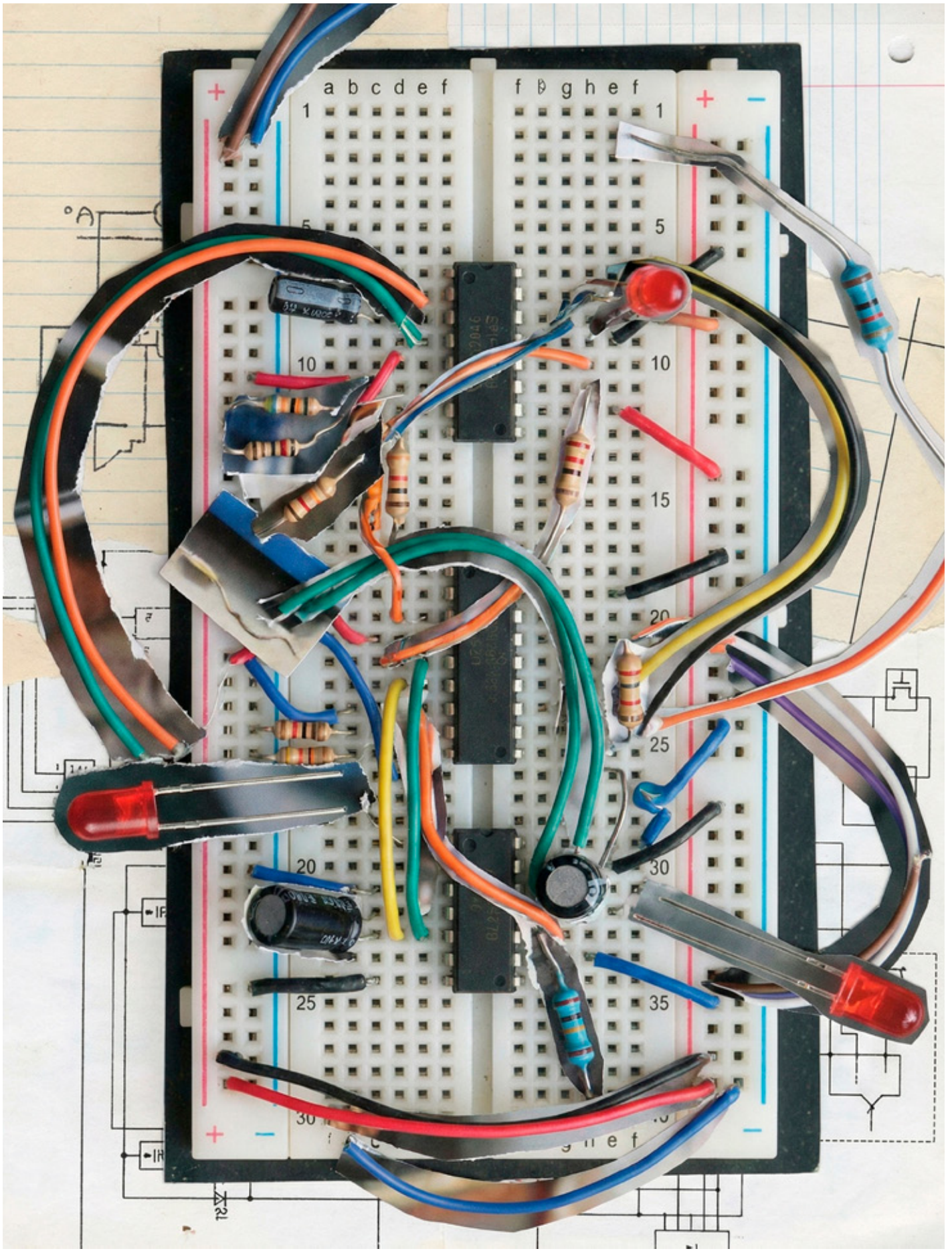
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Currents of Abstraction: The Breadboard as a Model for the Post-Photographic Image

MARK KASUMOVIC

Mark Kasumovic, *Breadboard Mockup*, digital photograph.

The contemporary crisis of the photographic image is not merely one of representation, but of material existence. As the chemical trace of silver halide recedes into history, replaced by the binary logic of the electronic signal, the photograph ceases to be an analogue inscription of light and becomes an inscription of electricity. This transition requires a fundamental re-evaluation of the theoretical models used to analyse visual culture. We must move beyond the single historical line connecting the camera obscura to the digital camera. This linear approach is insufficient to describe an era of computational imaging defined not by optics, but by complex, multidirectional flows of data, power and ideology that constitute a new *electrified* camera.

To navigate this electrified terrain, the metaphor of the electronic breadboard is proposed as a frame for understanding how, despite looking similar on the surface, electrified images continue to radically reshape the functions of photography. In electronics, the breadboard is a construction base for prototyping. Unlike the Printed Circuit Board (PCB), which permanently fixes components into a rigid, finalised schematic, the breadboard is defined by its provisionality, its re-usability and its openness to reconfiguration. Its components – resistors, capacitors, integrated circuits – are plugged into a grid of sockets, connected by jumper wires that can be moved, removed or rerouted at will. This apparatus mirrors Deleuze and Guattari's concept of the rhizome: a system of knowledge that has no beginning or end, but is always in the middle, between things, intermezzo.[1] The rhizome operates by variation, expansion, conquest, capture and offshoots; the breadboard operates by connection, resistance, capacitance and feedback. However, while the rhizome suggests an organic, sprawling, borderless network, the breadboard insists on the presence of a 'user' – someone who must actively plug, unplug and solder. It restores agency to the post-photographic subject.

Using the electronic breadboard as a metaphor allows us to acknowledge the provisional nature of knowledge production in the digital age. Just as a circuit on a breadboard is a prototype – a test of a hypothesis rather than a final product – the component texts within this article function as provisional probes into the vast, unrepresentable network of the information economy. They do not claim to offer a *TOTAL THEORY OF THE ELECTRIC IMAGE,* but rather test specific connections, measure specific resistances and amplify specific signals. To do this, six distinct components are identified: the (S)ubstrate, (R)esistor, (C)apacitor, (T)ransistor, (IC) integrated circuit and (O)utput. By treating each as both an electronic component and as a mode of photographic inquiry, a new current of understanding might emerge. This structure

1 ___ Gilles Deleuze and Félix Guattari, A Thousand Plateaus: Capitalism and Schizophrenia, translated by Brian Massumi, Minneapolis 1987, 25.

invites a 'modular prototyping' approach: the reader is free to 'short-circuit' linear narratives and examine these components in any order. Meaning is not found within the components themselves, but in the active flow of energy between them.

To operationalise this metaphor, a research method is employed that is situated at the friction point of academia and art – one that treats the photographic act not as a passive recording, but as a form of experimentation. I have previously argued that the camera is an instrument capable of poetic and radical documentary that interrogates the invisibility of contemporary technology, rather than merely depicting it.[2] By embedding artistic practice directly within the physical sites of scientific knowledge production – whether a particle physics laboratory or a data centre – the artist can function as an epistemic partner within the research process. This approach bridges the gap between abstract theory and material practice, using the camera to test the conductivity of these invisible networks. It ensures that the 'breadboard' remains more than a theoretical schematic; it becomes a method for generating an aesthetics of complexity capable of visualising problems inherent in our electrified reality.

Revisiting my archive since the emergence of digital photography, employing the breadboard metaphor and the *lens* of the electrified camera, reveals a latent circuitry connecting these images. While my practice has long interrogated the malleability of the medium and the stability of photographic truth, the shift to the digital has clearly escalated this crisis of representation. The intention has often been to document a physical world that feels increasingly elusive. Of course, material reality exists. Yet it seems as though the most vital aspects of our contemporary condition remain hidden from an electronic sensor that is programmed to capture only the reflection of human-visible light. Subterranean fibre-optic cables, the heat rising from server farms, or the invisible radioactive decay inside a laboratory are all realities that offer no visual reflection for the photographic lens to resolve, yet seem increasingly necessary for us to understand collectively.

Consequently, the electronic breadboard emerges as a vital model for imagining a photographic career under such conditions. Just as a breadboard allows for the provisional testing of a circuit, meaning in contemporary images is rarely fixed; it evolves with every new connection. In this light, my previous projects appear not as isolated series, but as components in a larger system: tourists functioning as transmitters of data, scientific laboratories constructing meaning through recording devices and the physical infrastructures that power it all. The transition to the electrified image complicates the functions of the camera, requiring us to map the circuit rather than simply capture the view. In this high-voltage environment, a master theory is impossible; one can only poke and prod, tinker and test and trace the connections one at a time.

2 ___ Mark Kasumovic, 'The Scientific Instrument and the Camera: Poetic and Radical Documentary and the Invisibility of Contemporary Technology', *holt journal for artistic research,* vol. 1, no. 2, 2024, 111–123. <https://holtjournal.co.uk/> (24.03.2026).

USER NOTES
Consistent with the breadboard's function as a tool for physical prototyping, each section concludes with *COMPONENT INSTRUCTIONS* designed to translate the theoretical abstractions of the electronic circuit into concrete methodologies for photographic practice. They function as heuristic algorithms for the post-photographic artist – a set of operating procedures to test, map and reconfigure the invisible networks of the image-world.

The Laboratory and the Camera

In the photographic series titled *A Human Laboratory,* the camera enters the spaces where the fundamental forces of the universe are interrogated. These spaces today – dark matter detectors, neutrino observatories, genetic banks – can be seen as the primary processors of material reality. They are the physical locations where the 'current' of scientific truth is generated. Like the photographic camera, laboratories are techno-cultural instruments, detecting fleeting and invisible observations designed to tell us something new about the world.[3] However, these spaces and their outputs, like cameras and photographs, are not simply transparent windows onto nature.

Following Bruno Latour and Steve Woolgar's anthropological analysis of the laboratory, these spaces can be viewed as factories for the production of 'inscriptions'.[4] Like analogue photography, the laboratory was born out of analogue measurements – perhaps beams of light inscribing waveforms onto photosensitive paper. However, the electrified laboratory no longer simply *inscribes;* it *transduces* invisible forces (neutrinos, radiation) into voltage or data. This data is not printed as a visible trace, but is fed into complex models defined by even more complex algorithmic software packages, disappearing into a 'black box' of calculation.[5] Despite this, the laboratory and its instruments, like the camera, remain machines that attempt to convert the messy, chaotic flux of the world into stable, mobile and understandable traces. In this sense, significant elements of knowledge production have not just shifted from the analogue to the digital, but from visible trace to invisible signal.

This prompts a critical question: what can a photograph of such mediated spaces achieve, if the camera can only record the surface of the laboratory and not its internal function? The decision to photograph the laboratory therefore becomes a fitting opportunity to raise questions surrounding knowledge production, inherent invisibility and the ramifications of a total transition to digital (or electric) knowledge. Given the striking similarities of the artist's camera and the laboratory itself – in their inscriptive and culturally grounded functions – images such as *Painter's Tape (Synchrotron Experiment)* can serve as a critical node of enquiry [fig. 1]. This photograph depicts a high-tech experimental setup held together, at times quite literally, by everyday painter's tape. This detail is not trivial; it disrupts the smooth 'myth' of scientific precision that can result from increasingly sophisticated electronic tools. This photograph reveals the laboratory as a human space, characterised by *improvisation, bricolage* and the *provisional* evolutionary nature of research.

This inherent provisionality aligns with the concept of the breadboard itself. A breadboard is a tool for prototyping, for testing ideas that are not yet finalised. *Painter's Tape* shows that even the most advanced and controlled science is, always has been and hopefully always will be, breadboarded. It is a work in progress, a temporary arrangement of components waiting to be solidified into fact – a fact that can only emerge through human consensus in any case. By documenting these provisional arrangements, and analysing them as human spaces and spectacles, such

3 ___ For an introduction into the role of observation within the laboratory, see Lorraine Daston and Elizabeth Lunbeck, *Histories of Scientific Observation,* Chicago 2011, 1. The authors describe how observation employs instruments to 'make the invisible visible, the evanescent permanent, the abstract concrete.'

4 ___ According to Latour and Woolgar, an 'inscription device' is any apparatus that transforms a material substance into a figure or diagram. See: Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts,* Princeton 1986, 51.

5 ___ This is explored further in the (R)esistor, but for now, Alexander Galloway describes this as the 'interface effect', where the seamlessness of the visible result is achieved only by rendering the underlying machine invisible. The black box is therefore not a void, but a political architecture designed to obscure its own 'condition of possibility'. See: Alexander R. Galloway, *The Interface Effect,* Cambridge 2012, 24.

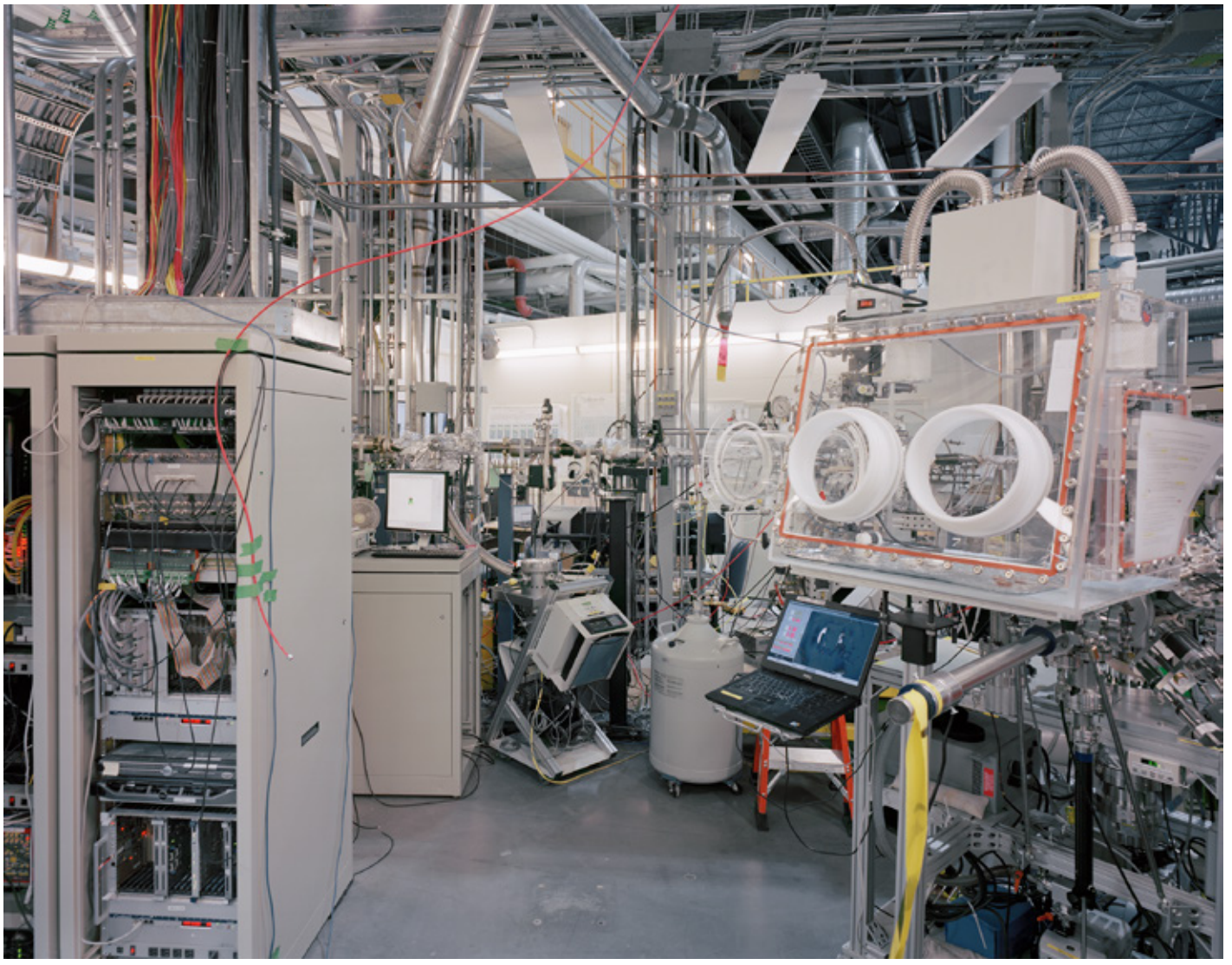
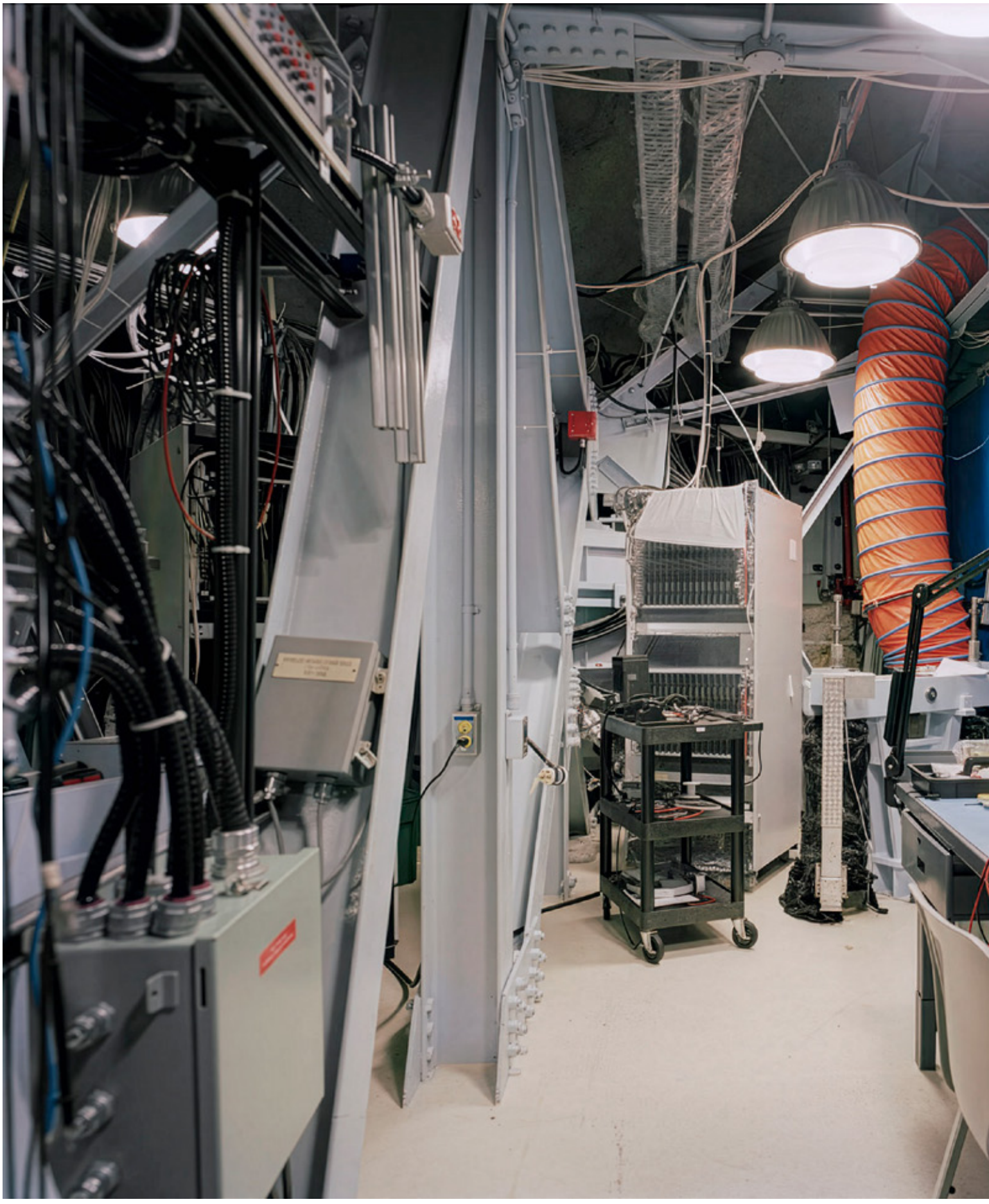
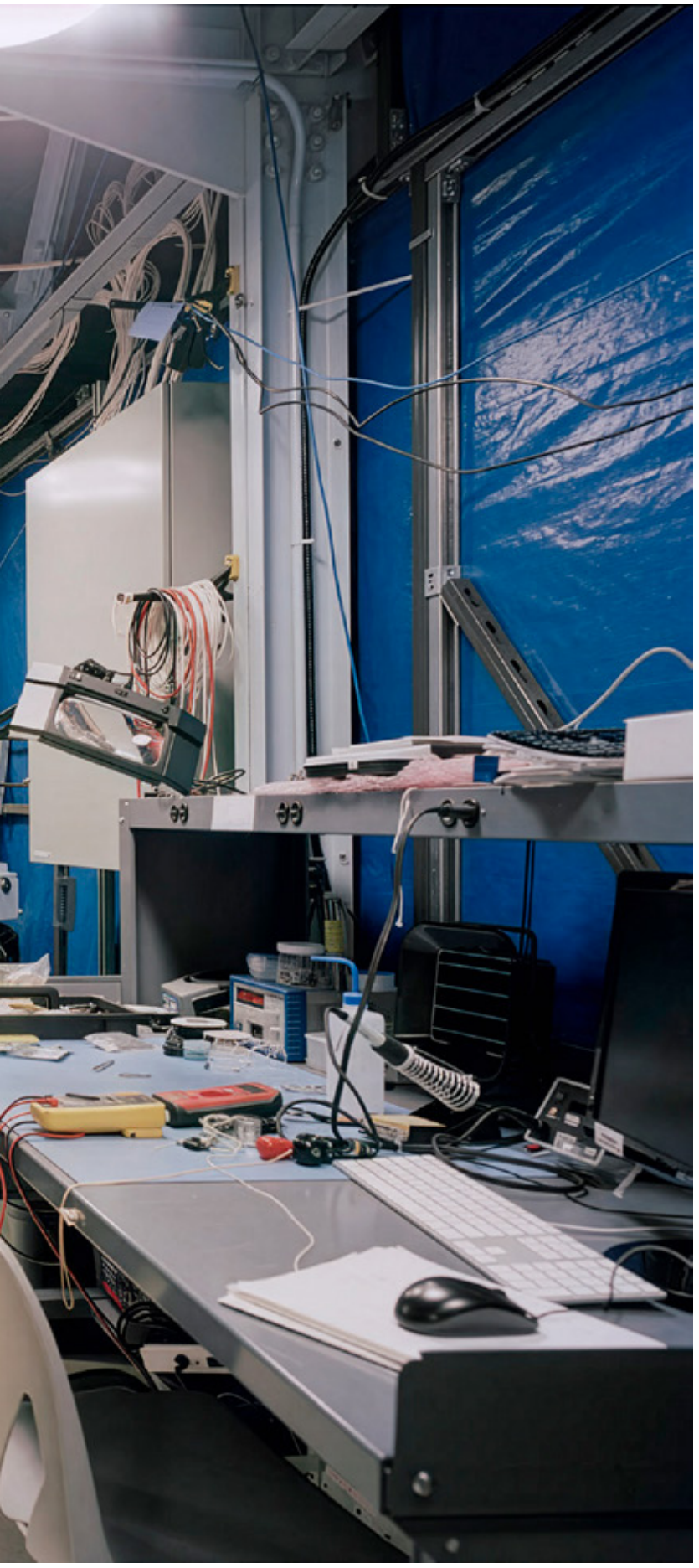


fig. 1
Mark Kasumovic, *Painter's Tape (Synchrotron Experiment)*, Canadian Light Source, Saskatoon, 2015.

fig. 2
Mark Kasumovic, *Empty Chamber (Dark Matter Experiment), Corner (Antennae Research Experiment)*, Anechoic Chamber, University of Waterloo, 2016, SNOLAB, Sudbury, 2016.





Mark Kasumovic, *Cloistered Room (Dark Matter Experiment)*, SNOLAB, Sudbury, 2016.

fig. 3
Mark Kasumovic, *Blue Corridor (Cosmic Ray Experiment)*, Pierre Auger Observatory, Malargüe, 2015.

6 ___ Peter Howlett and Mary S. Morgan, 'The Travel of Facts', in: Peter Howlett and Mary S. Morgan (eds), *How Well Do Facts Travel? The Dissemination of Reliable Knowledge,* Cambridge 2011, 6. The authors argue that facts are not immutable pebbles but are 'processed' and 'packaged' for circulation, a process that requires active maintenance and remaking.

photographs engage with the active making and remaking of facts.[6] They keep the controversy and construction visible, not to deny scientific truth, but to document the provisional consensus required to build it. Every technology is human; every technology involves decisions, and even the most sterile technological environment is riddled with the politics of the knowledge economy [fig. 2]. The act of representing the scientific experiment forces a view beyond the mid-nineteenth century ideal of 'mechanical objectivity' to see the provisional, human and constructed consensus that actually underpins our understanding of the universe.

The digital laboratory confirms that the nature of the photograph has shifted from a chemical trace of the visible to an electrical signal encoding the invisible. This shift fundamentally alters the 'subject' of the experiment: the electron, the neutrino and the gene are entities that exist beneath the threshold of human perception. Consequently, the traditional evidentiary bond – the notion that 'seeing is believing' – is short-circuited. When the referent is invisible, truth relies entirely on the opacity of the algorithm. This crisis of visibility is most acute in the context of climate change, a phenomenon where catastrophe can often only be visualised posthumously. In this gap between data and vision, scepticism festers; it becomes easy to deny the climate or speculate on cryptocurrency because the underlying reality has dissolved into abstract models.

The photograph *Corridor (Cosmic Ray Experiment)* illustrates this withdrawal of the optical subject [fig. 3]. The image depicts a sterile, blue corridor in a facility designed to detect cosmic rays. The rays themselves are everywhere and nowhere, passing through the earth and the architecture without leaving a trace visible to the human eye. The photograph can record the *infrastructure* of detection – the hallway, the lights, the cables – but the event itself remains outside the frame. Here, the laboratory functions as the (S)ubstrate. Just as an electrical circuit requires a common ground to function, scientific truth relies on this terrestrial zero-point – the duct tape, the bricolage and human consensus – to remain stable. However, this connection is fraying. As the burden of representing the invisible fractures scientific consensus, the 'ground' of the camera can also begin to give way.

This establishes a key theme: the asymptote of visibility. The closer the camera resembles the cutting edge of science (and electricity), the less there is to see. The image becomes a record of its own inability to capture the contemporary subject. The invisible (the neutrino or cosmic ray, or the economy of the image) is invisible because it has zero impedance with the human eye – it passes right through us.

This is not a failure, but a profound statement on the nature of electric knowledge. While scientific instruments have always functioned to make the invisible visible, the digital transition marks a shift from optical extension to electrical transduction. In the modern laboratory, instruments do not merely magnify the visible world; they transduce invisible forces into data, *seeing* nothing but *calculating* everything. The laboratory, like the digital image, is revealed not as a window, but as a fragile circuit vulnerable to noise. Therefore, the photograph cannot offer a portrait of nature in the traditional sense, but its careful use can still illuminate the precarious network of cables and consensus required to bring that nature into view.

COMPONENT INSTRUCTIONS
LOCATE THE GROUND. FIND THE PHYSICAL POINT WHERE THE ABSTRACT SIGNAL TOUCHES THE EARTH. DOCUMENT THE TAPE, THE DIRT AND THE PROVISIONAL SUPPORTS THAT HOLD THE ILLUSION TOGETHER.

fig. 4
Mark Kasumovic, *Server Room (Research University)*, Western University, London, 2015.

(R) The Resistor

Impedance, Opacity and the Black Box

The genealogy of the 'black box' does not begin with the microchip, but with the Victorian domestic interior. While scientists of the era approached electricity with practical rigour, the Electrical Room at Lord Armstrong's Cragside estate – the first house in the world powered by hydroelectricity – can be seen as a pivotal shift in the history of technology: the invention of the interface. Armstrong's laboratory was ostensibly a space of capture, designed to affix fleeting energy onto photographic plates. However, his true innovation lay not in the capture of energy, but in its *presentation*. By hiding the wires of his invention behind the walls of a domestic space, Armstrong enacted a decisive countermove against the visibility of the machine. He plastered over the circuits, erasing the messy 'bricolage' of the laboratory to leave only the pure, magical effect of domesticated light. In doing so, he introduced a 'resistor' into the circuit of meaning: a deliberate barrier between the user and the mechanism.

Concealment was not merely an aesthetic choice; it marked the structural birth of the black box. By rendering the (S)ubstrate invisible, Armstrong established the governing logic of today's digital economy: that the machinery must be submerged so the illusion of seamlessness can surface. Tracing this lineage to the present reveals that the modern data centre is simply Cragside writ large. The (R)esistance to visibility offered by such spaces is not an architectural accident, but the maturation of the *interface effect* Armstrong pioneered (see endnote 4). The mystery of electricity had been domesticated, transformed from a divine spark into a trade secret. Consequently, the opacity of the modern black box is no longer just aesthetic; it is political [fig. 4]. The removal of the wires from view has evolved into the removal of the entire infrastructure from public consciousness.

In a typical electronic circuit, a resistor limits the flow of current. It introduces impedance, regulating the energy to prevent the system from overloading. In the metaphorical circuit of this paper, the (R)esistor represents the inherent opacity of modern technology that resists visual penetration and understanding. Like Craigside, as technologies become more grounded in electrical systems, their internal workings become encoded in technical language rather than optics. A steam engine displays its function prominently; its pistons and gears are visible indices of its operation. The photographs of Bernd and Hilla Becher are, perhaps, the most significant archive of images that depict technology whose form imply their function. The Bechers' photographs of water towers, grain elevators and industrial machinery represent a momentary precursor to when the photograph would no longer be capable of recording the logics of technology. Conversely, a microchip, compared to technology of the nineteenth and early twentieth century, is a monolith.

An anechoic chamber – a room designed to absorb all sound and electromagnetic waves – is an intriguing photographic conundrum for the black box [fig. 5]. It is a space of zero reflection, a 'black hole' for digital signals. Visually, however, it is hyper-patterned. The walls are lined with geometric wedges of absorbent foam, creating a disorienting, fractal-like environment. The anechoic chamber is the ultimate visual resistor. It is a space designed to eliminate noise, yet to the camera, it presents a visual field of intense, repetitive static. The camera struggles to find a focal point; the depth of the room can collapse into a flat pattern: deeply structured, highly engineered and incredibly seductive, yet offering no narrative foothold for the viewer. It resists the gaze by absorbing it conceptually. Ultimately, both Cragside and the anechoic chamber reveal the evolving strategy of the black box. Armstrong concealed the mechanism to preserve the magic of the effect; the anechoic chamber *exhibits* the mechanism, yet remains so visually complex that it becomes magical in its own unreadable way. Both function as resistors, impeding the viewer's understanding: one through subtraction, the other through saturation.

fig. 5
Mark Kasumovic, *Corner (Antennae Research Experiment)*, Anechoic Chamber, University of Waterloo, 2016.

(R) THE RESISTOR

In many ways, the very digital technologies we use to 'clear up' the signal (to remove noise or to isolate data, the averaging functions of compression) result in a visual experience that is alienating and abstracted. In the digital age, the resistor can do its job too well; it can restrict the flow of meaning to a trickle. In other writings, an 'ethical' form of documentary has been proposed as a strategy that 'foregrounds the apparatus' and adopts 'alienation effects' to disrupt the seamless consumption of images. It borrows from a theory of interfaces put forward by Alexander Galloway, in which an aesthetics of incoherence meets a politics of coherence.[7] Repeatedly photographing the black box – photographing the *opacity* itself, or making strange the commonplace – is an ethical act. When photographing at the European Council for Nuclear Research (CERN), for example, I could not show subatomic particles. I could only show the substrates and the interfaces: the screens, the instruments, the visualisation tools used to detect them, or the strangeness of the contemporary laboratory. I could only show the *opacity of the interface.* The colourful lines on the software and screen are a simulation, a second-order reality. But by photographing the screen, the artist can introduce a layer of distance. We are looking *at* the looking; we can see and recognise the mechanism of translation.

As Vilém Flusser argued, the camera too is a 'black box' that turns the photographer into a mere functionary of its program.[8] The (R)esistor is the component that disrupts this program. By photographing the opacity – the screen, the interface, the glitch – the photographer refuses to play the role of the functionary and instead interrogates the apparatus itself. This is the 'impedance' that the resistor introduces, slowing down the consumption of the image. Despite not being able to reveal the inner workings directly, it can force the viewer to ask: 'What *am* I looking at? How *is* this image constructed? What is it *trying* to say?' In a world of seamless digital interfaces, where technology strives to be intuitive and invisible, the resistor – the black box, the glitch, the screen – is a necessary disruption. It reminds us that knowledge is mediated, constructed and resisted.

7 ___ Alexander R. Galloway, *The Interface Effect*, Cambridge 2015.
8 ___ Vilém Flusser, *Towards a Philosophy of Photography,* translated by Anthony Mathews, London 2000, 27.

COMPONENT INSTRUCTIONS
FIND A SYSTEM THAT IS WORKING PERFECTLY. INTRODUCE AN OBSTRUCTION. PHOTOGRAPH THE STRUGGLE OF THE SYSTEM TO CORRECT ITSELF.

(C) The Capacitor

Interfaces of Nearness

(C) THE CAPACITOR

In cybernetics, a capacitor is not merely a storage vessel; it is a device that resists changes in voltage, maintaining system stability against the chaos of the input. It functions as a temporal buffer, managing the lag between generation and consumption. In the circuitry of the post-photographic image, the infrastructure of the cloud – the vast, heavy, physical systems that store and transmit the energy of the digital world – performs precisely this capacitive function. It buffers the volatility of the physical world to ensure the smooth, continuous signal of the digital one. While much of this infrastructure is indeed hidden, some elements remain in the landscape out of necessity. This section focuses on photographs from a series titled *I Can Hear You Humming (2010),* the photograph Neighbourhood #1 (East Hamilton) [fig. 6] and the image

fig.6
Mark Kasumovic, *Neighbourhood #1 (East Hamilton)*, Hamilton, Ontario, 2010.

fig.7
Mark Kasumovic, *Neighbourhood #4 (Etobicoke)*, Etobicoke, Ontario, 2010.

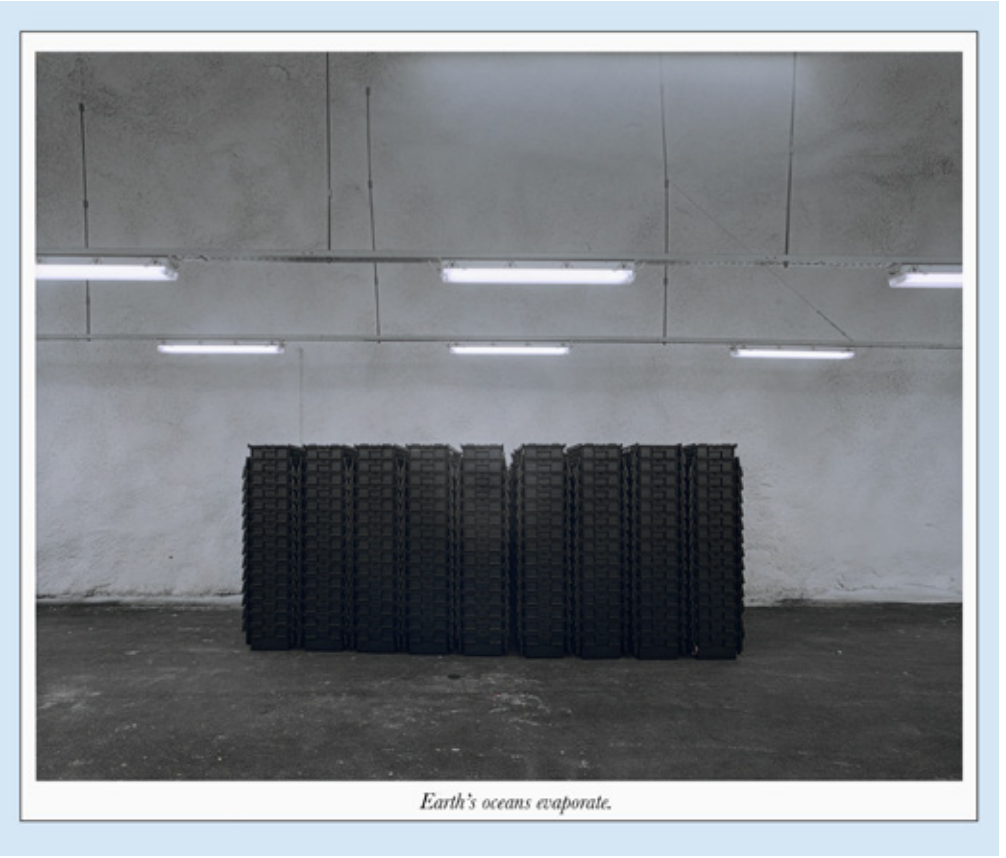


fig. 8
Mark Kasumovic, *Svalbard Global Seed Vault 6 (Vault #2)*, Svalbard, 2014; excerpt from A Human Laboratory,artist publication, p. 27.

Vault #3 (Seed Storage Experiment) taken at the Svalbard Global Seed Vault. These works document the material 'cloud' – the substations, pylons and genetic bunkers that sustain our virtual (and in case of emergency, our physical) existence.

While the digital image feels weightless and instant, like a spark, it is powered by a massive accumulation of resources, time and geology. *I Can Hear You Humming (2010)* focuses on the hidden-in-plain-sight monoliths of contemporary life: the infrastructure of electricity. Through reflective documentation, the series aims to extract these structures from the realm of 'photographic eyesore' and to elevate them to their proper status as the foundational subject matter of modernity. The initial impulse for the work came during a quiet walk through a conservation area near Hamilton, Ontario, where the typical sounds of the meadow were overtaken by a constant humming overhead: 4,000 megawatts of electricity surging from Niagara Falls toward a sprawling metropolis. The 'hum' heard was the audible manifestation of a strong electric field ionising the surrounding air – miniature, continuous sparks amplified by moisture into a 50 Hz or 60 Hz drone. For residents living in the shadow of these substations, this invisible force is a repetitive daily, physical reality [fig. 7]. The photographs seek to make this reality apparent to those more fortunate, hoping to return a sense of reverence – and unease – to the infrastructure of our most vital resource.

Many contemporary photographic works have shown us the dirty reality of the clean cloud. The aim here was instead to compel viewers to acknowledge the physical vibration of the 'clean' energy that powers our daily lives. The primary utility of the capacitor in an AC circuit is filtering – shunting high-frequency noise to ground to produce a clean sine wave. The electrical grid performs an identical operation on a planetary scale. It acts as a massive transducer, converting the dirty, chaotic physics of energy production (burning coal, nuclear decay, hydraulic pressure) into a standardised signal. It does not just hide the violence of extraction; it fundamentally rectifies it into a usable current. *I Can Hear You Humming (2010)* disrupts this filtering. By photographing the 'ugly' infrastructure – the substations, the wires, the warning signs – the images reintro-

(C) THE CAPACITOR

duce noise. Printed at large scale and viewed as a series, the resonance between the images would generates a phantom hum through a form of sensory induction.

If the pylons facilitate transmission by smoothing the micro-fluctuations of the present, *Vault #2 (Seed Storage Experiment),* embodies the capacitor's other primary function: the storage of potential energy for the future [fig. 8]. In both cases, the (C)apacitor functions as a temporal buffer. Located deep within the permafrost of the Arctic, the Svalbard Seed Vault operates as a planetary delay-line. It does not merely archive seeds; it holds genetic code in a state of suspended potential difference, ready to discharge this biological energy in the event of a systemic voltage drop (in this case, planetary crop failure). It is (and its exterior even visually resembles) a battery designed for a future discharge.

Photography possesses the ability to create 'interfaces of nearness', or *artistic mechanisms that help us pry deeper into the nature of technology by constant questioning.*[9] In the case of the seed vault images, the interface is the image of a human last resort, overlaid with text describing how the world will end in four billion years, eventually and inevitably, despite all human efforts. The discomfort that arises from these two parallel realities – preparations to prevent a self-induced demise and the inevitability of it anyway – is meant to be jarring. Such difficult concepts *should* be jarring; however, they are often hidden in the 'background noise' of the smooth interface of technology.

Indeed, the global 'climate crisis' and the abstraction of 'biodiversity loss' function like hyper-objects – too vast and too remote for the human mind to grasp. We require creative interfaces to bring these distant realities into proximity. *Vault #2* functions as such an interface. By photographing the interior of the vault – the frosted shelves, the black boxes, the quiet stasis – the images and texts can translate the abstract anxiety of the Anthropocene into a tangible, spatial reality. They reveal that the cloud relies on heavy, terrestrial grounding. Both the pylon and the vault show that the sublime is no longer just in nature; it is stored in the heavy, humming, frozen and *visually quiet* infrastructures we have built to survive it.

9 —— Martin Heidegger locates the potential for understanding technology not in science, but in the realm of art *(poiesis).* He argues that because art shares the same root as technology *(techne)* but reveals truth differently, it possesses a unique 'saving power' that allows us to see past the instrumental logic of the machine. The 'interface of nearness' acts as a counter-measure to what Heidegger describes as technology's tendency to abolish distance yet destroy true nearness. See: Martin Heidegger, 'The Question Concerning Technology', in: Martin Heidegger, *The Question Concerning Technology and Other Essays,* translated and with an Introduction by William Lovitt, London 1977, 34–35.

COMPONENT INSTRUCTIONS
DO NOT PHOTOGRAPH THE EVENT. PHOTOGRAPH THE ENERGY STORED BEFORE THE EVENT. PHOTOGRAPH THE WAITING.

(T) The Transistor

The Digital Threshold and the Glitch

In 2011, the following diary entry was written while photographing some of the world's most photographed places (see section 6: (IC) The Integrated Circuit). Consideration was given to what was happening when tourists were being photographed

fig. 9
Mark Kasumovic,
Camera Portrait #3,
2011.

fig. 10
Mark Kasumovic,
Camera Portrait #8,
2011.

taking photographs [fig. 9]. An electronic flash unit was also being deployed for the first time in my own work, my own prompting reflection on how electronic camera flash has been used as a marker of objectivity in the past: To suggest the (electronic) camera flash as in any way objective would be a difficult position to defend. Its nature is temporary and altering: the production of light that is too brief to fully comprehend and only exists within the world captured by the camera. The moments it allows the camera to capture are mere fractions of a second, moments that cannot be recorded by any other means or understood within a human understanding of time. It is, however, this very same phenomenon that makes the photograph illuminated by flash so very intriguing to scrutinise. Moments that were only a mere fraction of continuous time become significant, for no other reason than the fact that they were captured by a camera. One could suggest that each such photograph, illuminated by an unnaturally bright (electronic) light of the flash, is in effect the construction of a virtual world; one that never would have existed were it not for the camera that had created it.

Grounded in electricity, the *transistor* is the fundamental building block of the digital age. It acts as a switch or an amplifier, enabling the binary logic of 0s and 1s – on and off. In our breadboard, the (T)ransistor represents a threshold: a moment where the continuous, analogue signal of the world is chopped, quantified and converted into digital data. The ability to freeze time in microseconds and create a 'virtual' image is amplified by a sudden flash; it constructs a visual marker of electricity, and hints at a conversion from an analogue world to a digital image. An image that could not exist without electricity.

Flash and digital have sincerely altered our understanding of what looks 'normal' in photographic representation. These inventions do seem inevitable. Since the nineteenth century, humanity has been obsessed with seeing by electricity – the telephotograph, the photo telegraph, the early fax machine and the later inventions that rapidly expanded the reach of the human senses. The desire to transmit images as electrical signals is not new; it is fundamental to the medium. The (T)ransistor moment – the conversion of image to signal – has been the dream of photography since its inception. This desire to chop the continuous world into discrete signals has a specific lineage. Victorian inventor Alexander Bain's Chemical Telegraph (1843) did not merely scan; it used an electrified stylus to physically trace the topography of metal letters, turning touch into signal. The 'pixel' therefore begins not as a point of light, but as a point of contact.[10] The transistor is simply the acceleration of this Victorian mechanical switching – a logic of breaking the world into 0s and 1s that predates the computer by a century.

Thus, the 'Camera Portraits' from the series *Picture Perfect* (2012) were an attempt to explore how the transmission of the image had become (during the frenetic onset of the accessible digital camera) the primary function of the photograph for many and a decisive signal of the virtual worlds to come. The tourists at the Tour d'Eiffel, the Colosseum, or Peggy's Cove are not just looking; they are *transmitting*. In this circuitry, the tourist functions precisely as a transistor. In electronics, a transistor uses a small current to control a much larger one, acting as a switch or amplifier. Similarly, the individual tourist at the Eiffel Tower actuates a massive flow of data with a single shutter press. They act as the switching mechanism that converts the biological experience of *being there* into the digital currency of the platform economy. They are not merely witnessing history; they are amplifying it, regulating the flow of the site's visibility into the global network [fig. 10].

10 ___ We might view this as a historical short-circuit to the contemporary touch interfaces of contemporary technology, where the modern 'transistor tourist' initiates a flow of networked data through the capacitive touch of a glass screen via their phones and digital cameras.

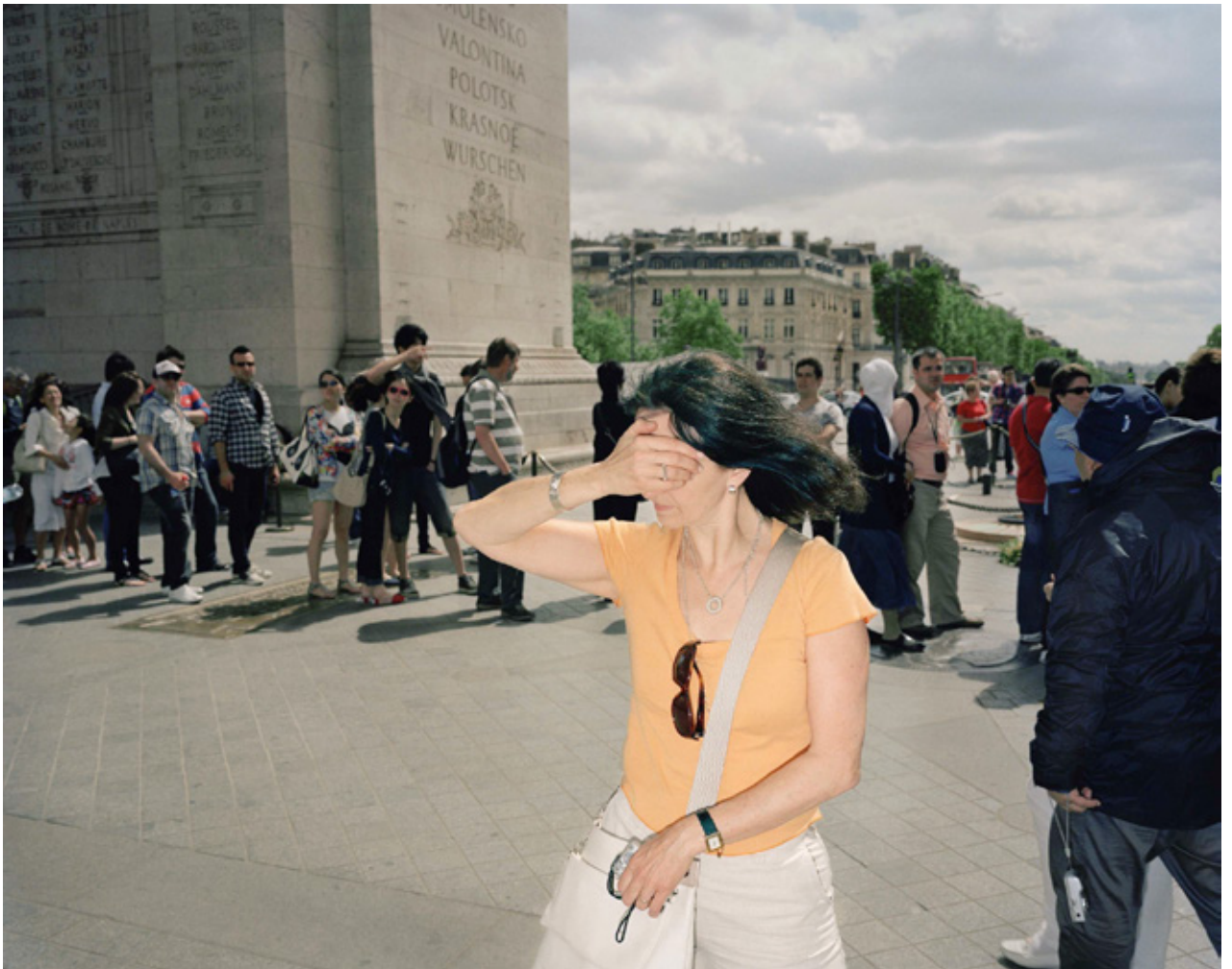

VALONTINA
POLOTSK
KRASNOE
WURSCHEN

fig. 11
Mark Kasumovic,
Camera Portrait #1,
2011.

fig. 12
Mark Kasumovic,
Camera Portrait #9,
2011.

(T) THE TRANSISTOR

However, telephotography may have expanded the reach of the human senses, *Picture Perfect* (2012) might also suggest the opposite: the ubiquity of the electric eye has also narrowed the reach of the senses. Many of us no longer see the site; we strain to see the electronic screen in the harsh daylight [fig. 11]. The transistor amplifies the signal (the image of the site) but degrades the message (the experience of the site). The world becomes a flow of information, a stream of electrons managed by the switching logic of the platform.

A final few notes from my journal when taking these photographs:
Tourism offers a uniquely ideal backdrop to explore the cultural transition of the photograph as it fades into digital obscurity … Here, in the most pictorially reproduced places in the world, we collectively choose to take the most pictures. From Instagram posts to Tumblr blogs, a vacation's worth of images clogging our hard drives, cell phone cameras and GoPro helmet cams, the sheer amount of data we create provokes a reconsideration of the purpose of these recordings. Where once a few rolls of film would have sufficiently described the world around us, now returning from a trip with twenty-four or so images might be considered lacking. Perhaps we choose to create digital memories, and lots of them, so that others may enjoy our experiences for us?

A single photograph, *Camera Portrait #9,* 2011, from this body of work speaks most eloquently about these issues. In *Camera Portrait #9,* a woman stands with her right hand covering her eyes and her left clenching a digital camera, while bystanders look at me taking a picture and others wait patiently to "see the sight". It resembles a staged photograph as much as a documentary image. It was taken in the exact place where millions of photographs have been taken before. It says more about photography than I ever could, yet rightfully raises more questions than it answers. It brims with the contradictions we find ourselves trapped within today. It offers an ode to the digital photographer – every one of us – as we collectively stare into our screens, creating a world we wish was as simple and perfect as it appears on the back of our digital camera [fig. 12].

COMPONENT INSTRUCTIONS
IDENTIFY THE MOMENT THE CONTINUOUS WORLD IS CHOPPED INTO DATA. PHOTOGRAPH THE SWITCH, NOT THE CURRENT.

(IC) The Integrated Circuit

(IC) THE INTEGRATED CIRCUIT

The Networked Gaze and the Algorithm

The integrated circuit (IC), or microchip, combines millions of transistors, resistors and capacitors into a single package. In our breadboard metaphor, the IC represents the Algorithmic Gaze – the complex, invisible electric systems that govern the production and circulation of images in the twenty-first century. Today, the underlying laws governing nature's self-inscription are no longer the physical laws of electromagnetism, but the algorithmic laws of platforms. The integrated circuit of the social web determines what is seen and what remains invisible. It functions by experimenting with the 'physics' of attention, utilising magnetism (polarisation and virality) to align the viewer's gaze and amplification (current) to oversaturate the network with data. In this microscopic architecture, visual culture is no longer organic; it is a processed signal, routed through logic gates designed to maximise engagement at the cost of nuance.

The IC metaphor captures the sheer density of this phenomenon. Just as a microchip packs millions of components into a tiny space, the contemporary tourist site packs millions of 'views' into a single geographic coordinate. This density was quantified in 2009, when researchers at Cornell University used the metadata of millions of Flickr images to map the 'most photographed places in the world' – a list including the Eiffel Tower, Trafalgar Square, Tate Modern and the Empire State Building.[11] This density suggests a topological shift: the landscape has been reconfigured into the architecture of a microchip. Just as the integrated circuit relies on the extreme proximity of transistors to process logic, the tourist site relies on the extreme density of photographers to process cultural meaning. The Cornell study reveals that these sites are no longer defined by their geography, but by their processing power – the sheer volume of images generated per square meter. The landscape has become a (S)ubstrate for the computation of visual data. However, the database logic of the IC is not new, but simply accelerates from the 'Bank of Nature' that Oliver Wendell Holmes described of the stereograph, where he envisioned a future in which the physical world would be secondary to its archived image.[12] The Cornell map reveals the completion of Holmes's prophecy: the tourist site is no longer a geographic location, but a node in a planetary stereoscope.

11 —— David Crandall, Lars Backstrom, Daniel Huttenlocher and Jon Kleinberg, 'Mapping the World's Photos', in: *Proceedings of the 18th International Conference on World Wide Web: Madrid, Spain,* 20–24 April 2009, New York 2009, 761–770, <https://doi.org/10.1145/1526709.1526812>.
12 —— See: Oliver Wendell Holmes, 'The Stereoscope and the Stereograph', *The Atlantic Monthly,* vol. 3, Boston 1859, 747. 'Form is henceforth divorced from matter. In fact, matter as a visible object is of no great use any longer, except as the mould on which form is shaped. Give us a few negatives of a thing worth seeing, taken from different points of view, and that is all we want of it.'

ERROR MESSAGE

In the spirit of the breadboard – where a failed component provides data for further analysis – it is useful to document the limitations of photographic enquiry. In 2011, prior to the *Picture Perfect* project, an attempt to map other infrastructures and the 'cloud' further by photographing the exteriors of major data centres, alongside following power lines to buildings drawing significant current, in search of the 'physical' internet. However, the resulting images were visually uninteresting: nondescript warehouses, security fences and manicured lawns. In traditional aesthetic terms, they were 'bad' photographs; lacking the visual cues necessary in many other images. Yet, treated as a prototype on the breadboard, this failure was a diagnostic finding. It revealed that the centre of the network is designed to be optically resistant – a black box hidden in plain sight. This representational failure forced a reconfiguration of the circuit. It became clear that the camera could not capture the *centre* of the network (the server farm) – and even when possible, it quickly becomes repetitive and uninteresting – but it *could* map the *edges*. The attempt to photograph the infrastructure was abandoned in favour of photographing the 'transmitters' (the tourists) instead.

As mentioned in the (T)ransistor, the photographic density of certain tourist places was explored in *Picture Perfect (2012),* visiting these high-frequency sites. Visually, it was concluded that the photographers themselves were the most intriguing elements of these historic landscapes; for the first time, everyone had a seemingly endless capacity to photograph without worrying about the cost of film. More than ever, people glared into the backs of their cameras, bathed in the electronic light of their glowing

fig. 13
Mark Kasumovic, Video still from *Peggy's Cove Reconstructed*, Halifax, 2012 (HD Video). Scan code for a 10-minute segment.

screens, preferring the simplicity of their compositions to the spectacle of the site itself. The photographers were not merely looking; they were *processing*.

In the video work *Peggy's Cove Reconstructed (2012),* an attempt was made to reverse-engineer this logic [fig. 13]. *If* the site resembles a processing chip, manual control of the *signal* was sought. This video was recorded at a popular tourist site and viewpoint in Halifax, Nova Scotia; the camera was positioned on a tripod and left to record for several hours. What resulted was a typical-looking video recording of tourists milling around and interacting with the tourist landscape. After capturing this footage, some of the many tourists moving within the recorded landscape were meticulously rotoscoped (cut out frame-by-frame), creating a library of human actors that could be reintroduced into the scene at will, dynamically and independently of any other moments in the video. Through this technique, I could manipulate the (photographic) 'truth' of the tourist site: I could control the movement of the sky and water independently; determine when people entered or exited the frame; trap them in infinite loops of consumption. The parlour trick of the work was its 'hyper-reality'; despite heavy digital manipulation, careful rotoscoping meant it looked so much like a typical video recording at a tourist site that the manipulation could easily go unnoticed. Only minor glitches, or careful attention by the viewer, would reveal the manipulations.

This painstaking, manual re-simulation of reality is an antecedent to today's AI-generated video. What took hundreds of hours to 'compute' by hand can now be generated by neural networks in minutes (and looks strikingly similar in its uncanny referencing from existing real-world footage). At the time, however, this output helped highlight the logic of the software used to create it. It revealed that the digital image was not a window, but an intense and resource-consuming computation resembling the tourist site itself. The landscape was compiled and automated. Today, even more so.

When viewing *Peggy's Cove Reconstructed (2012),* or a modern AI 'video', the 'grain' of the integrated circuit is seen – not the grain of silver halide, but the grain of the algorithm. As Lev Manovich suggests, the 'tools' of digital media are metaphors that hide the mathematical operations underneath.[13] The IC metaphor allows us to

see through these tools. It reminds us that the 'reality' of the digital photograph is not the light that hit the sensor, but is revealed by exposing the logic of the network that processed it. The camera has become a sensor for the integrated circuit, feeding data into the black box to train the algorithm and refine the map. In this system, the photographer is no longer a witness; as in *Picture Perfect (2012),* they are a worker in a data factory.

13 ___ Lev Manovich, 'Inside Photoshop', in: *Software Takes Command: Extending the Language of New Media,* New York 2013, 136–161.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COMPONENT INSTRUCTIONS
STOP MAKING NEW IMAGES. ENOUGH IMAGES ALREADY EXIST. THE TASK IS NOT TO CREATE, BUT TO
SORT.
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(O) The Output Feedback Loops and Radical Documentary

The final component of our breadboard is the output: the result of the circuit's operation. But in cybernetics and electronics, the output is often fed back into the input, creating a feedback loop. In public spaces, if images are to mirror the external world, outputs cannot be constrained to prints on the wall; they must act as a live current. In this way, the exhibition space itself functions as the final component of the breadboard, where the image is not just displayed, but physically fed back into the viewer's body. The viewer is not a passive observer but an active circuit component; a variable resistor whose body closes the circuit, allowing the current of the artwork to flow and make meaning. This section thus focuses on strategies of display in photography through various exhibitions and experiments and introduces the concept of Radical Documentary to close the circuit and generate critical feedback.

In installations of *A Human Laboratory (2013),* the gallery is transformed into a reactive, hostile environment. Within, the viewer becomes an input, tripping sensors that physically alter the visibility or function of the photographs and installations. For example, a viewer's approach to examine images of historic scientific instruments triggers a burst of dense synthetic fog [fig. 14]. The closer one steps to inspect, the more the room fills with opacity; however, the fog also alludes to smoke, steam and pollution, all direct and loaded markers of modern technologies. This introduces a negative feedback loop: the viewer's desire to see triggers a mechanism of aesthetic incoherence that makes seeing either difficult or impossible. This literalises the concept of (O)pacity discussed in the (R)esistor component. By forcing the viewer to struggle for the image, they experience the resistance of the medium physically. Later in the exhibition, large-scale photographs of server racks are mounted on motorised armatures; again, the viewer's presence introduces kinetic energy into a static document, generating a low-frequency rattle. The 'hum' of the data centre is no longer a theoretical abstraction (as discussed in the (C)apacitor); it is a tactile vibration moving through the gallery floor. It makes the invisible energy of the data centre more palpable in the gallery space.

The above mentions of 'coherence' necessitate a definition of Radical Documentary, distinct from the prevailing 'glitch aesthetics' of digital art.[14] 'Radical Documentary' has previously been asserted as featuring both an *aesthetic* and *politic of*

fig. 14
Installation view of *A Human Laboratory*, ArtLab Gallery, Western University, 2013.

incoherence – a strategy of visual deconstruction designed to make the viewer unsee the commonplace. In the gallery, the photographs within *A Human Laboratory (2013)* are often presented next to text entries narrated by actors that mimic the authoritative knowledge systems of scholarly writing (e.g. footnotes and references); however, these historic and scientific 'facts' are not wholly explanatory, but rather historic contradictions and loose relationships inspiring lateral thinking when considering human discovery.[15] In the electrified era, visual and textual incoherence is not enough. The *A Human Laboratory (2013)* installation expands this concept from the surface of the print to the space of the gallery. It is a mode of representation characterised not simply by incoherence, but by strategic signal interruption. This does not mean 'nonsense'; it means a refusal to cohere into a simple, consumable message. It is a refusal of the smooth signal of traditional documentary to force the apparatus to reveal its own transmission protocols.

Radical Documentary operates less like artistic circuit bending, which seeks chaos for the sake of novelty, and more like reverse engineering. In electronics, one applies a probe to a circuit to map its logic gates and pathways. Artists must probe into the 'truth-production' machine of photography. In this case, combining scientific facts with 'glitched' Photoshop errors or obscuring the gallery with fog is not an attempt to destroy the document, but to *decompile* it [figs. 15 & 16]. These interventions force the viewer to look *at* the logic of the display rather than through it, revealing the ideological circuit board that underpins our consumption of truth. Ultimately, Radical Documentary proposes a shift in the way photography is used to

(O) THE OUTPUT

14 ___ For a more thorough definition of 'Radical Documentary' that I propose, see: Kasumovic 2024 (reference 1).
15 ___ <http://www.kasumovic.net/instrumental/AHL.mp4> (24.03.2026).

fig. 15
For the exhibition at the Art Gallery of Mississauga, the server unit on the right was ‘photoshopped’ out of the wall mural, framed and hung in front of the artefacts that resulted from using the spot healing brush behind. When the viewer peeks behind, they see the ‘grain’, or the mistakes that (human-programmed) automated software makes when tasked with removing objects from photographs. A small photograph of a damaged model of the human nervous system (fig. 16) is located nearby. Photo Credit: Toni Hafkenscheid, 2013.

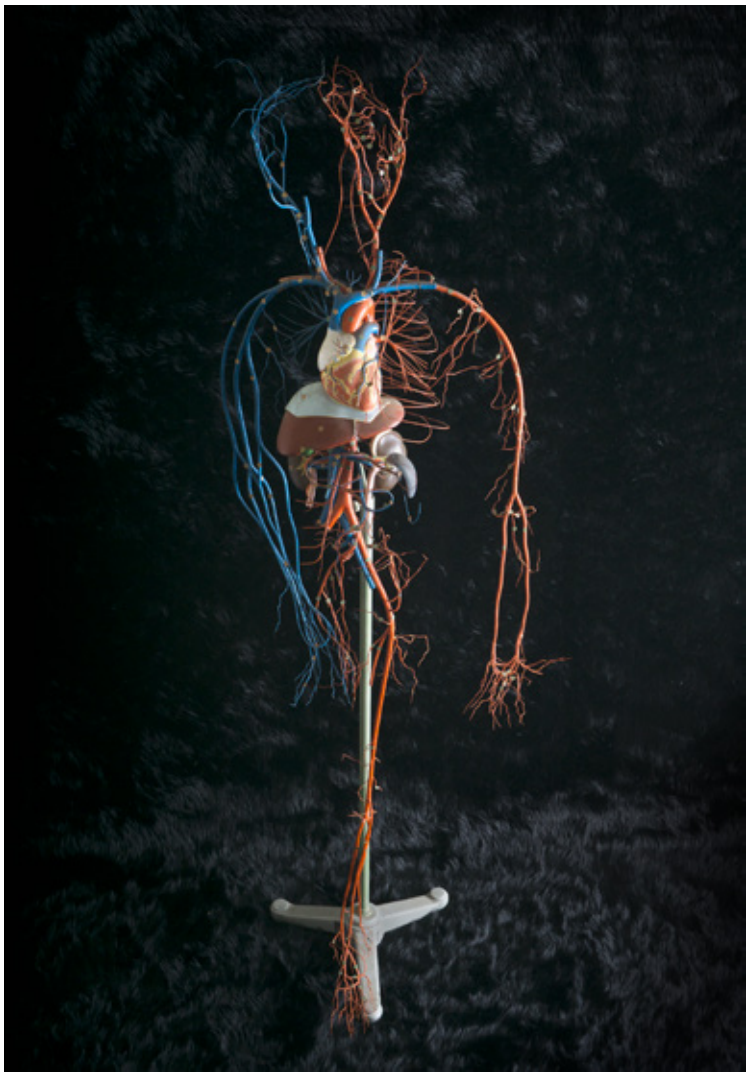

fig. 16
Nervous System (Damaged), from the University of Toronto Science Instrument Collection, 2016.

represent closed systems. It treats 'truth' as a dynamic circuit state. By refusing to resolve the image into a seamless whole, images can keep the circuit 'open'. It ensures that the viewer cannot passively consume the data of photography, but must actively complete the connection, acknowledging that in the post-photographic era, truth is something that must be constantly negotiated against the noise.

Finally, the breadboard metaphor allows us to see the connections between the Victorian researcher and the modern data tourist. It connects the 'Octopus Trails' of MIT to the fibre-optic cables of the internet. It reveals that photography has always been an electrical art, a way of managing the currents of the visible. As the camera becomes fully integrated into the planetary computation of the integrated circuit, the task of the artist is not to produce more images (more data), but to map and expose the circuit. To show the resistors, the capacitors, the black boxes. To trace the flow of power and ideology. To build a breadboard where these invisible forces can be tested, reconfigured and ultimately, seen. Where the *Currents of Abstraction* can flow and the circuit is live.

(O) THE OUTPUT

COMPONENT INSTRUCTIONS
DO NOT RESOLVE THE IMAGE. LEAVE THE WIRES EXPOSED. CLOSE THE CIRCUIT. FEED THE OUTPUT BACK INTO THE INPUT.

Conclusion

Feedback Loops and Radical Documentary

If the *(S)ubstrate* grounded us in the material reality of the laboratory, the *(R)esistor* revealed the political opacity of the black box, the *(C)apacitor* stored the latent anxiety of the archive and the *(T)ransistor* marked the threshold of digital conversion, what then is the final output of this circuit?

The electronic breadboard has been proposed here as a metaphor to navigate the 'electrified terrain' of the post-photographic image. But a breadboard is never meant to be a permanent resting place. It is a site of prototyping, testing and provisional connection. I argue that the crisis of representation we face – where the most vital forces of our existence (climate change, algorithmic governance, subatomic decay) remain invisible to the human eye – cannot be solved by a single discipline or a single mode of inquiry. The linear history of photography is insufficient; we need a circuit that is multidirectional, adaptive and alive.

Just as scientific instruments transduce invisible forces into data, the artist's camera must transduce the abstract anxieties of the Anthropocene into tangible, emotional realities. But the photographer cannot work in isolation. The complexity of the black boxes we face – whether they are server farms, algorithmic simulations or climate models – requires us to move beyond the silo of the art world. There is an urgent necessity for interdisciplinarity in the face of 'wicked problems' – complex, multi-valent crises that resist singular technical solutions. In these high-voltage environments, the artist can function as an epistemic partner rather than a mere illustrator. Science produces the *signal,* the raw data of temperature rise or subatomic decay, but often lacks the mechanism to transmit this signal effectively to a public receiver. The 'breadboard' model solves this by positioning the artist as the circuit's *transducer.* By converting data into affective, symbolic, and experiential images and forms, the artist helps close the loop between technology and the public sphere.

The 'breadboard' might therefore expand beyond the electronic metaphor to become a model for human infrastructure. Interdisciplinary communities can function like robust integrated circuits. This creates a space where the provisional nature of artistic inquiry meets the rigour of scientific data to co-create solutions. In this context, the artist is a critical component capable of impedance matching: adjusting the 'voltage' of complex scientific truth so it can be received by the human sensorium without burning out the viewer. If we fail to integrate this aesthetic function, we risk building a society that can calculate its own destruction but is powerless to feel it.

The output of our circuit, then, is not a final image, but a *methodology of connection*. We must leave the safe enclosure of the gallery and plug ourselves into the messy, chaotic flux of laboratories, policy rooms, and community halls. We must build a breadboard where the currents of abstraction flow not just through silicon and silver halide, but through a living network of collaborators working to make the invisible forces of our world legible, feeling, and actionable.

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COMPONENT INSTRUCTIONS
ACT AS THE SOLDER. CLOSE THE LOOP BETWEEN DATA AND EMOTION. GENERATE A SIGNAL THAT
CANNOT BE IGNORED.
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