.

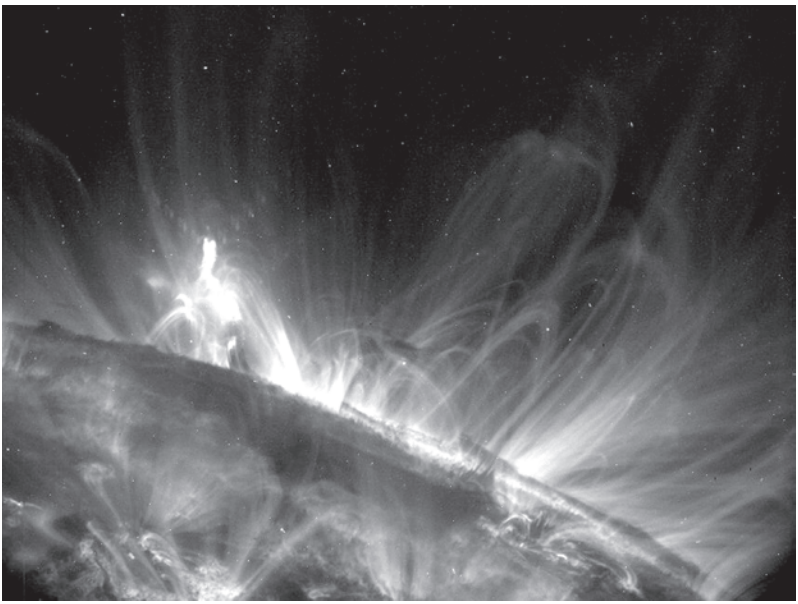
From the accompanying notes we are made to understand that the white flashes we see in *Brilliant Noise* are solar emissions travelling in elastic loops projected from the sun's corona. *Black Rain* offers only the occasional recognisable orientating view (of the distant Milky Way, for instance), and the notes tell us that what we are seeing is the Heliospheric Imager satellite as it is blasted with solar winds and coronal mass ejections (CMEs), which appear as blinding white light and sound like static interference.[25] Beyond the emphasis on the technological mediation of celestial activity, the persistent jitter and continuous, omnidirectional rotation of point of view also give a strong sense of the fragility and precariousness of these manmade objects floating in space, valiantly transmitting incredible images back to earth. *Brilliant Noise* and *Black Rain* successfully highlight the ingenuity of humanity's technological accomplishments whilst simultaneously conveying a visceral reminder of the overwhelming vastness and indifference of the universe.

Where artists like Semiconductor are creating computer animations to celebrate the wonders of the cosmos, as we have seen, scientists rely on digitally captured and computer-generated visualizations to interpret the data amassed by their instruments, and they increasingly use animation to communicate these discoveries to the general public. In recent decades the use of animation in theoretical, speculative (or as Mark J. P. Wolf calls them, 'subjunctive') science documentaries has become more common. These animations are intended for general audiences and deal in scientific speculation, whereby 'computer imaging and simulation are concerned with what *could be*, *would be*, or *might have been*' (Wolf 1999: 274). This has, of course, given rise to debates around indexicality and how the digital has changed the nature of documentary, although most scholars concede that animation can be a legitimate means of conveying abstract scientific concepts as long as the degree of approximation is acknowledged. Wolf argues in favour of the advances in knowledge that computer animation enables, stating that 'in this era of computer simulation, there is a greater willingness to trade close indexical linkage for new knowledge that would otherwise be unattainable within the stricter requirements of indexical linkage that were once needed to validate knowledge empirically' (Wolf 1999: 274). However, other scholars like Andrew Darley have voiced concern about the increasing use of speculative simulation presented as legitimate documentation, and he calls instead for a more openly critical form: 'one allowing much more significance to the ever-present uncertainty and disputation that inevitably attends science's own developing and shifting constructions (or representations) of reality' (Darley 2003: 254). He points out that many science films continue to present viewers 'with assured and univocal stories of discovery and progress, pre-digested for their edification' (Darley 2003: 232). Semiconductor's *Magnetic Movie* can be read as a critique of this tendency but it simultaneously acknowledges the challenge and the need to translate scientific discoveries into communicable signs.

Magnetic Movie takes place in several rooms in NASA's Space Sciences Laboratory where Semiconductor has introduced brightly coloured animated visualizations

25. Their electronic soundtracks are derived from samples of solar natural radio and are controlled by the fluctuations in the intensity of the brightness of the image. Thus *Brilliant Noise* and *Black Rain* flicker and flare with static interference both visually and aurally. On their DVD *Worlds in Flux*, Semiconductor presents *Brilliant Noise* with eleven audio interpretations of the film by eleven different musicians, allowing viewers to choose to experience the film in a number of different ways. The artists featured are: Antenna Farm, Disinformation, Thomas Dimuzio, Ensemble, Gæoudjiparl, Robert Hampson, Iris Garrelfs, Our Brother The Native, Max Richter, The Twilight Sad and Cristian Vogel.





Semiconductor, *Brilliant Noise* (2006). Courtesy of the artists.

of magnetic fields.[26] The work is actually composed of a series of still images to which Semiconductor have applied computer-generated animation and 3D compositing techniques creating the illusion that various incarnations of magnetic fields are actually manifesting within the labs and offices. A kinestatic, virtual camera effect serves to conjure an embodied presence that floats around and spies on the deserted labs where these extraordinary activities are taking place.[27]Actual Very Low Frequency (VLF) audio recordings of magnetic fields and magnetic radiation (including recurrent 'whistlers' produced by fleeting electrons) are heard on the soundtrack, and the VLF data controls the movements of the animations that are approximating the invisible magnetic fields (using the same technique as that employed in *All The Time In The World*). The soundtrack delivers the voice-overs of several scientists attempting to describe the physical properties of these phenomena as they occur on the surfaces of the sun and the planet Mars. Semiconductor's animations exactly illustrate the scientists' descriptions of the fields, yet importantly they are shown occurring in incongruous places: under tables, in glass containers, and around the machines that populate the laboratory. The magnetic fields are animated in black and white and implausibly candescent shades of red, green, blue and yellow. The work exhibits a loose, episodic narrative structure (some of the voice-over descriptions start mid-sentence) ending in a climax wherein the colourful animations of magnetic waves mesh and increase in size, bulging out beyond the confines of the laboratory, finally engulfing the entire building in green wavy projections suggestive of the polar auroral lights.[28]

Through the use of voice-over, *Magnetic Movie* places special emphasis on the language that scientists use to describe these invisible phenomena. In the first utterance of the film, Janet Luhmann states that 'magnetic fields are by their nature invisible', adding that, nonetheless, 'there are some things that nature does to make them more visible'.[29] Because magnetic fields control the atmosphere around them, she explains, scientists deduce that they take on certain shapes, such as 'loops' and 'hairy balls', and the charged particles that make up the atmosphere follow along the trajectories created by the magnetic fields. The mundanity and playfulness of the scientists' descriptions – their recourse to terms like 'hairy balls' – calls to mind Bertrand Russell's observations about the abstractness of modern physics:

> Ordinary language is totally unsuited for expressing what physics really asserts, since the words of everyday life are not sufficiently abstract. Only mathematics and mathematical logic can say as little as the physicist means to say. As soon as he translates his symbols into words, he inevitably says something much too concrete, and gives the readers a cheerful impression of something imaginable and intelligible, which is much more pleasant and everyday than what he is trying to convey. (Russell 2009: 56–57)

This voice-over makes evident a particular difficulty that physicists themselves face when they are attempting to describe their findings to non-experts. As Mosterín has argued, 'physicists are careful in the use of their technical terms, but often loose in their general vocabulary (words like seeing, observing, discovering or studying)'. He notes that, for instance, 'cosmologists often talk of "observing" the Big Bang (or its immediate afterglow)' (Mosterín 1998:71). Indeed, the desire to describe these suprasensible events in terms of how they might appear if they could be seen by the naked eye seems to be an almost irresistible compulsion. A scene in *Magnetic Movie* is particularly striking in this context. One of the scientists describes the magnetic fields on Mars from an impossibly personified perspective; he states, 'If you're above one given region of Mars' surface, you might see magnetic field lines bursting out straight towards you, and as they get closer to you they start to curve away and turn so that they zoom off into the distance and they bend back and they go diving down. But you're not seeing

26. Animate Projects commissioned the work for Channel 4 in 2007 following Semiconductor's five-month residency at NASA's SSL. The work is available online at: http://vimeo.com/1166968. Accessed 27 May 2013.

27. Also known as the Ken Burns effect, kinestasis is a technique that animates still photographs to create the illusion of camera movements such as tracking, zooming and panning.

28. The *aurora borealis* are the result of energy brought by the solar wind hitting the earth's magnetic field at the polar regions.

29. Scientists Janet Luhmann, Bill Abbett, David Brain and Stephen Mende are credited at the end of the film. Stephen P. McGreevy made the VLF recordings.

just one of these, you see this happening all around you'. During this vivid exposition, viewers are presented with contrasting images of glowing red and blue squiggly lines that sprawl out across the room and around the walls and ceiling of the empty laboratory in a faintly comical way that accentuates the necessary limitations of describing such a phenomenon in terms of subjective experience. The majority of the animations in *Magnetic Movie* interpret the magnetic fields' trajectories as streaming coloured lines with 'dancing dots' moving along them, acting almost as caricatures of what the scientists are describing. However, a scene in which the magnetic fields are animated in 'close-up' illustrates more precisely the difficulty of visualizing a phenomenon that can only be seen as an effect on its surroundings. This moment features red and black balls bouncing around what look like clear straws (the scientist describes them as 'intergranular lanes'), which the artists have created by mixing broad white lines with an unfocused background. In order to depict the forces of the magnetic field, Semiconductor are obliged to 'cheat' by representing the quality of colourlessness (invisibility) as transparency, and how, visually, could they do otherwise?

Magnetic Movie offers up a complicated interaction between the authority of the scientists' voice-overs, the animated visualizations, and their location in the laboratory. By situating the brilliantly coloured visualizations of magnetic fields in the scientists' laboratory (instead of, say, on the sun, or on Mars), *Magnetic Movie* reminds us that our understanding of these phenomena has as much to do with the esoteric instruments and equations scribbled on chalkboards that scientists use to process this information as it does with the sun itself or the planet Mars. The use of the VLF data and sound reiterates the contradictions inherent in attempting to render these phenomena for the human senses, because sound is a phenomenon whose existence is dependent on the vibrating molecules in the earth's atmosphere (magnetic fields in deep space would not make noise). In *Magnetic Movie*, the tension between the interpretive subjectivity of art and the purported objectivity of science is foregrounded by the interplay of animated visualization, scientific narrative and the abstraction of digital information. This strategy draws special attention to science's speculative extension beyond direct sense-experience, an extension that puts tremendous faith in technological mediation – on machines that penetrate beyond what the eye can see. In common with the other works that I have discussed here, *Magnetic Movie* emphasizes the importance of remaining at least witting, if not critical, of the increasingly technological means by which contemporary scientific investigation is conducted without succumbing to the full-blown scepticism of post-positivist epistemological relativism.[30] Jarman and Gerhardt manage to present complex scientific subjects whilst simultaneously offering viewers an opportunity to consider the inherent problems of visualising both 'ancestral', terrestrial events and the 'invisible' activities of the material universe. At the same time, their work celebrates the wonders of what contemporary science has discovered about our universe, and they confirm the value of engaging with the findings of scientific exploration from the perspective of visual art.

30. Based on the influential works of philosopher W. V. O. Quine and historian of science Thomas Kuhn, post-positivist epistemological relativism 'allows for the possibility of alternative and conflicting views without adjudicating which is objectively correct: none are, or rather each is, correct from the perspective of some epistemic point of view, and all points of view have equal standing' (Rosenberg 2005: 191).

Post script

Semiconductor's work is receiving increasing attention, and their presence is being felt within the art world. They are also making their mark in the international scientific community. More importantly, perhaps, is the attention they have garnered in the mass media, 'where they have been influential in redefining the application and aesthetics of scientific visualisations' (Jarman and Gerhardt 2012). Programmes such as the BBC's *Wonders of the Solar System, Men of Rock,* and *Wonders of the Universe* have all incorporated their works, and many have adopted animation techniques developed by the artists themselves. Reflecting on the message within the epigraph with which I began this article, there would still appear to be a pressing need for the kind of philosophical critique of scientific representation that a close reading of Semiconductor's works can elicit.

Acknowledgements

Special thanks to Catherine Elwes and the MIRAJ editorial team for their helpful comments and suggestions. Thanks also to Ruth Jarman and Joe Gerhardt for their personal communications.

REFERENCES

Cahill, J. L. (2011), 'Hors d'Oeuvre: Science, the short film and *The Perception of Life*', *Framework*, 52: 1, pp. 66–83.

Darley, A. (2003), 'Simulating natural history: *Walking with Dinosaurs* as hyper-real edutainment', *Science as Culture*, 12: 2, pp. 227–56.

Deleuze, G. and Guattari, F. (1987), *A Thousand Plateaux* (trans. Brian Massumi), Minneapolis: University of Minnesota Press.

Dulac, G. (1978), 'From "Visual and Anti-Visual Films"', in P. A. Sitney (ed.), *The Avant-Garde Film: A Reader of Theory and Criticism*, New York: New York University Press, pp. 31–35.

Frank, A. (2012), 'Why are physicists hating on philosophy (and philosophers)?', http://www.npr.org/blogs/13.7/2012/05/01/151752815/blackboard-rumble-why-are-physicists-hating-on-philosophy-and-philosophers. Accessed 5 November 2012.

Ihde, D. (1991), *Instrumental Realism: The Interface Between Philosophy of Science and Philosophy of Technology*, Bloomington: Indiana University Press.

—— (2012), *Experimental Phenomenology: Multistabilites*, 2nd ed., Albany: State University of New York Press.

Jarman, R. and Gerhardt, J. (2007), 'Semiconductor', in *Semiconductor: Worlds in Flux* (DVD liner notes), England: Fat Cat Records, pp. 2–3.

—— (2009), 'Semiconductor: Magnetic movie', in A. Selby (ed.), *Animation in Process*, London: Lawrence King Publishing Ltd., pp. 170–75.

—— (2011), 'Semiconductor: Worlds in the making', exhibition catalogue, Foundation for Art and Creative Technology (FACT), Liverpool, 1 July–11 September.

—— (2012), E-mail correspondence, 20 June.

Johnston, J. (1999), 'Machinic vision', *Critical Inquiry*, 26: 1, pp. 27–48.

Kemp, M. (2000), *Visualizations: The Nature Book of Art and Science*, Oxford: Oxford University Press.

—— (2006), *Seeing/Unseen: Art, Science, and Intuition from Leonardo to the Hubble Telescope*, Oxford: Oxford University Press.

Meillassoux, Q. (2008), *After Finitude: An Essay on the Necessity of Contingency* (trans. Ray Brassier), London: Continuum.

Mosterín, J. (1998), 'Technology-mediated observation', *Philosophy and Technology*, 4: 2, pp. 68–80.

Richards, M. (2009), *Marina Abramović*, New York and London: Routledge.

Rosenberg, A. (2005), *Philosophy of Science: A Contemporary Introduction*, London: Routledge.

Russell, B. (2001), *The Problems of Philosophy*, Oxford: Oxford University Press.

—— (2009), *The Scientific Outlook*, New York and London: Routledge.

Serres, M. and Latour, B. (1995), *Conversations on Science, Culture and Time* (trans. R. Lapidus), Ann Arbor: University of Michigan Press.

Szuszczewicz, E. P. (1995), 'Visualization: A pathway to enhanced scientific productivity in the expanded missions of space and earth sciences', in E. P. Szuszczewicz and J. H. Bredekamp (eds), *Visualization Techniques in Space and Atmospheric Sciences*, Washington, DC: National Aeronautics and Space Administration, pp. 3–12.

van Dijk, J. (2006), 'Picturizing science: The science documentary as multimedia spectacle', *International Journal of Cultural Studies*, 9: 1, pp. 5–24.

Wahlberg, M. (2006), 'Wonders of cinematic abstraction: J. C. Mol and the aesthetic experience of science film', *Screen*, 47: 3, pp. 273–89.

Wilson, S. (2002), *Information Arts*: *Intersections of Art, Science, and Technology*, Cambridge, MA: Leonardo.

Wolf, M. (1999), 'Subjunctive documentary: Computer imaging and simulation', in J. M. Gaines and M. Renov (eds), *Collecting Visible Evidence*, Minneapolis: University of Minnesota Press, pp. 274–91.

CONTRIBUTOR DETAILS

Lilly Husbands is a doctoral candidate in Film Studies at King's College London. Her research is concerned with closely investigating contemporary North American and British works of experimental animation, focusing particularly on the varieties of non-normative aesthetic experience that such works invite and cultivate. Her interests include experimental cinema and video, animation and special effects, film aesthetics, film philosophy, spectatorship and film music.

E-mail: lilly.husbands@gmail.com

Intellect books

publishers of original thinking | www.intellectbooks.com

artUS 2011–2012

The Collector's Edition

Edited by Paul Foss and Laurence A. Rickels

ISBN 978-1-78320-002-3 | 312pp
£29.95, $45.00 | 2013
Paperback | 279x216mm
eBook available

artUS magazine collects international art criticism and is celebrated for its critical vigour and uncompromised perspective. Presenting new art reviews, essays and features, the magazine has gained a loyal following among scholars of international contemporary art and culture because of its established yet alternative approach to the American and international art scenes. As a critical and academic alternative to the more commercially driven popular arts magazines, *artUS* is one of the world's leading academic resources for vibrant and uncensored critical discussion. This collector's edition gathers together the print versions of *artUS* magazine's issues 31 through to 33 and features texts on Grant Wood, *Cannibal Holocaust*, Buddhist art, Paul Thek, John Currin, Alexander McQueen, *Cloning Terror*, Marlene McCarty, Tõhoku, Occupy movements, Ed Kienholz, *The Language of Objects in the Art of the Americas*, philosophy of shadows, Boris Lurie, food as art and mummy movies.

Paul Foss founded artUS *in 2003 in Los Angeles and previously taught history and philosophy of science at the University of New South Wales, Australia, before becoming editor of* Art & Text *from 1984 to 2002. Laurence A. Rickels is professor of art and theory at the Academy of Fine Arts Karlsruhe, Germany, and Sigmund Freud Professor of Media and Philosophy at the European Graduate School in Saas-Fee, Switzerland.*

We are here to support your ideas and get them published. To send us your new book or journal proposal, please download a questionnaire from www.intellectbooks.com.

To view our catalogue or order our books and journals visit **www.intellectbooks.com**

Intellect, The Mill, Parnall Road, Fishponds, Bristol, BS16 3JG.

Tel: +44 (0) 117 9589910
Fax: +44 (0) 117 9589911