Explosive volcanic eruptions, crackling geomagnetic storms, accelerated crystalline growth —Semiconductor's work harnesses the wonders of the natural world. Having been embedded at institutions like the NASA-affiliated Space Sciences Laboratory, and regularly collaborating with leading scientists, the inquisitive duo of Ruth Jarman and Joe Gerhardt demonstrate the role artists can play in exploring the unknown.

Text: Daniel West —— Photography: Rick Morris Pushinsky

Left: Cubbyholes in Semiconductor's studio contain a curious mix of redundant technology and comfy winter clothing.

Upper right: More bygone tech—a MiniDisc deck, cassette recorder, S-Video player, and radio tuner. "They are all formats that were going to be 'the future,' and we can't bring ourselves to get rid of them," Jarman notes dryly.

Middle right: Drawings from *Complexity*, a series in progress. Each of these test prints has been "hand-sculpted digitally" and will ultimately be realized on hand-made carbon paper. "At the moment they are hanging about so we keep them in mind."

Lower right: A place for everything and everything in its place—these crates contain prints from *Flow Maps* and *Seismograph Drawings* that were recently exhibited at Centro de Arte Moderna (CAM) in Lisbon.

—— Science and art are incestuous. Though the two are distinct in their methods and aims, there has always been a propagative exchange between them. During the Renaissance, educated Italians were schooled in both as part of a unified quest for knowledge and enlightenment termed Natural Philosophy. From da Vinci's anatomical drawings to Turner's nineteenth century paintings visualizing Faraday's electromagnetic theories, artists have regularly been inspired by and contributed to their sister discipline. Scientists have often returned the gaze, with sixteenth century cartographers and nascent biologists borrowing Albrecht Dürer's illustrative techniques, James Clerk Maxwell sculpting the first three-dimensional scientific visualisation from clay in 1874, and Nobel laureate Niels Bohr using cubism to understand quantum physics.

Brighton-based duo Semiconductor is emblematic of a more recent convergence of science and art. As computer prices dropped in the 1980s and '90s, the tools and techniques of experimentation were extended from labs to studios. Studying at the University of Brighton, Ruth Jarman and Joe Gerhardt were swept up by the creative possibilities encoded within information technology. From music videos for DAT Politics to live performances using their own audio-visual software, Semiconductor's early work was a fusion of computer graphics and glitchy electronic music. The results were often incoherent but intriguing, as if Bridget Riley had been imprisoned in a web café with Squarepusher.

Like their contemporaries, Jarman and Gerhardt discovered that the computer's very structure and processes—its 'technicity'—tilted their output towards abstract digital expressionism. Despite new media's experimental context, the output was often similar in tone and form. Arts festivals such as London's onedotzero, Barcelona's Sónar, and Berlin's transmediale helped filter out the more meretricious work, but I and many other cultural critics grew bemused with the pervasive staleness during the new media art boom. Its aesthetic and formative freshness quickly tired, revealing a lack of narrative and character—in both senses of the word. Just as free jazz turned from innovative to irrelevant, a creative cul-de-sac began to suffocate digital animation.

New media artists were in a paradoxical bind, with computers having both liberated and constrained their powers of expression. Semiconductor was acutely aware of this problem. "Deconstructing the computer and its language was part of the whole scene at the time. We called ourselves Semiconductor because we were only in part control of what we were making—the computer was the third member of our group," admits Gerhardt. "It was really hard to escape the identity that it would impose on your work," adds Jarman. The pair's words are revealing in both content and tone. Though their admissions are unified, the delivery couldn't be more different. Gerhardt has an abrasive nervousness accentuated by his angular frame, whereas Jarman is easygoing and extroverted. These oppositional personalities give a charged air to the ground-floor room of their Brighton home studio. Between his left-brain analytical coolness and her right-brain social warmth, Semiconductor's computer seems less an antagonist than a neutral mediator.

As Jarman and Gerhardt's frustrations with their silent partner grew, the pair cast out for inspiration from the tool's source. Computing had broadened their vocabulary but it had also kindled an interest in science itself. The duo's early work had explored earthquakes, electromagnetism, and viruses, but 2005 saw their first direct use of scientific data, with recordings of seismic disturbances from the British Geological

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Sonic Inc. Part of Semiconductor's working methodology was forged through audiovisual performances at scores of international festivals from 2004-08. Using their custom software Sonic, Inc, the duo drew on tablets to generate sound that was visualized and animated in real-time. "We were the element that made it erratic and we were an uneven match for the computer," Jarman explains. Sonc Inc. and other earlier experiments with computer-assisted improvisation even yielded a moniker: "We recognized that the computer always had its identity in the work, and we were only semi-conducting the process."

Artists in laboratories. While long a staple of galleries and artist-run centres, recent years have seen widespread residency opportunities in scientific labs and research facilities. Semiconductor have been embedded at the Smithsonian Mineral Sciences Lab (2010), San Francisco's Exploratorium (2010), and The University of California, Berkeley's Space Sciences Laboratory (2005-06).

Above left: Lava flow maps from the The Geological Society of Japan. These were used to inform a new in-development *Flow Maps* painting series exploring "colour, form, motion, and gravity."

Above right: Paint, used for the aforementioned *Flow Maps*, as well as a tripod-mounted light and a dead projector that burnt out while beaming *Black Rain*.

Survey turned into a soundtrack and used to animate Northumbrian vistas. *All the Time in the World* was an attempt to represent the deep time of geology. Semiconductor's interest in transcending the limits of experience was expanded the following year with *Brilliant Noise*. This piece also translated scientific data into sound, but its raw material was thousands of stills of the Sun taken by satellites and observatories. The stills were edited and composited into a short film, the brightness of which triggered changes in the soundtrack.

Jarman and Gerhardt's contribution to the data was both understated and radical. "All we had to do was extract the images, but nobody had ever brought all of that visual data together. Quite often scientists would only study a couple of seconds," explains Jarman. Moreover, the choice of plain black-and-white lent the film an unfamiliar power. Whereas most artistic and mass media solar imagery has intense reds, oranges, and yellows, here we see an otherworldly, monochrome sun. As eerie synths wash over the atypical imagery, we're reminded of our own solar system's inaccessibility and the alien nature of technology itself. Where Turner had used painting to mediate his fascination with the Sun in the nineteenth century, here our subjectivity is extended by apparatuses. Semiconductor highlights a contemporary sublime visible only through machines themselves—a heterogeneous assemblage at once human, machinic, and natural.

Brilliant Noise's distinctiveness stemmed from the decision to maintain the source data's own aesthetics, which are usually heavily mediated. "Scientists would normally colourize things to represent elements in the spectrum, but we left the data close to its original form," says Gerhardt. Semiconductor went one step further in 2009 with *Black Rain*, by coaxing astronomers to enhance errors and anomalies in their images of solar flares. Like *Brilliant Noise*, the film was presented in various configurations including a five-metre-high projection at the home of Britain's scientific establishment, the Royal Society. *Black Rain* brought lab teams and researchers face to face with their equipment's flaws and inconsistencies—its own subjectivity, if you will.

The crossover between perfect and imperfect, between technical and organic, is a central theme of Semiconductor's work. *Black Rain*'s footage is drawn from the gap between the Sun and the Earth, but this is far from the pure 'negative space' that one might expect artistically. Jarman and Gerhardt populate this marginal zone with tracking lines and giddying changes of perspective that reveal technology to be messy and disorienting, directly contradicting the qualities with which it is usually associated. This mediation acquired an ethical dimension in Semiconductor's recent work, *Some Part of Us Will Have Become*. Our vision is again augmented by equipment, in this case an underwater rover's attempts to plug the Deepwater Horizon oil pipe. Jarman and Gerhardt recorded web video streams of BP's ham-fisted attempts to contain the spill, which were then edited and set to a robot soliloquy scripted by artist and writer Rowena Easton.

As the rover laments an "empire of descent" and a "continuity of collapse," we are shown a new perspective on hubris. "It was a beautiful and horrific event seen from a third point of view outside the human race. It's an alien, but an alien made by us," says Gerhardt. The seriousness of the subject was lent extra weight by an orchestral score and relatively static camera shots. In contrast to *Brilliant Noise*'s psychedelic abstraction, this short had a more filmic atmosphere with

Joe (and Ruth) versus the volcano. One of Semiconductor's most memorable adventures saw them encamped beside Tungurahua volcano in Ecuador while researching *Worlds in the Making*. "We spent two nights in this wooden shack on the hill opposite to the volcano," Jarman remembers. "The first time we stayed there was completely cloudy, and we were freezing cold lying under loads and loads of blankets. The volcano would erupt and you would actually feel the shockwave hit you. And we would just look at each other, and ask 'is this okay?'" Back in the studio, the duo interpreted Tungurahua's seismic data as jolting audio for the piece's score.

FACT. Semiconductor's first major solo exhibition, *Worlds in the Making*, was produced in 2011 for the Liverpool-based Foundation for Art and Creative Technology. Extending out of Merseyside Moviola, a nomadic film festival founded in the mid-1980s, FACT formed in 1997 and quickly vaulted into high profile media art related ventures that included the staging of ISEA 98. In 2003, FACT moved to its new permanent facilities, which contain three THX-certified cinemas and four gallery spaces.

Vintage signal generators that were acquired at garage sales and used to create the soundtrack for Semiconductor's first film *Retropolis*. "Now they just look good," says Gerhardt.

the rover camera's data overlays lending it a gritty realism reminiscent of Ridley Scott's tech-noir. There's a criticality, too, which is more pointed than either of the black-and-white solar shorts. As oil billows out of the uncapped pipe, we are invited to reflect on the power of technology to enhance capitalistic greed. Hunger for natural resources is a key driver and funder of scientific innovation.

Science may provide the source material and inspiration for most of Semiconductor's work, but Jarman and Gerhardt aren't afraid to bite the hand that feeds them. Many of their films aggressively dismantle the scientific method. A residency on the Galápagos Islands, for instance, found form in the works *Indefatigable* and *Worlds in the Making*. The first exposed science's necessarily pedantic yet at times almost absurd categorization imperative. Botanists dissecting a plant are shown as dedicated to the point of zealotry. The second shows the strangeness of volcanologists' practices, findings, and subject matter. Taken out of context, the stream of data voiced by a researcher is both poetic and faintly ridiculous. "Location nineteen, point three zero nine five, point three zero four two four," the disembodied voice tells us. "Sample F zero two, dash two, dash two."

"Science isn't an answer to anything because every answer can be overturned. Science is finding the right questions and building the right tools to do that," explains Gerhardt with an air of confidence. "TV documentaries are often presented as fact, because there's a disparity between what the layman understands and the scientist understands," adds Jarman. "We're somewhere in-between, questioning science, questioning how science compares itself to our actual experiences." The position they describe reminds me of the writings of Bruno Latour, the French sociologist who has spent much of his career attacking scientific objectivity. He showed the intrinsic fictions that emerge from the production of facts, and even the parallels between arts and sciences.

If Latour has posed these questions already, I wonder, what are Jarman and Gerhardt bringing to the debate? The question prickles them, and I get the sense that they are more comfortable critiquing than being critiqued. The answer, perhaps, is that rather than simply attacking the humanity of science, Semiconductor celebrates and provokes it. This approach can be seen most clearly in *Magnetic Movie*, a documentary of sorts shot on a residency at NASA's Space Sciences Laboratory in 2006. As various researchers explain the secret lives of magnetic fields, the shapes and movements they describe are shown infiltrating their labs. The lines and dots are dynamic and mischievous, spreading from equipment to corridors, outgrowing their experimental origins, much like Semiconductor's own interdisciplinary agitation. "Magnetic field lines are always drawn as lines but fields aren't lines at all, so it's a translation that is inaccurate but is the best way to make it meaningful. It's Chinese whispers," quips Gerhardt.

The mention of Chinese whispers resonates with Jarman as she starts discussing the distance to their subject matter. The duo doesn't attempt to understand the factual basis of science, she says, hoping that naiveté will protect creative autonomy. This approach might seem acutely artistic, but scientists are also embracing the tools of fictionalization to gain new research perspectives. "Science is going further into the quantum, beyond the experiential, so creating visual interpretations is becoming vital. The relationship between the art and science worlds is constantly shifting and at the moment it's in a really interesting place," says Jarman. In this way, works emerging out of Semiconductor's residencies help to connect scientific findings with new audiences, but they also refract the data and theories addressed.

20Hz may be the duo's most polished example of this creative distortion. In 2011, Semiconductor re-imagined a geomagnetic storm that had been recorded by the University of Alberta's CARISMA radio telescope. The high frequencies were converted into audible clicks and pops that resemble a tropical downpour of rain. This soundtrack was then used to create a visualization that takes various aesthetic liberties with the source data. Yet this distance is an essential part of Semiconductor's artistic license, a freedom that ensures more powerfully affective experiences. The monochrome peaks and troughs are reminiscent of Harold Edgerton's iconic milk splash photograph of 1936, but it also brings to mind Semiconductor's earlier animated op-art pieces like *Puffed Rice* and *A-Z of Noise*. *20Hz* has a more cohesive, structured logic to its abstraction than those earlier works and this clarity is reflected in the recognition it received at the San Francisco and Ann Arbor film festivals.

20Hz is crucial to understanding Jarman and Gerhardt's goal as artists. Rather than positioning themselves as outright cynics, they prefer to emphasise a commonality with scientists. "We're interested in the external world: in touching, seeing, hearing things beyond ourselves. Artists have always been explorers," claims Gerhardt. This fascination for externality and an impulse to represent it seems to unite Semiconductor and their quarry, but where scientists seek to understand, Jarman and Gerhardt want mystification. "If art wasn't strange to people and it made sense, then there wouldn't be much point in it," says Gerhardt.

Jarman and Gerhardt are by no means the only artists seeking out the uncanny in science. Indeed, in the past decade the 'scientific turn' within the arts might be seen as a response to the threat it is faced with. The drive to innovate and discover in labs has encroached so deeply into the mysteries of our universe that physicists at CERN held a meeting with religious leaders in the wake of discovering the Higgs boson, or 'God Particle' as it is often called. "So many people are afraid of science in the art world because it is more creative and innovative. There are far more new ideas in *New Scientist* than in *frieze*," says Gerhardt. Although he's aware of the threat that science poses for artists, it would be a mistake to infer that this means Gerhardt fears it, much less that Semiconductor's work is an attempt to overcome it. Conversely, Semiconductor is attempting to remind scientists, the public, and themselves that, in the words of geneticist J. B. S. Haldane, "the universe is not only queerer than we suppose, but queerer than we can suppose."

As evolutionary biologist Richard Dawkins has argued, thinking the improbable opens up intellectual space beyond existing paradigms. Speaking at a TED Conference in 2005, he cited the "shattering mental revolution" that Copernicus began by proving that the Earth orbited the Sun. Semiconductor's *Heliocentric*, which traces the Sun's arc movement using time-lapse and astronomical tracking, is undoubtedly more modest than Copernican theories, but that doesn't make it trivial. The film uses technology to create effective proof of physics we now take for granted, broadening awareness of these theories. But perhaps it also goes further by extending potentiality as a category. Semiconductor's work helps remind us that the known, the likely, the possible, the improbable, and the impossible aren't neatly divided categories but blurred zones in constant flux. Science is an essential way of placing knowledge within this spectrum to achieve progress, but its focus on proof is arguably blinkered unless offset by a measure of madness. Art is ideally created to expand our perceptive faculties and provide this vital deterritorialization. As Dawkins himself said, "In the vastness of astronomical space and geological time, that which seems impossible ... might turnout to be inevitable." ———

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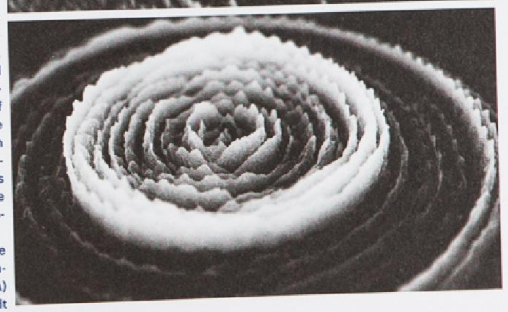
Sound films. In 2007 Semiconductor released *Worlds in Flux*, a DVD compiling thirteen of their 'sound films' on FatCat Records. City rhythms, tectonic shifts, solar winds, and audiovisual performance excerpts were organized into a concise and compelling encapsulation of the duo's practice. Reinforcing their commitment to the fusion of sound and image, the DVD featured eleven specially commissioned *Brilliant Noise* soundtracks by noteworthy musicians including Max Richter, Thomas Dimuzio, Robert Hampson, and Cristian Vogel.

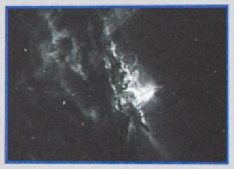


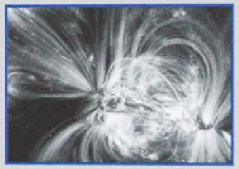
20HZ: QUIVERING WAVEFORMS

Associated with Sun-related phenomena such as solar flares and coronal holes, geomagnetic storms are caused by solar wind shock waves striking the Earth's magnetic field two to three days after the event. When these shock waves 'hit' the upper reaches of the atmosphere they cause fluctuations in the electric current within the magnetosphere and ionosphere, potentially disrupting satellite, radio communication, and power grid systems in the process. Outside of infrastructure failure and the dancing lights of the northern and southern auroras, these storms are sufficiently far-removed from day-to-day life that most people have limited awareness of them. Semiconductor's 2011 short film *20Hz* set out to capitalize on this knowledge gap and explore a geomagnetic storm through animation.

Translating data collected by the Canadian Array for Realtime Investigations of Magnetic Activity (CARISMA) program into audio, Jarman and Gerhardt developed expressive graphics to represent the ebb and flow of a mid-storm magnetosphere captured at a frequency of 20 hertz. In the animation, vibrating waves shimmer across an imaginary surface, oscillating between dense pointillism and miniature eruptions that expand in concentric circles. "We wanted to represent waveforms in a way that was unfamiliar, and the result was a technique that reveals them as three-dimensional and tangible looking objects, which appear as quivering waveforms that interact to create interference patterns in varying detail." These patterns are loosely synchronized with the sounds of crackling static, warbling whistles, and a dull rumbling that evokes the echo of distant thunder. "We call *20Hz* one of our sculptural works, as we used the sound to generate and control the image," they summarize. Rendered similar to rippling water, or perhaps a crystalline 3D graphic equalizer, these 'sculptural' forms and the underlying geomagnetic storm that they represent, are not only accessible but lucid—*20Hz* is literally science fiction.

(1)





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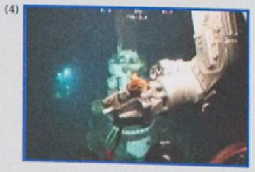

(p.6) 20Hz
2011, film / 05:00 / HD & HD 3D single channel

(1) Brilliant Noise
2006, film / various lengths / SD / HD single channel & multi-channel versions / recognition: Best Video at Experimental Film and Video Festival, Seoul (KR) 2006, Second prize at Science Film Festival, a Coruna (ES) 2008

(2) Magnetic Movie
2007, film / 04:47 / selected recognition: Scientific Merit Award at Imagine Science Film Festival, New York (US) 2009, Best Film at Cutting Edge at the British Animation Awards (GB) 2008 / *produced during an Arts Council England International Artists Fellowship at the NASA-affiliated Space Sciences Laboratory, UC Berkeley, California (US)*

(p.26) & (3) Crystallised
2011, film / HD, various lengths / *a generative animation series that simulates mineral crystal growth synchronized to sound recordings of ice crystals, this technique was also featured in the 2011 piece Worlds in the Making*

(4) Some Part of Us Will Have Become
2012, film / 05:45 & 0:300 TV edit / HD single channel / broadcast: January 11th 2013, Channel 4 / collaborators: Hildur Guðnadottir (music), Rowena Easton (text) / commissioned by: Channel 4 and Arts Council England / *comprised of streaming video captured during the Deepwater Horizon disaster*

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