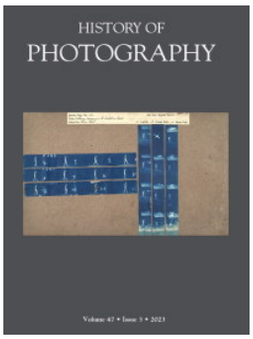

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The Mechanical against Objectivity: Industrialism and Inoperativity in Eadweard Muybridge's *Animal Locomotion* (1887)

Michelle Smiley

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The Mechanical against Objectivity: Industrialism and Inoperativity in Eadweard Muybridge's *Animal Locomotion* (1887)

Michelle Smiley

Address for correspondence:
mlynnsmiley@gmail.com

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Throughout his 1887 photographic atlas, *Animal Locomotion*, the photographer Eadweard Muybridge uses the serial, instantaneous imagery of chronophotography – a medium typically associated with the automated mechanisms of industrial productivity and scientific analysis – against the economies for which it was developed. This article aims to identify a subcategory of works in the series termed 'inoperative images', meaning photographs that both depict non-productive gestures – such as dancing, posing and lying down – as well as those sequences that, thanks to mechanical failures, inconsistent time intervals or the rearrangement of plates, ultimately proved useless for physiological analysis. Where previous scholars have attributed Muybridge's lack of rigorously applied scientific method to a desire for an aesthetic product, these inoperative images may also be understood as creative resistance to the mechanisation and industrialisation of photographic labour in the last quarter of the nineteenth century. In this context, a different understanding of *Animal Locomotion* as an anti-industrial document comes to light, one that illustrates how the mechanical may work against the goals of purpose-driven, standardised time and objectivity.

Keywords: *Eadweard Muybridge (1830–1904); chronophotography; technology; science; industrialism; glitch*

Introduction: Beating Time

In an 1887 photographic sequence titled *Beating Time*, twenty-four individual photographic frames, each neatly separated by a black border, reveal a series of close-ups of a hand in motion (figure 1). The gridded format of four rows of images consisting of six frames each offers an image of geometric order and progressive motion. Further scrutiny reveals that the series illustrates the hand from two separate points of view. In the first set of images in the top two rows, the scene is photographed from the side. Truncated at the forearm, the hand appears disembodied as the subtle musculature and bones of the fingers bend, stretch and flex before the camera. In the frontal series in the bottom two rows, the hand can be seen stretching out towards the camera, as if grasping for some invisible object while the light plays off the outstretched fingers. On closer inspection, the precise relationship of one frame to the next is not entirely clear. The supposed motion

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Figure 1. Eadweard Muybridge, Plate 535 in *Animal Locomotion*, 1887. Collotype. Museum of Modern Art, New York. Gift of Robert A. Taub.

suggested by the gridded arrangement of rows does not seem to follow an identifiable pattern of movement, like a single circular motion of the wrist or a wave. Instead, it is hard to follow what motion the sitter is making if we 'read' the series in sequential order. Overall, the individual frames exhibit a quality of free-floating modularity, where images might be shuffled around without changing the meaning of the series as a whole.[1] Rather than a legible succession of frames that necessarily lead from one instant to the next, it is as if the sitter is performing a ritual sequence of sign-gestures of occult significance.

This cryptic image was published as Plate 535, one of hundreds of studies that formed part of Eadweard Muybridge's stop-motion photographic atlas, *Animal Locomotion: An Electro-Photographic Investigation of the Consecutive Phases of Animal Movement* (1887). The *Locomotion* studies were conducted between 1884 and 1886 at the corner of 36th and Pine Streets in Philadelphia, on the newly constructed veterinary campus of the University of Pennsylvania. The stop-motion work in Philadelphia was made possible by funding through the University in its new role as a centre for research, experimental science and technological innovation.[2] In this capacity, the studies were overseen by a six-person committee composed of artists, scientists and administrators.[3] The project was eventually published in 1887 by the New York Photogravure Company as an eleven-volume set of 781 collotype plates printed on double folio sheets of paper approximately 19×24 inches.[4] Each plate contains between twelve and thirty-six instantaneous photographs showing sequential movements of bodies arranged in gridded rows. The eleven volumes form a partial encyclopaedia of human and animal movement, containing in total more than twenty thousand individual frames. Each plate shows living bodies of all kinds – men, women, children, elephants, monkeys, birds, horses – captured while performing various gestures such as walking, jumping, fighting, flying 'or other actions incidental to every-day life', in order to illustrate the motion and play of muscles.[5] Yet the modularity and inscrutable relationship among the frames in *Beating Time* – the poetic title of which would seem to epitomise the goal of Muybridge's serial instantaneous photography – in fact proves resistant to the very economies of science and industry that made its production possible.

1 – Homay King provides a similar reading of Christian Marclay's *The Clock* (2010); see Homay King, 'Christian Marclay's Two Clocks', *Virtual Memory: Lens-Based Art and the Dream of Digitality* (Durham, NC: Duke University Press, 2015), 47–70. Much of the analysis concerning the electronic aspects and temporality of motion studies is informed and indebted to King's scholarship.

2 – Muybridge's connection to the networks of Philadelphia art and science has gone largely unremarked upon. Elspeth Brown has noted that the project was 'one of the first sponsored research projects of the modern American university'; see Elspeth Brown, 'Racialising the Virile Body: Eadweard Muybridge's Locomotion Studies 1883–1887', *Gender & History*, 17, no. 3 (November 2005), 627–56 (627). For one exception, see Emily Handlin, 'Moving Beyond Vision: Eadweard Muybridge in Philadelphia' (PhD thesis, Brown University, 2015).

3 – The committee consisted of Provost William Pepper, Professor of Anatomy Joseph Leidy, Professor of Physics George F. Baker, Professor of Veterinary Anatomy and Pathology Rush Shippen Huidekoper, Professor of Dynamical Engineering William D. Marks, Professor of Civil Engineering Lewis M. Haupt and the painter Thomas Eakins. In addition, Edward H. Coates, Chairman of the Instruction Committee at the Pennsylvania Academy of Fine Arts, was appointed chairman, with Harrison Allen, an emeritus Professor of Physiology, serving as secretary.

Two major streams of scholarship have taken on the mammoth task of analysing the significance and influence of *Animal Locomotion*. The first, and earliest, camp views the stop-motion work as a proto-cinematic document.[6] A bronze statue that still stands in the Lucasfilm campus in San Francisco depicts Muybridge with his zoopraxiscope—a device he designed to display his stop-motion images by rapidly spinning them to convert them into moving pictures – proudly proclaiming the larger-than-life figure in an accompanying plaque as the 'father of cinema'.[7] Rebecca Solnit's 2003 book, *Eadweard Muybridge and the Technological Wild West*, extends this argument, situating Muybridge as a precursor not only to Hollywood but to California's other famous industry, Silicon Valley, where the visual breakdown of gestures presages twenty-first-century view of the human as a productive machine that can be analysed and optimised for maximum output.[8] In a 2022 essay, Tim Cresswell succinctly characterises Muybridge's work as the beating heart of 'a field of abstracted mobilities that includes the time-motion study of Taylorism in factories, the rise of the railroad, clock time, and timetables in urban life', going so far as to argue for twenty-first-century surveillance tools including gait analysis and radio frequency identification as direct descendants of Muybridge's project.[9] Collectively, these interpretations of the motion studies see their importance as the epitome of a kind of way of imaging the world that could be marshalled for the rationalisation and optimisation of movement. On the flip side, feminist scholars including Marta Braun, Linda Williams, Janine A. Mileaf and Sarah Gordon have underscored Muybridge's instantaneous photography, in particular his photographs of women, as sequences that lay bare the project's concern with ideals of aesthetic composition. As Gordon has written, many of Muybridge's plates were motivated by a 'desire to appeal to artists', as he 'craftily composed aesthetic compositions that encourage contemplation of the page as a whole rather than sequential viewing, frame by frame'.[10] These scholars emphasise Muybridge's instantaneous photographic project as a work of *stop*-motion, as static images rather than *motion* studies.

Where might Plate 535, *Beating Time*, land among this art–science, static–movement dichotomy? On the one hand, unlike other illustrations in *Animal Locomotion*, Plate 535 resists a desire for cinematic synthesis and motion analysis. In Plate 1 of Volume 1, *Walking*, for example, showing a nude man photographed walking at twelve instants from three different angles, the orderly grid invites the viewer to read the series of photographic instants from left to right, imaginatively recreating the captured motion as one continuous movement (figure 2). Comparatively, *Beating Time* does not depict a clearly defined progression of linear movement. Unlike the man walking, which illustrates an image of regular, progressive motion from point A to point B, the formal structure of Plate 535 depicts the stationary movement of a hand moving in place

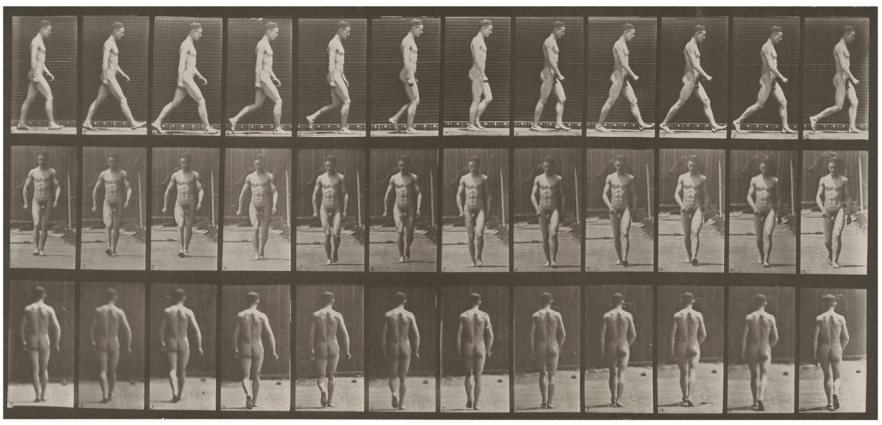

Figure 2. Eadweard Muybridge, Plate 1 in *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts.

4 – J. B. Lippincott of Philadelphia was initially supposed to publish the work, but with the scope of the project and the overall cost – close to $30,000 – the plates were published by the New York Photogravure Company, which was given the rights to the *Prospectus and Catalogue of Plates*, the marketing tool Muybridge published in 1887; see Marta Braun, *Eadweard Muybridge*, Critical Lives Series (London: Reaktion Books, 2010), 186–67.

5 – Eadweard Muybridge, *Prospectus and Catalogue of Plates* (Philadelphia: J. B. Lippincott Company, 1887), 4.

6 – For an incomplete list of works that point to Muybridge as one of the 'fathers' of cinema, see Terry Ramsaye, *A Million and One Nights* (New York: Simon and Shuster, 1964); Harlan Hamilton, '"Les Allures du Cheval": Eadweard James Muybridge's Contribution to the Motion Picture', *Film Comment*, 5, no. 3 (Fall 1969), 17–31; Robert Bartlett Haas, 'Eadweard Muybridge: 1830–1904', in *Eadweard Muybridge: The Stanford Years, 1872–1882*, ed. by Anita V. Mozley (Stanford: Stanford University Museum of Art, 1972), 11–36; Kevin MacDonnell, *Eadweard Muybridge: The Man Who Invented the Moving Picture* (Boston: Little, Brown, 1972); Gordon Hendricks, *Eadweard Muybridge: The Father of the Motion Picture* (New York: Grossman Publishers, 1975); Robert Bartlett Haas, *Muybridge: Man in Motion* (Berkeley: University of California Press, 1976); Ernie Gehr, 'Aspects of Eadweard Muybridge's Photographic Work', in *Radical Light: Alternative Film & Video in the San Francisco Bay Area, 1945–2000* (Berkeley: University of California Press, 2010), 19–25; Stephen Barber, *Muybridge: The Eye in Motion* (Washington, DC: Solar Books, 2012; distributed by University of Chicago Press); and Dimitrios Latsis, 'Landscape in Motion: Muybridge and the Origins of Chronophotography', *Film History*, 27, no. 3 (2015), 1–40.

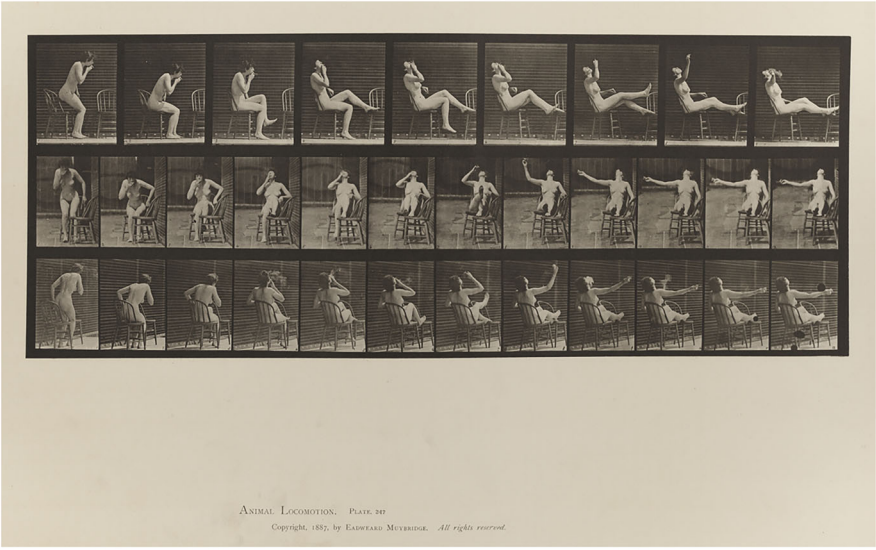

Figure 3. Eadweard Muybridge, Plate 247 in *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts.

in a haphazard, seemingly unpredictable fashion. Where the movements of the man walking are deconstructed by the serial, sequential format of the grid, in the case of *Beating Time* the same gridded composition effectively interrupts the hand's gestures in a way that serves more to obscure the trajectory of its movements than to break them down for greater legibility and analysis. Yet the flexions of the wrist and hand seen in Plate 535 also do not clearly align with the kind of visual gratification evident in a sequence like Plate 247, where, as Gordon describes, the model 'reclines languidly in a pose of ecstasy and release' (figure 3).[11] Put simply, *Beating Time* is too weird and complex to voyeuristically enjoy. The strange figure, imperfectly obscured by the black cloak worn against a dark backdrop, conceals more than it reveals. Rather, as a sequence picturing the static motion of a hand moving in place, *Beating Time* illustrates how the power of *Locomotion* works to paradoxically play within, even widen, the gaps between motion and stasis generated by the medium of stop-motion, sequential photography.

I am taking some liberties by beginning with *Beating Time,* an image relatively unique amongst the 781 plates published in the final version of *Animal Locomotion*.[12] However, the eccentricities and ambiguities of Plate 535 unveil a covert resistance to scientific analysis and industrial regularity, frustrating the desire – to make the human body legible for analysis – that was the titular goal of the 'electro-photographic investigation of consecutive phases of animal movements'. I will call this subcategory of sequences within the *Locomotion* studies 'inoperative images'. My use of this term plays on the artist and theorist Harun Farocki's concept of 'operative pictures', by which he refers to images that do not simply represent things but in fact 'do' things in the world.[13] In the sense that I use it here, inoperative images refer both to the specific types of gestures depicted and to the ultimate uselessness of many of the plates as a whole as data sets for physiological study. Among the hundreds of movements represented in *Animal Locomotion*, Muybridge illustrates figures dancing, posing, lying down and smoking, gestures that demonstrate little propulsive movement or even purpose. These sequences stand in contrast to the many other 'operative' gestures depicted in *Animal Locomotion*, including the movements of bricklayers, blacksmiths and other manual labourers, where the depicted motions are both goal-oriented and productive. Such inoperative gestures – those that produce nothing but their own movement – also crucially fail to illustrate a series of any identifiable linear motion and the relation

7 – Where no evidence suggests that Muybridge ever projected his photographs as motion pictures, the photographer did provide supplementary presentations to his motion studies with his zoopraxiscope, a circular disc onto which hand-drawn versions of his photographs were spun, creating the illusion of motion. See Eadweard Muybridge, *The Attitudes of Animals in Motion Illustrated with the Zoopraxiscope* (London: W. M. Clowes and Sons, 1882).
8 – Rebecca Solnit, *Eadweard Muybridge and the Technological Wild West* (New York: Viking, 2003). Muybridge's work is sometimes cited as inspiration for the scientific management photographs of Frank B. Gilbreth and Lillian M Gilbreth; see Frank B. Gilbreth and Lillian M Gilbreth, 'The Effect of Motion Study Upon the Workers', *Annals of the American Academy of Political and Social Science*, 65 (May 1916), 272–76. For more on the corporate cultures of optimisation of human labour, see Elspeth H. Brown, *The Corporate Eye: Photography and the Rationalization of American Culture, 1884–1929* (Baltimore: Johns Hopkins University Press, 2000).
9 – Tim Cresswell, 'Visualizing Mobility', in *Muybridge and Mobility*, ed. By Anthony W. Lee (Berkeley: University of California Press, 2022), 9–52 (25).
10 – Sarah Gordon, *Indecent Exposures: Eadweard Muybridge's Animal Locomotion Nudes* (New Haven, CT: Yale University Press, 2015), 113–14.
11 – Ibid., 125.
12 – *Beating Time* is one of a short series of stop-motion sequences of a hand performing motions in close-up for the camera included in *Animal Locomotion*; other movements of the hand include drawing a circle (Plate 532), clasping hands (Plate 533), lifting a ball (Plate 534) and hands changing a pencil (Plate 536).

from one image to the next, instead dancing around and within the gaps between frames.[14]

Further, the complexity of Muybridge's stop-motion apparatuses used in the making of *Animal Locomotion* courted moments of failure and glitch that engendered a messy irregularity in the resulting image series. As Braun, Gordon and others have detailed, the *Locomotion* album is far from a perfect document of mechanical and scientific objectivity. The use of multiple cameras, each requiring its own glass negative plate and each creating new opportunities for misfire and malfunction, means that the series as a whole is riddled with unequal time intervals, rearranged sequences and repeated frames.[15] Although often successful at masking these irregularities with the visual veneer of the orderly grid, scientifically numbered plates and an extensive introduction extolling the scientific nature of the project – a classic case of 'methinks the lady protest too much' – *Animal Locomotion* in fact documents the failures of both the figures before the camera and the recording instruments and materials to conform to the project's mandate to capture and decipher the secrets of bodily movement. Instead, these unruly and inoperative images reassert the all-too-human qualities of unpredictability and irregularity in the face of an increasingly mechanised modernity.

The glitchiness of the *Animal Locomotion* project resists the intention of the university to produce scientific data while also responding to the uncertain status of the photographer at a moment when the medium was becoming increasingly mechanised and automated. Where the cross-currents of industrial production and aesthetic ambition that carry throughout the *Animal Locomotion* work have been thoroughly investigated by Muybridge scholars, by looking at it within the context of the depreciating value of photography as a skilled profession, at a time when both the operators and their equipment were reduced to automatic and instantaneous instruments to execute the will of management, we may come away with a revised understanding of the nature of the 'new temporality' inaugurated by chronophotography and the role of the hand that 'beats time'.[16] The gaps between frames and uncertain trajectories of movement from one figure to the next gesture towards moments of pause and unpredictability in *Animal Locomotion* that ultimately underwrite and resist the mandates of the nineteenth-century clockwork, mechanical universe.[17]

Attempting Objectivity

Since its inception, the instantaneous, stop-motion photograph has been tasked with holding nineteenth-century, idealised projections of objectivity and knowability. As Braun, Michael Leja, John Ott and others have shown, Muybridge's earlier studies of the horse in motion, conducted at the industrialist tycoon Leland Stanford's Palo Alto ranch in 1872, prompted a crisis in painterly representations of motion that set up a dichotomy of artistic falsity versus scientific truth.[18] Where earlier equestrian paintings showed the horse gracefully lifting off the ground in a 'flying gallop', as in Théodore Géricault's *Derby at Epsom* (1821) where the horse's legs are all extended out from the body in a graceful leap, the Palo Alto motion studies revealed a more awkward visual truth, in which the horse's legs are seen curled up under itself while lifted off the ground, as seen in Plate 3 of Muybridge's 1878 published cabinet card of the horse Sallie Gardner 'running at a 1:40 gait' (figure 4).The old equation that 'beauty is truth, truth beauty' no longer applied. Muybridge's equestrian photographs prompted a choice between truth or beauty, leading some painters to take the extraordinary step of repainting older canvasses where

13 – Harun Farocki, 'Phantom Images', *Public*, 29 (2004), 13–22 (21); see also Trevor Paglen's discussion of Farocki's categories in 'Operational Images', *e-flux*, 59 (November 2014), ⟨https://www.e-flux.com/journal/59/61130/operational-images/⟩.

14 – My understanding of inoperative gestures here draws on Giorgio Agamben's discussion; see Giorgio Agamben, 'Notes on Gesture', in *Means Without End: Notes on* Politics, trans. by Vincenzo Binetti and Cesare Casarino (Minneapolis; London: University of Minnesota Press, 2000), 49–58.

15 – Braun first presented these findings in Marta Braun, 'Muybridge's Scientific Fictions', *Studies in Visual Communication*, 10, no. 3 (1984): 2–21; see also Marta Braun, 'Muybridge's Animal Locomotion: The Director's Cut', *History of Photography*, 24, no. 1 (2000), 52–54.

16 – Tom Gunning, in reference to Muybridge, has written: 'This new temporality was systematic, measured and produced by precision machinery, and could only be expressed by abstract mathematic measurements'. Tom Gunning, 'Animating the Instant: The Secret Symmetry between Animation and Photography', in *Animating Film Theory*, ed. by Karen Beckman (Durham, NC: Duke University Press 2014), 45–46. Mary Ann Doane has also interpreted chronophotography as part of the 'temporal demand' of modernity, where 'the standardization and rationalization of time can be linked to changes in industrial organization and perceptions of an affinity between the body of the worker and the machine', both of which were tied to chronological time and homogeneous space. Mary Ann Doane, *The Emergence of Cinematic Time: Modernity, Contingency, the Archive* (Cambridge, MA: Harvard University Press, 2002), 4, 5.

17 – For one account of the slow, uncertain encroachment of standardised and industrial time, see Peter Galison, *Einstein's Clocks and Poincaré's Maps* (New York: W. W. Norton, 2003).

18 – Marta Braun, 'Muybridge, Authorship, Originality', *Early Popular Visual Culture*, 11, no. 1 (2013), 41–51 (42–43); Michael Leja, *Looking Askance: Skepticism and American Art from Eakins to Duchamp* (Berkeley: University of California Press, 2006), 67–71; and John Ott, 'Iron Horses: Leland Stanford, Eadweard Muybridge, and the Industrialised Eye', *Oxford Art Journal*, 28, no. 3 (2005), 407–28.

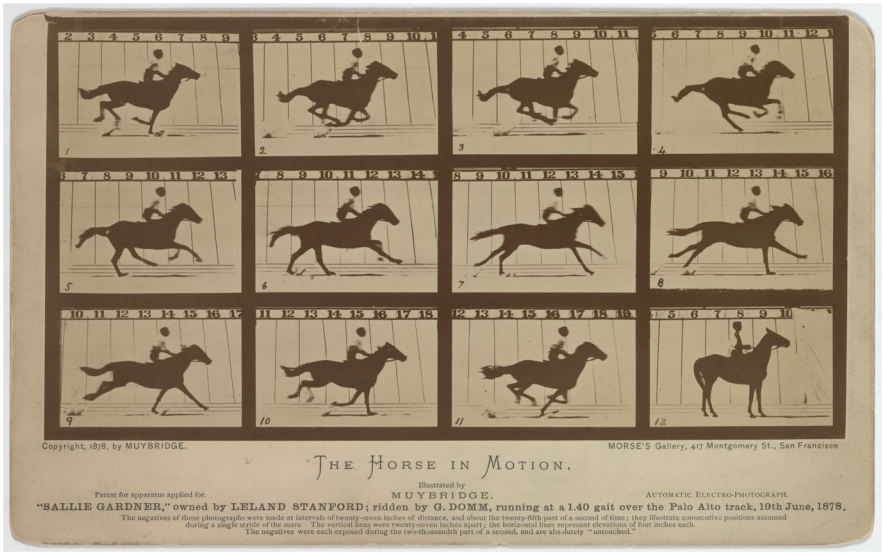

Figure 4. Eadweard Muybridge, *The Horse in Motion, illus. by Muybridge. 'Sallie Gardner,' owned by Leland Stanford, running at 1:40 gait over the Palo Alto track, 19 June 1878: 2 frames showing diagram of foot movements*, 1878. Albumen print. Library of Congress, Washington, DC.

representations of movement were proven by the camera to be inaccurate or false.[19] In this way, Muybridge's instantaneous equine photographs were perceived as mechanical correctives to the errant hand of the painter.[20]

Not only would they provide the 'objective' image of the horse's limbs in full gallop, but they would also make possible better training and optimisation of the horse's musculature. In a demonstration for journalists held on 15 June 1878 to prove the veracity of Muybridge's photographic process to an observing public, one observer noted that while the images 'rob the horse of that gracefulness generally credited to him', they 'will nevertheless prove invaluable to persons concerned in the care and training of the trotters'.[21] While not a graceful image, the stop-motion photograph was nevertheless valued for the ways in which it could optimise equestrian training methods. As Ott has argued, 'the Muybridge photographs standardised a sort of physiological time, so to speak, by which the actions of animals and humans could be clocked and against which they could be measured'.[22] The dream of using the camera to dissect, measure and eventually optimise the movements of the body seemed to sacrifice art in the service of science.

This human–machine debate hints at a larger cultural problem at the end of the nineteenth century, in which the human was becoming more machine-like, while the machine took over much of the work previously conducted by camera operators. In the prospectus to *Animal Locomotion*, Muybridge highlights the lack of handwork in his photographs to signal the images' unvarnished objectivity, writing: 'The figures illustrating the various movements are reproduced from the original negatives by the photo-gelatine process of printing, without any attempt having been made to improve their pictorial effect, either in outline or detail; or to conceal their imperfections'.[23] The advent of instantaneous images captured in as little as 1/5000th of a second, as Muybridge claimed, highlighted the camera's suprahuman ability to stop motion as its own unique contribution to the representation of movement.[24] The world no longer had to hold still for the camera, as the camera stilled the world. This development prompted a new crisis about the role of the hand in the production of images, one that would have significant implications for the photographic arts.

The instantaneity, indexical nature and lack of handwork in the chronophotographic studies all conform to what historians of science Lorraine Daston and Peter Galison have termed the regime of 'mechanical objectivity', which they characterise as 'the insistent drive to repress the wilful intervention of the artist-author, and to

19 – A notable incident, reported in May 1887, concerned the French painter Ernest Meissonier, who allegedly repainted one his equine canvases after viewing Muybridge's photographs of a galloping horse; see Françoise Foster-Hahn, 'Marey, Muybridge and Meissonier: The Study of Movement in Science and in Art', in *Eadweard Muybridge*, ed. by Mozley, 103–106.

20 – It is important to note that many critics disagreed whether such photographic 'corrections' were appropriate to the aesthetics of painting, arguing that ocular truth should be favoured over machine vision; see ibid.; and Leja, *Looking Askance*, 59–92.

21 – *Sacramento Daily Union*, 18 June 1878, quoted in Marta Braun, *Eadweard Muybridge* (London: Reaktion Books Ltd., 2010), 143.

22 – Ott, 'Iron Horses', 421.

23 – Muybridge, *Prospectus*, 4.

24 – Muybridge makes this claim in *Descriptive Zoopraxography, or, The Science of Animal Locomotion Made Popular* (Philadelphia: University of Pennsylvania, 1893), 7.

put in its stead a set of procedures that would, as it were, move nature to the page through a strict protocol, if not automatically'.[25] In other words, the human could no longer be trusted to accurately record observations. It would become the task of the machine to do so 'objectively', removing any human bias from the scientific process of data collection. According to Daston and Galison, mechanical objectivity appeared sometime around 1830 as a new epistemic virtue in the sciences, whereby the older regime in which the scientist served as the sage interpreter was replaced by a desire to record and represent nature without human intervention. This method of recording information was meant to orient the image away from the interpretive, intervening 'author-artist' in order to let nature inscribe itself independent of an interpreter.[26] For Daston and Galison, this procedure was perfectly embodied in the medium of photography, valued as a tool of mechanically objective information capture for its lack of human interpretation, automatism and the objectivity of those images 'impressed by nature's hand'.[27]

25 – Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 121.

26 – Ibid.

27 – Ibid.

In the earlier California studies, Muybridge employed the wet-plate collodion process, which required that the plates be coated and exposed in the ten to twelve minutes before the collodion layer dried to retain sufficient light sensitivity. The early equestrian images published in *The Horse in Motion* (1882) were in fact overpainted by Muybridge to correct the underexposed negatives. Muybridge's work at the San Francisco Olympic Club, published as *The Attitudes of Animals in Motion* (1881), also resulted in little more than silhouette outlines of his subjects, resembling more hand-drawn cartoons than lens-based photographs. For many critics, the postproduction intervention of the hand delegitimised these images, making them 'fraudulent' and 'inartistic'. In the words of William Rulofson, a former associate of Muybridge's, who remarked on the use of hand-touching in the Sallie Gardner images, 'Photographically speaking, it is "bosh"'.[28] Further, both the complicated machinery deployed to capture the horse's movements as well as the horse herself failed to live up to the task at hand. In the Palo Alto studies, the horse Sallie Gardner ran against and broke 'a series of fine threads stretched perpendicularly across the track in front of each camera', which triggered the shutter.[29] But the horse was spooked by these wires and leaped in air midway through the process, giving 'a wild bound in the air, breaking the saddle girth as she left the ground'.[30] With Gardner's erratic leap mid-production, organic life refuses to subject itself to the strictures of mechanical capture. Rather than relying on an operator's touch and instinct to manually release the shutter at the right moment, the hard wire of the 'objective' process of photographic observation in fact failed as a tool for objective data-gathering, necessitating the reintroduction of the hand to overpaint and clarify the subject only indistinctly captured in the photographic negative.

28 – Quoted in Erin Pauwels, 'Resetting the Camera's Clock: Sarony, Muybridge & the Aesthetics of Wet-Plate Photography', *History of Technology*, 31, no. 4 (2015), 482–91 (483).

29 – William Dennis Marks, 'The Mechanism of Instantaneous Photography', in *Animal Locomotion: The Muybridge Work at the University of Pennsylvania. The Method and the Result* (Philadelphia: J. B. Lippincott Company, 1888), 9–33 (22).

30 – *Pacific Rural Press*, 22 June 1878. Quoted in Braun, *Eadweard Muybridge*, 142.

As Cresswell and others have highlighted, looking closely at the last frame in the 1878 cabinet card of the horse in motion, one can see the sequential numbers at the top of the image meant to track the progressive motion of the horse have returned back to zero.[31] Could this additional frame have been inserted to make up for the image lost to the horse's erratic leap? Reading the image this way, where the visible rearrangement of frames ambiguously returns us back to a starting position without any clarity about where or when this frame was captured, we may see how *The Horse in Motion* has more in common with *Beating Time* than may have been previously recognised. Both illustrate less a synthesis of an actual movement than a mosaic of moveable parts. In both the 1878 composition and Plate 535, Muybridge has 'beat' time not just in the sense that the camera has moved faster than the world it captured, but also in the ways in which time has been rearranged, mixed up and otherwise tampered with.

31 – Cresswell, 'Visualizing Mobility', 40. For more on the looping structure of much of Muybridge's work, see Friedrich Tiejten, 'Loop and Life: A False Start into Protocinematic Photographic Representations of Movement', *History of Photography*, 35, no. 1 (2011), 15–22.

From its earliest days and throughout the medium's history, the labouring body, and the hand in particular, has been a prime pictorial subject for photographers: from Daguerre's first boot shiner on the Boulevard du Temps, to Alfred

Stieglitz's obsessive picturing of the hands of Georgia O'Keeffe, to László Moholy-Nagy's series of untitled photograms. As Allan Sekula has argued, the hand pictured by the camera serves as a locus of 'a nostalgic organicism predicated on the ritual banishment of the camera from the productive processes'.[32] In other words, an intensified fascination with the very manual labour eliminated by the automatic, instantaneous image-machine. Remarkably, for a project intimately concerned with bodily gestures of all kinds, few scholars have investigated the photographer's own bodily gestures that would have been employed throughout the making of *Animal Locomotion* as an integral component of the motion studies. The technical advances in automation and mechanisation in camera technology in the 1880s provoked a renewed crisis for professional photographers who had long sought to legitimate their pictorial products alongside the plastic arts of painting and sculpture. As Robin Kelsey has argued, it is the role of chance that sets photography apart from the arts of sculpture and painting: 'Pressing the button fosters a sense of having produced the picture, but how far does that responsibility extend? Has the person who has accidentally taken a superb photograph made a work of art?'[33] By the late nineteenth century, changes in photographic technology and commercial production methods made the *Locomotion* studies possible while also provoking a further crisis in a medium that had always been characterised by an ambiguity concerning the relation of hand to image.

32 – Alan Sekula, 'An Eternal Esthetics of Laborious Gestures', *Grey Room*, 55 (Spring 2014), 16–27 (18).

33 – Robin Kelsey, *Photography and the Art of Chance* (Cambridge, MA: Harvard University Press, 2015), 2.

The Dry Plate

The kinds of hand gestures required for photographic production circa 1880 were in the middle of a profound and lasting transformation. The dry-plate process, developed by the English photographers Richard L. Maddox and Charles Harper Bennett in 1871, would prove essential to the completion of *Animal Locomotion.* [34] The new method of producing negative plates combined gelatine with the sensitising chemicals cadmium bromide and silver nitrate. This mixture was later heated at a high temperature, greatly increasing its sensitivity and hardening the emulsion, reducing the plate's vulnerability to scratches. Unlike wet collodion, the dry plate's predecessor, the gelatine dry plate could be stored for several months after exposure, allowing the photographer greater mobility and ease of production outside a studio setting. Now one could take pre-coated photographic plates on a trip, without the need to cart along a cumbersome darkroom, and develop the plates at a later time. Whereas as late as the 1870s, the average photographer had to ready the emulsion, coat the glass plate, adjust the camera settings, expose, develop and fix the plate, all on the site when and where the image was taken, making of the photographer not only a camera operator but also a decentralised handicraft producer, the switch to dry plate simplified the process and eliminated much, if not all, of such handwork aspects required on the front end of the photographic process. Between 1879 and 1883, the first dry-plate factories began opening in Europe and the USA, including those of George Eastman in Rochester, New York, John Carbutt in Philadelphia and Gustav Cramer's G. Cramer Dry Plate Company in St. Louis. Both Carbutt and Cramer provided photographic supplies for Muybridge's work in Philadelphia. In 1879, Carbutt founded the Keystone Dry Plate Works, which would become the first manufacturer of celluloid emulsions for photographic plates less than ten years later. The same year, Eastman designed a machine to continuously coat glass plates with gelatine emulsion, speeding the industrial mass production of photosensitive plates and essentially eliminating the handwork required to prepare negatives for exposure.[35]

34 – See Richard L. Maddox, 'An Experiment with Gelatino-Bromide', *British Journal of Photography*, 28, no. 592 (8 September 1871), 422–23 (422).

35 – US Patent no. 226,503 (application filed 9 September 1879; issued 13 April 1880).

Mass-produced dry plates were explicitly discussed in period literature as part of the crisis in photographic labour and a new source of the destabilisation when it

came to understanding the relationship between the photographer's hand and the photographic image. Produced in factories, pre-coated and sold in boxes of a dozen each, the dry plates were a newly standardised and industrialised product for the photographic industry. As one commentator put it, the dry plate 'needs no skilful manipulation, like the wet plate, as the care and skill have all been put into the plate itself by the manufacturer'.[36] Dry-plate technology was also singled out as one of the sources for a new ambiguity concerning who would be considered the creator of photographic images. As R. D. Chapan wrote in the 1882 article 'Dry Plate Gush', 'Of course, photographers are using dry plates, or, perhaps more properly speaking, dry-plates are using the photographers', expressing how the photographer's gestures, through the simplification and ease of operating automatic cameras, now seem to originate not within the mind or body, but from the tools and materials themselves.[37] Where the dry plate allowed a new crop of amateur photographers to take up photographing as a leisurely hobby, just like or at the same time as bicycling, canoeing and sailing, professional photographers had a more complicated relationship to such technical advances.[38] In a description of a visit to the dry-plate works of Cramer in 1884, the editors of the *Philadelphia Photographer* expressed ambivalence over the outsourcing of the handwork formerly done by the photographer in the chemical and mechanical preparation of plates. After observing the totality of the operations, where a legion of workers toiled in underground alcoves hurriedly cutting, coating and drying plates, they were convinced that Cramer 'had run the dry-plate business considerably into the ground', referring to the shoddy operations that privileged speed of production over quality of product.[39]

A growing awareness of the loss of embodied skills among photographers can be detected in the increasing number of memoirs of those photographers who made their mark as daguerreotypists some forty years earlier, such as James F. Ryder's remembrances published in an 1887 issue of the *American Annual of Photography* or Henry Hunt Snelling's memoir of John A. Whipple, 'Looking Back: or, the Olden Days in Photography', published in an 1887 issue of *Anthony's Photographic Bulletin*.[40] These reminiscences would grow as the first generations of photographers whose deaths represented a loss of both photographic history and skill.[41] In an 1887 article for *Scientific American,* George M. Hopkins, motivated both by a nostalgia and a looming sense of the loss of knowledge, illustrates the processes of daguerreotype production, including the gestures of scouring, buffing, fixing and gilding with this note: 'Daguerreotypy, although one of the most notable inventions of the present century, is already obsolete. It is nearly forgotten by those who practiced it, and is not preserved in all its details in the literature of photography' (figure 5).[42] By the 1880s, with the camera operator liberated from manual work, both the tools and gestures of photographic practice have become embedded, not in the photographer's body but in the industrial factories producing dry plates. For photographers like Muybridge, Hopkins and many others, who had spent decades producing photographs through the more labour-intensive wet-plate, albumen and even daguerreotype processes, the oncoming industrialisation of the medium through the dry plate represented a loss of what historian Pamela Smith has called 'artisanal epistemology', the often non-verbal, embodied gestures and muscle memory built up from a lifetime of pouring collodion, buffing plates and manually removing the shutter.[43]

Simultaneous to these technical developments, the issue of photographic authorship made its way through the US legal system. In 1882, the photographer Napoleon Sarony sued the Burrow-Giles Lithographic Co. for making eighty-five thousand unauthorised prints of his well-known image of Oscar Wilde, a case that made it all the way to the Supreme Court. Even though an 1865 amendment to copyright law had previously extended protections to photographs, the lithographic company argued that the images were mechanical products, not original works, and therefore

36 – D. J. Tapley, *The New Recreation, Amateur Photography: A Practical Instructor* (New York: S. W. Green's Son, 1884), 25.

37 – R. D. Chapan, 'Dry-Plate Gush', *Philadelphia Photographer*, 19, no. 227 (November 1882), 325–327 (325).

38 – See Sara Dominici, '"Cyclo-Photographers", Visual Modernity, and the Development of Camera Technologies, 1880s–1890s', *History of Photography*, 42, no. 1 (2018), 46–60.

39 – 'The G. Cramer Dry-Plate Works', *The Philadelphia Photographer*, 21 (January 1884), 10–12 (10). It is important to note that the divisions of labour employed at the dry-plate factory existed in some fashion in the professional daguerreotype studios of the 1850s, with the crucial difference that the business owner was also frequently the photographer.

40 – James F. Ryder, 'A Reminiscence', *American Annual of Photography and Photographic Times Almanac for 1887* (New York: Scovill Manufacturing Company, 1887), 144–46; and Henry Hunt Snelling, 'Looking Back; or, the Olden Days in Photography', *Anthony's Photographic Bulletin*, 19, no. 18 (22 September 1888), 559–63.

41 – See Abraham Bogardus, 'The Days of the Daguerreotype', *Youth's Companion*, 77, no. 18 (20 April 1903), 210–11; and 'Stray Leaves from the Diary of the Oldest Professional Photographer in the World', *Photo Era: The American Journal of Photography*, 16, no. 2 (February 1906), 104–107.

42 – Geo. M. Hopkins, 'Reminiscences of Daguerreotypy', *Scientific American*, 56, no. 4 (1887), 47, 52.

43 – Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2006), 59–94.

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REMINISCENCES OF DAGUERREOTYPY.

BY GEO. M. HOPKINS.

DAGUERREOTYPY, although one of the most notable inventions of the present century, is already obsolete. It is nearly forgotten by those who practiced it, and is not preserved in all its details in the literature of photography. It is undoubtedly safe to say that a very small proportion of professional photographers, and a still smaller proportion of amateurs, have any practical knowledge of the subject. The writer, though never a professional daguerreotypist or photographer, very early in life acquired a practical knowledge of photography in the days when daguerreotypy was at its best. The interest then awakened has since been maintained through every phase of the growth and development of the art; and recently, depending on memory alone, the writer has extemporized apparatus, and successfully carried out the daguerreotype process.

It will be remembered that Neipce and Daguerre sought independently of each other for a method of producing sun pictures. Neipce at first employed plates coated with bitumen. He formed a partnership with Daguerre in 1829, but died before the invention now known as daguerreotypy was perfected.

After the death of Neipce, Daguerre improved the art to such an extent that Neipce's son allowed it to go under its present name. Both inventors received annuities from the government for giving the invention to the public.

In this country the art was first practiced by Morse, and was improved by Draper soon after it was introduced here.

Daguerreotypy was very simple, easily understood, and easily managed, and was learned by many who found it a light business, requiring little capital and returning large profits.

The plates employed were copper faced with silver. The metal was hard rolled, and the plates, as received from the manufacturers, were flat and quite smooth, but not polished. The first step toward the preparation of the plate for use was to clip the corners and turn down the edges slightly, in a machine designed for the purpose, to bring the sharp edges of the plate out of reach of the buff employed in producing the necessary polish.

The plate was held, for scouring, in a block having clips on diagonally opposite corners for engaging the corners of the plate. One of the clips was made adjustable, to admit of readily changing the plates. The block was mounted pivotally on a support clamped to the table, as shown in Fig. 1.

The scouring was effected by sprinkling on the plate the finest rottenstone from a bottle having a thin muslin cover over its mouth, and the rottenstone as well as the square of Canton flannel with which it was applied was moistened with dilute alcohol. The center of the Canton flannel square was then clasped between two of the fingers, and moved round and round with a gyratory motion until the plate acquired a fine dead-smooth surface. The last traces of rottenstone were removed by means of a clean square of flannel. The plate was then transferred to a block mounted on a swinging support, and buffed by the vigorous application of a straight or curved hand buff formed of a board about four inches wide and thirty inches long, padded with four or five thicknesses of Canton flannel, and covered with buckskin charged with the finest

(Continued on page 52.)

1. Scouring the Plate. 2 Buffing. 3. The Rotary Buff. 4. The Dark Room. 5. The Gallery. 6. Developing the Plate. 7. Fixing. 8. Gilding or Toning.

DAGUERREOTYPY.

Figure 5. Illustration from 'Daguerreotypy'. From Geo. M. Hopkins, 'Reminiscences of Daguerreotypy', *Scientific American* 56:4 (1887), page 47.

did not quality for authorial protection. In the case, the Supreme Court ruled in favour of Sarony, determining that the photographs were 'writings', the term used in the copyright clause, and therefore qualified as protected creative expression. As Robin Kelsey has written of William Henry Fox Talbot, 'by obviating the need for the manual skill of drawing', the camera 'vested art properly in the mind and eye rather than in the hand'.[44] Muybridge personally experienced the increasing ambiguity concerning who or what could be credited as the true author and owner such photographs under this regime of industrial production and instantaneous image-capture.[45] In a blow to Muybridge's notoriety and income, in 1883 the photographer was denied authorship over the images used for Stanford's publication of *The Horse in Motion*.[46] Over the course of the lawsuit, the question at stake was whether the Palo Alto photographs were the intellectual property of Muybridge, the photographer, or Stanford, the financial backer. The historian and biographer of Stanford,

44 – See Kelsey, *Photography*, 49. For a discussion of authorship in Muybridge's work, see Braun, 'Muybridge, Authorship, Originality'.

45 – For an account of the challenges that Muybridge's photography posed to more traditional conceptions of authorship, see Braun, 'Muybridge, Authorship, Originality'.

46 – For an account of the lawsuit, see Haas, *"Eadweard Muybridge: 1830–1904"*, 27–30.

Norman E. Tutorow, has sided in favour of the industrial tycoon, arguing that Stanford 'made a number of helpful suggestions along the way, even going so far as to assign a railroad engineer to the project to assist Muybridge with technical difficulties. To Muybridge was given the responsibility of using his incomparable technical skills to carry out the instructions of his employer'.[47] A statement by Stanford himself confirms that this is indeed how the industrialist considered Muybridge's role in the project. Throughout the trial, Stanford repeatedly referred to Muybridge as a mere 'employee'. During the trial, Stanford, in a letter to Stillman, insisted that 'the actual facts are from the beginning to the end that [Muybridge] was an instrument to carry out my ideas'.[48] In other words, Stanford was the brains of the operation, directing the energies of his hired hand, Muybridge, making the photographer, not unlike his camera, a kind of animate tool that ultimately required direction from its operator.[49]

With this in mind, we can return to Muybridge's *Beating Time* with renewed interest and insight. It is part of a set of photographs of hands which also include sequences of a hand drawing a circle, grasping a ball and clapping, all taken less than one year after his defeat in Muybridge V. Stanford. In *Beating Time*, the hand of the operator reappears as the source of Muybridge's stop-motion images, a sequential portrait of the work of the 'hired hand'. The hand in *Beating Time* can be read as a reassertion, not only of Muybridge's authority as the author of the stop-motion photographs but also of the role of technology and its skilled operation in their generation. Yet Muybridge's reassertion of the hand is not without qualification. In the *Osgood vs. Muybridge* suit, Osgood representing Stanford as the publisher of *The Horse in Motion*, Stanford claimed that he had employed 'expert engineers, electricians, mechanics, assistants and labourers to assist in the project', and that he personally owned 'all the cameras plates, paper, chemicals, machinery, apparatus, appliances, models, subjects, skill and labour', including the skill and labour of Muybridge.[50] Stanford's Taylorist view of his relation to Muybridge underscores how the photograph, when understood as a product of the machine, meant that the photographer could be separated from the skill and labour employed in the chronophotographic chain of production. This gap between photographer and photograph, between hand and image, is dramatised in the jerky, deracinated movements of the fingers and wrist in *Beating Time*. In each individual frame, the hand performs ambiguous and difficult to decipher gestures, operations in space with seemingly no productive purpose or function, drawing lines in the air that leave no trace. The fact that the hand pictured belongs to J. Liberty Tadd, then director of the Pennsylvania Museum and School of Industrial Art, further draws attention to the hand's significance as a crisis in skilled pictorial production amidst an industrialising economy.[51] In *Beating Time*, it is as if the rest of the sitter's body has no idea what the hand is doing.

The Making of Animal Locomotion

Towards the end of the nineteenth century and through the beginning of the twentieth, a group of photographers, artists and scientists including Muybridge, Étienne-Jules Marey, Thomas Eakins, Jules Janssen and Ottomar Anschütz developed various methods of 'chronophotography', a term coined by the French physiologist Marey and later declared by the International Congress of Photography in 1889 as the official name to describe all sequential instantaneous photographic processes, replacing older phrases like 'series photography', 'sequence photography' or 'animated photography'.[52] A highly technical new genre of photographic capture, chronophotographic practices pushed the medium to its mechanical and chemical limits. The rapid and sequential capture of a series of instantaneous images required the fastest available lenses, highly sensitive photographic emulsions and the ability to open and close the

47 – Norman E. Tutorow, *Leland Stanford: Man of Many Careers* (Menlo Park: Pacific Coast Publishers, 1971), 177.

48 – Letter to J. D. B. Stillman, 23 October 1882, Leland Stanford, *Leland Stanford Papers* (SC 33a, Special Collections and University Archives, Stanford University, Stanford, CA), Box 1, Folder 17. Quoted in Ott, 'Iron Horses', 428.

49 – Giorgio Agamben gives an account of Aristotle's meaning of 'animate instrument'; see Giorgio Agamben, *The Use of Bodies*, trans. by Adam Kotsko (Stanford: Stanford University Press, 2016), 11.

50 – Quoted in Haas, "*Eadweard Muybridge: 1830–1904*", 27.

51 – J. Liberty Tadd was also an artist and friend of the Philadelphia painter Thomas Eakins. Many of the female models seen in *Animal Locomotion* were introduced to Muybridge by Tadd. Tadd's face is visible in the cyanotype proofs for this series now held at the National Museum of American History in Washington, DC. See Braun, *Eadweard Muybridge*, 188.

52 – Deac Rossell, 'Chronophotography in the Context of Moving Pictures', *Early Popular Visual Culture*, 11, no. 1 (2013), 10–27 (10).

shutter within an interval of one-tenth of a second.[53] With the introduction of the dry plate, Muybridge's studies of movement would continue to expand and improve in quality of detail and speed of capture. The Philadelphia photographer William H. Rau, who had attended Muybridge's lecture on 'The Romance and Realities of Animal Locomotion' in the spring of 1883 at the Pennsylvania Academy of Fine Arts, made note that the stop-motion projections displayed 'were mostly silhouettes, excepting the white animals, which had some detail'.[54] An accomplished photographer in his own right, Rau offered: 'The pictures were all made by the wet process, and were good for such; but rapid dry plates would give, without doubt, fuller detail'. The dry-plate process, which by the 1880s was also referred to as the 'instantaneous process', fixed many of these problems for Muybridge while also, crucially, eliminating the need to individually prepare almost twenty thousand individual negatives used throughout the making of *Animal Locomotion*.[55]

For the Philadelphia work, Muybridge arranged as many as thirty-six cameras side by side in a number of configurations, each of which were equipped with its own dry-plate negative (figure 6). A portion of the cameras were arranged laterally along a shed – a simple wood building that housed twelve of the cameras – and placed, as recounted by the study's principle engineer William Dennis Marks, 'at a perpendicular distance of about fifteen metres (forty-nine feet) from the line of progressive motion on the track'.[56] A series of lateral cameras were encased within this 'camera-house' positioned on the southern side of the enclosure in front of a series of wooden boards painted white, so that they could reflect a maximum amount light towards the centre of the track where models would walk, run, dance, hammer anvils, lay bricks, and perform a variety of other gestures (figure 7). In a method initially developed during his time in Palo Alto, the multiple camera shutters were triggered via an electrical current produced by strings laid across the path of the model.[57] Consequently, the intervals of each exposure were not tied to the regular rhythms of a clock, but to the uneven and sometimes unpredictable movements of the animal's body. Muybridge's thread-release method, as Marks recounts, resulted in unequal as well as unrecorded time intervals and wasted plates due to premature exposure, frustrating the desire to synthesise the continuous moments of bodies.[58] Rather than mobilising the camera as a neutral observer taking images in regulated clock time, the thread-release method actually aligned the moment of photographic capture with the body, triggering only when the subject decided to move.

53 – For more on the importance of the association of this time interval with instantaneity, see Jimena Canales, *A Tenth of a Second: A History* (Chicago: University of Chicago Press, 2011).

54 – William H. Rau, 'Mr. Muybridge's Lecture with the Zoopraxiscope', *The Philadelphia Photographer*, 20, no. 231 (March 1883), 78–79 (79). William H. Rau was later hired in the 1890s to document newly lain track put down by railroad companies to showcase the scenery seen along the routes. See *Traveling the Pennsylvania Railroad: The Photographs of William H. Rau*, ed. by John C. Van Horne (Philadelphia: University of Pennsylvania Press, 2002); see also *East of the Mississippi: Nineteenth-Century American Landscape Photography* (Washington, DC: National Gallery of Art; New Haven: Yale University Press, 2017).

55 – For 'the instantaneous process', see 'Camera Amateurs: Spread of the Mania for Photography', *San Francisco Daily Chronicle*, 4 September 1885, 513.

56 – Marks, 'Mechanism of Instantaneous Photography', 22.

57 – Samuel S. Montague, Leland Stanford's chief engineer, had helped Muybridge create the electronic lens shutters in Palo Alto and, later, a young railroad engineer named John D. Isaacs was invited in 1877 to help figure out how to operate them. For more on Isaacs' role in the authorial dispute over Muybridge's work at Palo Alto, see Braun, *Eadweard Muybridge*, 138; and Ott, 'Iron Horses', 414.

58 – Marks, 'Mechanism of Instantaneous Photography', 22–23.

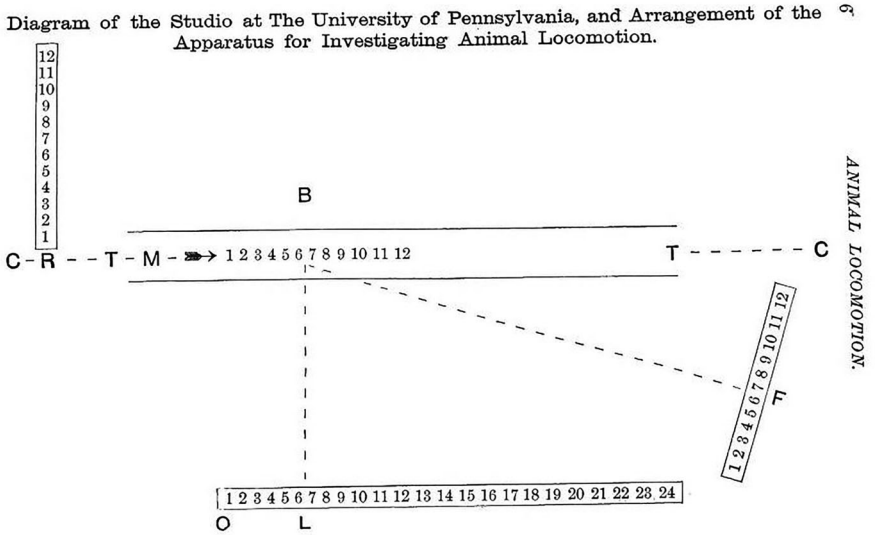

Figure 6. Eadweard Muybridge, 'Diagram of the Studio at the University of Pennsylvania and Arrangement of the Apparatus for Investigating Animal Locomotion'. In Eadweard Muybridge, *Animal Locomotion: An Electro-Photographic Investigation of Consecutive Phases of Animal Movements, Prospectus and Catalogue of Plates* (Philadelphia: University of Pennsylvania, 1887), 6.

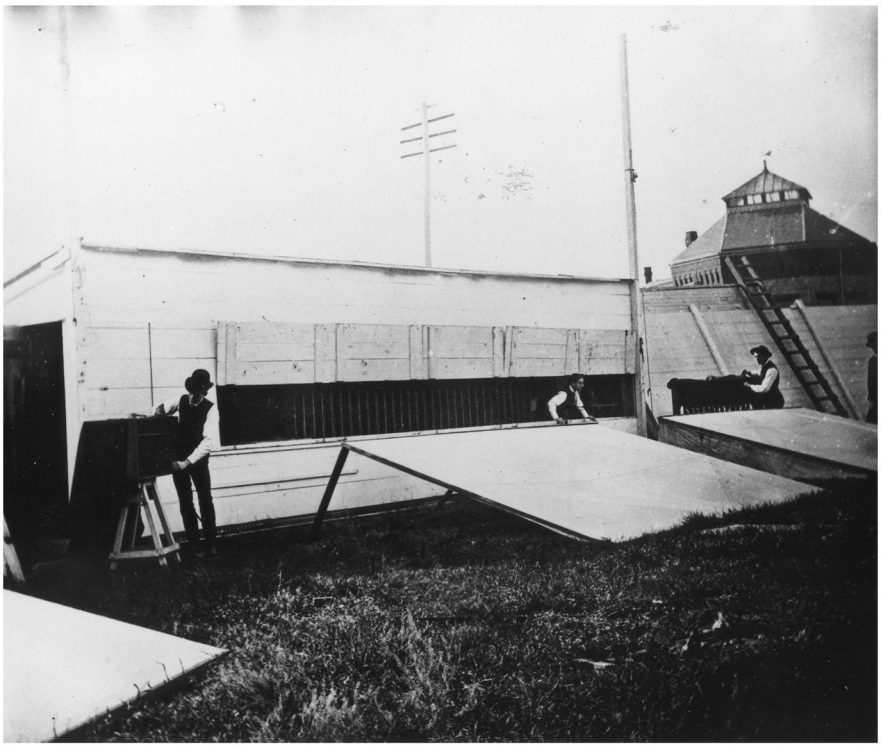

Figure 7. Photographer unknown, 'Eadweard Muybridge's outdoor camera house, 36th and Pine Streets', ca. 1887. Penn University Archives, Philadelphia.

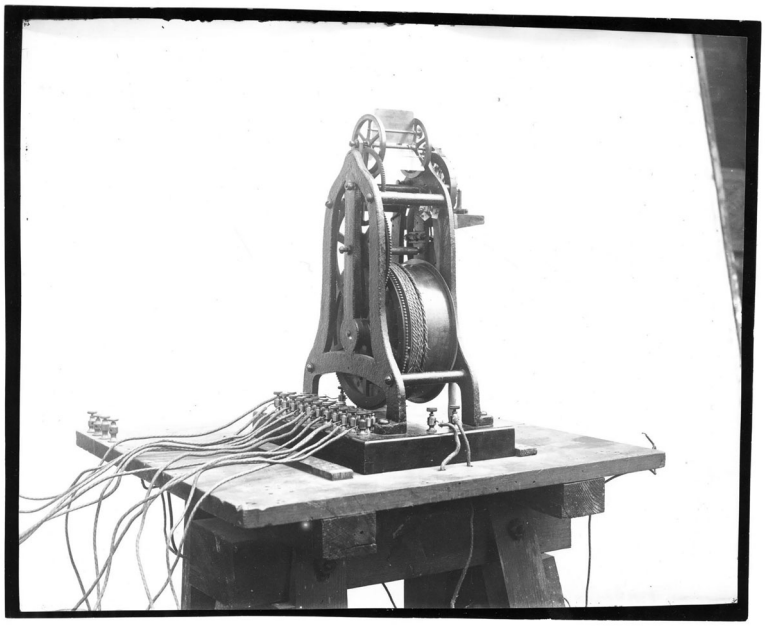

Figure 8. Photographer unknown, 'Electric release mechanism for cameras used in Muybridge's *Animal Locomotion* study, ca. 1887'. Penn University Archives, Philadelphia.

The photographer made attempts to regularise the mechanisms triggering the camera shutters. Muybridge modified his method for the Philadelphia studies, using 'a circuit-breaker […] for making the successive electrical contacts *automatically and at equal intervals*, long or short, as desired', by use of a machine referred to as the 'contact-motor' (figure 8).[59] In 'The Mechanism of Instantaneous Photography', Marks provides a description of what a typical session would consist of, using a walking horse as an example:

> The cameras being already focused, an assistant proceeds to set the exposers, and the horse is started on a trial-trip down the track that we

59 – Ibid., 23. Emphasis added.

> may see about how much time he occupies in making one *8* stride. We count ten strides in eleven seconds (those of us who are experienced in such things may, perhaps, remark that he is a rather slow walker), and another assistant then adjusts the contact-motor by altering the weights and fan governor so that the contact-brush will pass over the first twelve segments of the ring in about one and one-quarter seconds, making a slight allowance for safety; 'because', the assistant will tell us, 'we would rather get the whole stride in only eleven phases than run the risk *of not* getting it in twelve, if the horse should decide to saunter a little'. Next he gets the chronograph ready for action, and the other assistant meantime having finished setting exposers, brings the necessary plate-holders from the dark room – twelve small ones for the lateral cameras and one large one for each portable battery – and places them in the cameras. The slides are drawn and we are all ready.[60]

60 – Ibid., 27–28. Original emphasis.

This description is enlightening not only for its exposition on the exact methods used to produce the studies, but also how it reveals the highly constructed nature of this photographic event. The amount of labour that went into orchestrating the scene before the camera attempted to eliminate as much unpredictability in the situation as possible, even as the individual personality of the horse – 'he is a rather slow walker' – still asserted itself against the desired regularity of the production. After this series of preparations, the operator would stand directly beside the camera in which the first photograph of the series was to be made. When the subject reached the desired position at the start of a performed gesture, the operator pressed a 'contact-key', releasing an electrical current from the motor and initialising a chain reaction whereby up to thirty-six different photographs of the subject were captured.

With only the 'momentary contact of the key', the operator could produce three sets of simultaneous views, twelve each, from three different angles. With this novel mechanism of serial, instantaneous photographic capture combined with the use of pre-coated dry plates, chronophotography further widened the gap between the photographer and the process of photographing. Curiously, the accounts of the making of *Animal Locomotion* included in Muybridge's *Prospectus* as well as the analytical findings of members of the supervisory committee including the medical student Francis X. Dercum, physiologist Harrison Allen and engineer Marks published as *The Muybridge Work at the University of Pennsylvania* (1888), make little to no mention of the work executed in the darkroom. The one mention of the photographic dry plates 'prepared especially for [Muybridge] by Cramer' notes their fragility: 'the slightest premature of white light would have fogged them. The greatest care was therefore necessary in handling the plate-holders outside. They were carried to and from the dark room each one in a thick black cloth bag, which was removed only under the focusing-cloth of the camera'.[61] The post-production development of the plates was of little interest for the engineer Marks, who was mainly occupied with designing the electronic motor.

61 – Ibid., 22.

The electronically controlled shutter mechanism, whereby the condensed gesture of pressing a button would trigger a series of pre-programmed machinic operations, releasing the snap of up to twenty-four camera shutters 'automatically and at equal intervals, long or short, as desired', illustrates what French anthropologist André Leroi-Gourhan described, more than a century after *Animal Locomotion*, as an advanced stage of liberation of the human body from gestures and work where 'both tool and gesture are now embodied in the machine, operational memory in automatic devices, and programming itself in electronic equipment'.[62] Just as the dry plate had absorbed the gestures and knowledge of the daguerreotypist and wet-plate photographers, here too the automated, electronic shutter has again usurped the role of the photographer to even decide when to take the image. That

62 – André Leroi-Gourhan, *Gesture and Speech*, trans. by Anna Bostock Berger (Cambridge, MA; London: The MIT Press, 1993), 238.

knowledge and decision-making capacity was now embedded within the electronic machinery. There is no 'decisive moment', but only a pre-programmed moment of photographic capture. With the introduction of the electric shutter, the *Animal Locomotion* work stands as an early example of electric media art, one that foreshadowed the condensed, everyday gestures of flipping switches and pushing buttons that now stand as unavoidable mediators of our engagement with the world.[63] In Muybridge's camera set-up it is as if the electrical impulses of the brain have been transferred to the tool of the camera, giving the mechanism a new degree of animacy and unruliness, as the ever-widening gap between hand and product fostered lacunas in which material spontaneity could flourish.

With the camera operator liberated from manual work, both the tool and gesture become embedded not in the photographer's body, but in a complex electronic motor machinery. The hand of Plate 535, flexing and bending, could be seen to be mimicking the simple, concentrated movement to which the photographer had been reduced: the momentary press of the contact key. Simplified to what Jean Baudrillard, in *The System of Objects*, has characterised as the technically mediated movements' 'broken-up sequence of impoverished gestures, of sign-gestures bereft of rhythm', the camera operator moves less with a sense of purposive effort than with the ritual re-enactment of the lost labour of the photographer.[64] Dissociated from the manual aspects of the process, his gestures come to lack any clear signification or purpose. With the electromechanical apparatus of the motion studies, the camera set-up has become exponentially more complicated than the human gestures previously marshalled for the production of photographic images. For Baudrillard, writing some eight decades after Muybridge's motion studies, the result is a symbolic impoverishment when it comes to the human body: 'In the face of the functional object the human being becomes dysfunctional, irrational and subjective'.[65] The simple flexions of the wrist in Plate 535 may be seen to mimic the weightless, almost disembodied gestures of the photographer behind the camera. The gestures of the photographer's hand are shrunk down and simplified into the automatic and instantaneous gesture of pressing the electronic shutter button.

As Braun has described, Muybridge's notebooks chronicling the photographic sessions conducted for *Animal Locomotion* make note of the variety of misfires and inaccuracies that this cutting-edge electromechanical process of image-capture produced. Braun details that out of the 778 experiments recorded in the notebooks, 118 of them have no time record at all. The records indicate no fewer than fifty-two camera failures throughout the making of the process, as well as twenty-eight chronograph failures, in which the tuning-fork device employed to measure the intervals between exposure failed to record. Additionally, ninety-five separate instances of darkroom-related mishaps were recorded, including the fogging mentioned by the engineer Marks – the resulting loss in quality and detail in an image caused by extraneous light or radiation – or breaking of plates.[66] Some of these mishaps are visible in the published collotypes. Frames four through nine depicted in the top row of images in Plate 166, *Jumping Over a Man's Back (Leapfrog)*, show evidence of a cracked negative plate and the loss of emulsion (figure 9). A similar loss of image layer is evident on the legs of the wrestlers seen in Plate 345 (figure 10), while a series of frames from Plate 101, *Nude Woman Turning, Ascending Stairs and Waving a Hand*, is both blurry and scratched (figure 11). In the end, the complex electronic machinery and prefabricated, industrial plates did less to quell the unpredictable, material vagaries of the process. Rather, the elimination of the kind of control professional photographers of decades past would have had over the process – carefully monitoring the coating of plates and using their own sense of timing and intuition to judge when and how long to exposure the

63 – For more scholarship on the role of technology as a mediator for the body's engagement with the world, see Bruno Latour, 'On Technical Mediation', *Common Knowledge*, 3, no. 2 (1994), 29–64; Don Ihde, *Bodies in Technology* (Minneapolis: University of Minnesota Press, 2002); and Peter-Paul Verbeek, *What Things Do: Philosophical Reflections on Technology, Agency, and Design* (State College: Pennsylvania State University Press, 2005).

64 – Jean Baudrillard, *The System of Objects* (London: Verso, 2005 [1968]), 60.

65 – Ibid.

66 – See Braun, 'Muybridge's Scientific Fictions', note 17.

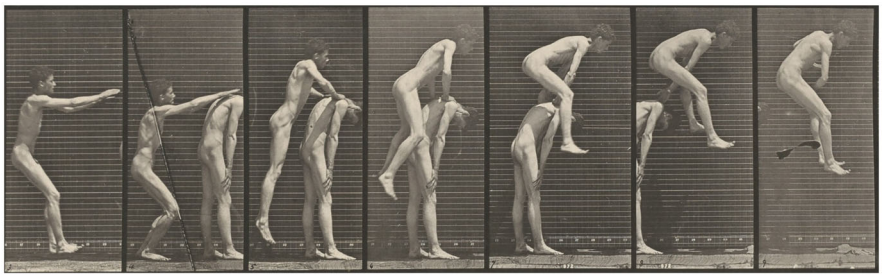

Figure 9. Detail from Eadweard Muybridge, Plate 166 in *Animal Locomotion*, 1887. Collotype. Philadelphia Museum of Art.

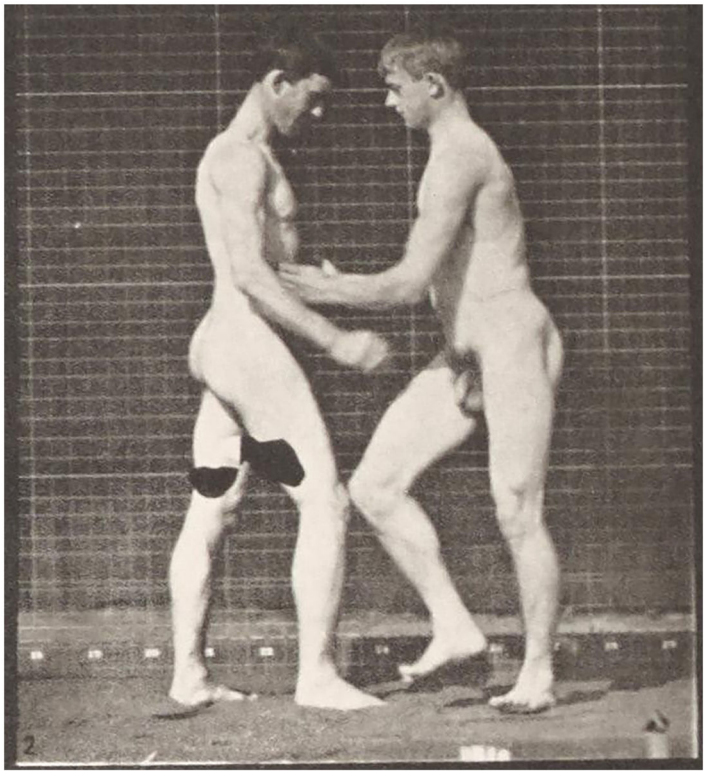

Figure 10. Detail from Eadweard Muybridge, Plate 345 in *Animal Locomotion*, 1887. Collotype. Philadelphia Museum of Art. Gift of The Philadelphia Commercial Museum, 1962.

Figure 11. Detail from Eadweard Muybridge, Plate 101 in *Animal Locomotion*, 1887. Collotype. Philadelphia Museum of Art. Gift of The Philadelphia Commercial Museum, 1962.

plate – was eliminated, opening a gap in oversight that allowed such unruly material accidents to run rampant.

Photo Faber: *Mechanising Labour in the 1880s*

The quelling and control of both matter and, specifically, human bodies in the service of industrial production formed a crucial node in the complex contexts in which the locomotion studies were produced. Many of the sequences of manual labour depicted in *Animal Locomotion* represent the kinds of simplified and repetitive bodily movements that came to form the backbone of a new science of work that appeared at the end of the nineteenth century. At this moment, a new understanding of the labouring body emerged, one that was stripped of its associations with human will, moral purpose and even technical skill. As historian Anson Rabinbach has described in *The Human Motor*, thanks to the scientific discoveries made at the end of the nineteenth century – including, most importantly, the second law of thermodynamics – the human body came to be understood as a kind of machine, one that, like the steam engine or the electric motor, converted energy into mechanical work. Buttressed by a modern society that 'idealized the endless productivity of nature', labour was stripped of its social and cultural dimensions.[67] In its stead, the body, as the source of labour power, came to be subjected to detailed laboratory investigation, surveillance, measurement and control by a new professional: the engineer. The goal of the engineer, often in the capacity as an employee of corporations or scientific institutions, would be to study the movements of the human body and find those motions and gestures that optimised the amount of energy spent vis-à-vis the amount of productive work accomplished.[68] In other words, the engineer was responsible for studying and refining the worker's movements just like any other machine found on the factory floor. The most famous of these early engineers, largely credited with the development of what came to be known as 'scientific management', was Frederick Winslow Taylor.

In the summer of 1884, the same moment when Muybridge was beginning his work at the University of Pennsylvania, twenty-eight-year-old Taylor was in the midst of conducting some of his earliest time studies for the reorganisation and optimisation of machine shop labour.[69] The son of a wealthy Germantown banker, Taylor had risen up the ranks to become chief engineer at the Midvale Steel Factory in the Nicetown neighbourhood of Philadelphia. As the historian Andrew Dawson has argued, Taylor was something of an outsider on the shop floor, coming from an upper-class family, and never agreed to allow skilled workers the right to self-regulation in return for their cooperation to the production of complex machinery. In an effort to resolve a labour dispute with the skilled machine operators, Taylor sought to remove the knowledge and agency of the machinists, insisting on the right of the owner to direct their labour. Beginning in 1881, he used time study experiments – in which the engineer used a stopwatch to time the fastest workers in specific tasks – to discover what level of production was achievable, demanding that each worker perform at the highest level of speed recorded for each individual task. After a protracted fight with the mechanics who protested the demand to raise output, Taylor determined that unskilled labour would not only be easier to study and to dissect, but also could replace the skilled shop floor mechanics who refused to speed production to Taylor's standards. As Dawson has described, Taylor discovered that, 'Unskilled laborers were also easier to replace and made fewer objections to the arbitrary reorganization of work that time study assistants demanded'.[70] By replacing skilled machinists with unskilled labourers who performed simple, discrete tasks, Taylor effectively eliminated education and training costs, putting total control and knowledge in the hands of management.

67 – Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley: University of California Press, 1992), 4.

68 – For more on the engineer's key role in corporate business, see David F. Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (New York: Knopf, 1977).

69 – For more on Taylor's time studies, see Robert Kanigel, *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency* (New York: Viking, 1997).

70 – Andrew Dawson, *The Lives of Philadelphia Engineers: Capital, Class and Revolution, 1830–1890* (Farnham: Ashgate, 2004), 236.

Although no evidence exists that Taylor and Muybridge ever met or were aware of the others' time and motion studies, the initial $5,000 granted to the photographer to fund *Animal Locomotion* was in part financed by Coleman Sellers, cousin of the co-owner of Midvale Steel, William Sellers.[71] Additionally, as Gordon has noted, Lewis M. Haupt, one of the members of the project's oversight committee and a professor of civil engineering, had been at work developing his own theories of industrial and worker efficiency, out of an interest in developing transportation and commerce in and around Philadelphia, even before Taylor's earliest time studies.[72] Further, Muybridge employed working-class Philadelphians as models. In the summer of 1885, Muybridge commented: 'I have the greatest difficulty […] in inducing mechanics, at any price, to go through the motions of their trade in a nude condition to the waist only'.[73] Although the mechanics Muybridge employed refused to do so in the nude, many did ultimately pose for the photographer in loin cloths.[74] The tantalising connection between the Sellers brothers and Muybridge's employment of mechanics leaves open the possibility that some of the models pictured blacksmithing may have been employees of the Midvale Steel Works (figure 12). Some of these figures who resisted Muybridge's request to pose in the nude might have also been among the workers who protested Taylor's optimised methods of breaking tasks into discrete parts for optimisation. Not unlike these resistances to the demands of management, time and again the plates of the motion studies fail to live up to the modern imperatives of standardisation, commodification and optimisation to which engineers like Taylor and Haupt aspired.[75]

By August 1884, according to Thomas Anschutz, a friend of Eakins who, at the time, was conducting his own motion studies on the veterinary campus, Muybridge had yet to make much progress in his proposed studies. Referring to a series of images made with a single lens, none of which have evidently survived, Anschutz recounted:

> [Muybridge] is making some very nice photographs of men and women doing things. Such as throwing, jumping stepping down and up etc. These are all made as I crudely explained on one plate. So that it shows the figure at intervals of a few inches as it goes through the movement. These images, of course frequently overlap but do not seem to confuse on that account. This work is, of course, done with one lense [*sic*]. He has not yet done nay work with his series of lenses and I hear they do not work. The shutters are too clumsy and slow. The university people are dissatisfied with the affair as he cannot give them the result they expected. Which was to photograph the walk of diseased people paralytics etcr. [*sic*] so that by means of the zoopraxiscope (help!!!) they could show their peculiarities to the medical student. This it seems however cannot be done even with the best known contrivances. So they would like to fire the whole concern but they have gone too far to back out.[76]

Only two months into a project that would span three years and $30,000, the photographer was already at odds with the goals of his funders and overseers as the 'slow' and 'clumsy' shutters could not produce the expected results for the 'university people'. The tensions evident in Anschutz's account were evidently not resolved as Muybridge continued to employ photographic techniques that fell out of favour with the university scientists and engineers seeking to apply the photographic evidence in their own studies.[77]

A comparison of images produced by Muybridge and his fellow chronophotographer Thomas Eakins illustrates the difference between an 'operative' chronophotograph and the clumsy, discrete frames produced by Muybridge's method. In the summer of 1884, Eakins photographed his friend and colleague George Reynolds nude while pole vaulting (figure 13). To capture this image, Eakins used a rotating 'wheel' plate, a design based on an apparatus used by Marey, to record

71 – For more on the role of the Sellers family in industrialising Philadelphia, see Domenic Vitiello, *Engineering Philadelphia: The Sellers Family and the Industrial Metropolis* (Ithaca: Cornell University Press, 2013).

72 – Gordon, *Indecent Exposures*, 60–61.

73 – *Philadelphia Times*, 2 August 1885, 5.

74 – Gordon, *Indecent Exposures*, 70.

75 – Doane, *Emergence of Cinematic Time*, 33–34.

76 – Thomas Anschutz to J. Laurie Wallace, August 1884, Archives of the Pennsylvania Academy of Fine Arts, Philadelphia. Quoted in Braun, *Eadweard Muybridge*, 186.

77 – Francis X. Dercum, a medical student and member of the supervising committee, was largely frustrated by the failures of Muybridge's work to allow him to further his analysis of so-called 'abnormal movements' of the University of Pennsylvania patients seen in *Animal Locomotion*. For more on Dercum and Muybridge's collaboration, see Marta Braun and Elizabeth Whitcombe, 'Marey, Muybridge, and Londe', *History of Photography*, 23, no. 3 (1999), 220–22.

Figure 12. Eadweard Muybridge, Plate 374 in *Animal Locomotion*, 1887. Collotype. Nelson-Atkins Museum of Art. Charles Bregler's Thomas Eakins Collection, purchased with the partial support of the Pew Memorial Trust.

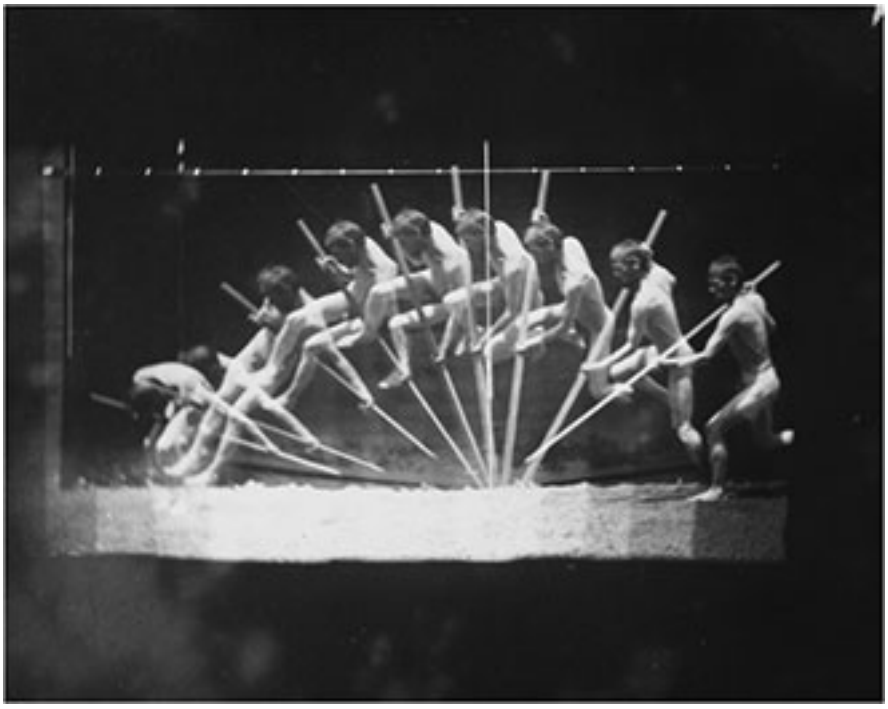

Figure 13. Thomas Eakins, *Motion Study: George Reynolds Nude, Pole-Vaulting to Right*, 1884. Dry-plate negative, 3 5/8 × 4 5/8 in. Pennsylvania Academy of Fine Arts.

multiple exposures on a single surface.[78] The resulting photograph shows the course of Reynolds's bodily trajectory in a fluid arc of motion. Over the course of each exposure, the model's body becomes superimposed on top of itself, at times obscuring the body in favour of recording an image from which the abstract elements of velocity, time and space travelled could be best excavated. By contrast, Muybridge's study of the movements of a pole-vaulter in Plate 164 dissects the models'

78 – Thomas Eakins, 'Notes on the Construction of a Camera', in *A Drawing Manual by Thomas Eakins*, ed. by Kathleen Foster and Amy Beth Werbel (New Haven, CT: Philadelphia Museum of Art, in association with Yale University Press, 2005), 101–108.

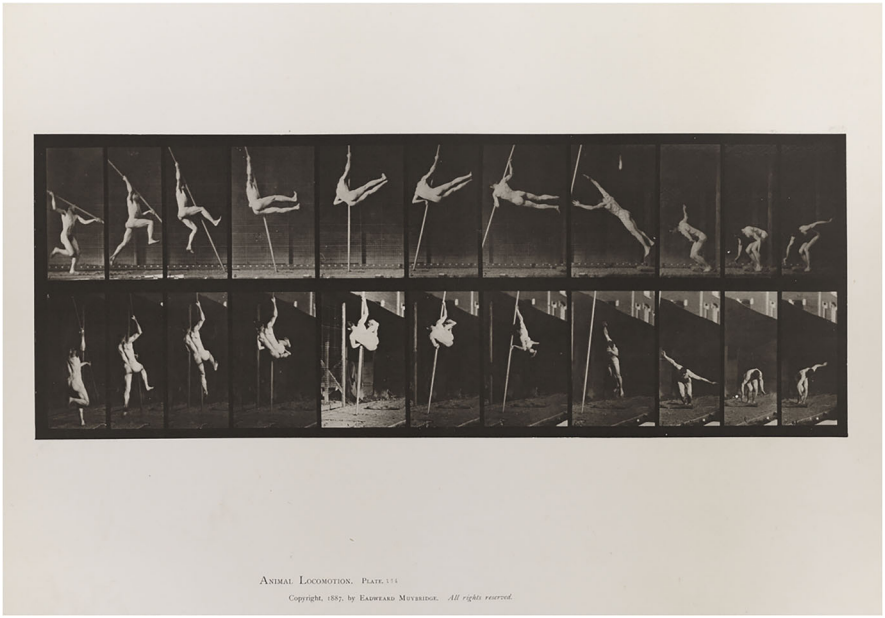

Figure 14. Eadweard Muybridge, Plate 164 in *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts.

movements into discrete frames, displaying the body without any superimposition to better visualise the spectacular act of gravity-defying motion, an aesthetic consistent with the photographer's earlier lectures on the horse in motion (figure 14). Where Eakins's pole-vaulter illustrates a spectacle of fluid movement, Muybridge emphasises the spectacle of stoppage. Where the aesthetic effect of Eakins's image rests on the ability of the camera to hold and trace an arabesque line of movement, Muybridge's image draws on the shock value of the instantaneous image's power to abruptly capture an awkward image of the body frozen mid-flight. Unlike Eakins, whose single-plate method allowed for a reading and reconstruction of the path of motion, Muybridge's use of discrete frames for each phase of the course of action displays a series of modular instants, in which the space between exposures is emphasised rather than elided.

During the same summer that *Beating Time* was captured, Muybridge enacted a series of self-portraits for his chronophotographic cameras. In the catalogue to the series, Muybridge, identified as Model 95, describes himself as an 'ex-athlete, aged about sixty', and appears in six plates throughout *Animal Locomotion.*[79] Plate 491 shows the photographer in the acts of hammering an anvil, using a hatchet and sawing a board, illustrated with ten frames each (figure 15). In these series, Muybridge performs his own instrumentality for the camera. Freed from the task of manually clicking the camera shutter, Muybridge stands in front of the camera, ritually putting his body to use by reenacting motions of manual labour no longer needed behind the camera. This was not the first time that Muybridge had photographed himself in the guise of a manual labourer. As early as 1881, the photographer is seen, again in the nude, in *The Attitudes of Animals in Motion,* where he appears in Plate 110 swinging a pickaxe. Ott argues that the 1881 self-portrait shows the photographer's subjection to a Gilded Age industrial gaze with a view towards mechanising the body of the photographer as Stanford had done with the horse: 'Although the photographer is still technically Muybridge, the point of view, both literally and metaphorically, is Stanford's. Whether aware of it or not, by performing the role of labouring instrument before his cameras, Muybridge too became the object of

79 – Muybridge appears in plates 489, 490, 491, 519, 520 and 521.

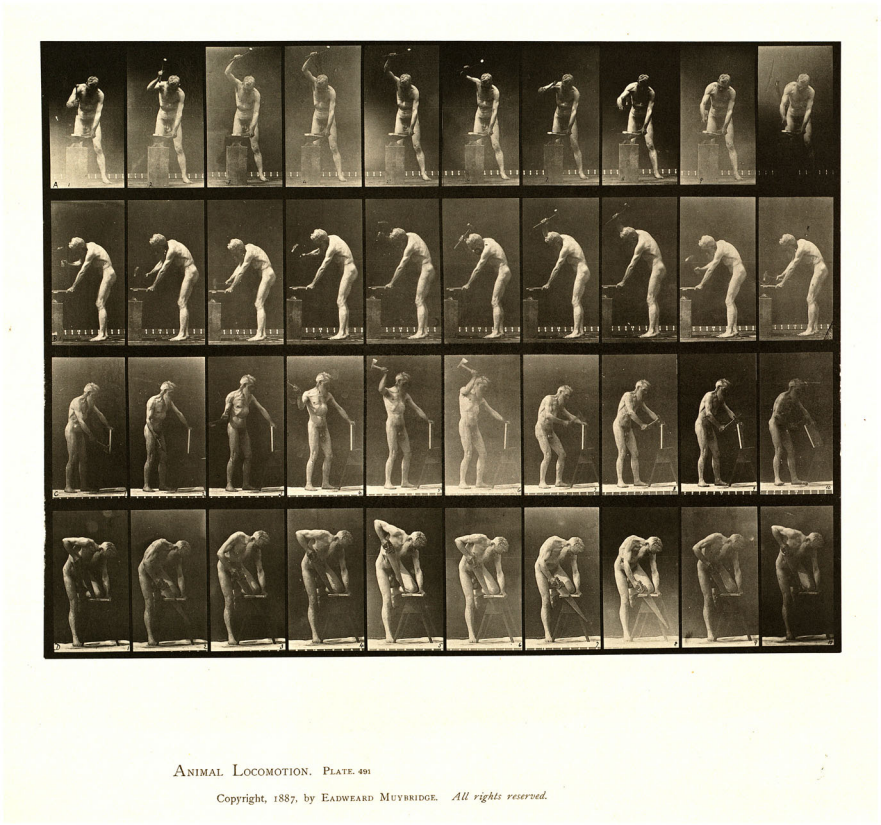

Figure 15. Eadweard Muybridge, Plate 491 in *Animal Locomotion*, 1887. Collotype. Boston Public Library.

the industrial gaze'.[80] Yet the repetition of his labouring for and in front of the camera in the *Locomotion* studies years after his work with Stanford, and completely naked no less, would seem to indicate a degree of self-assertion, confidence and perhaps even cheekiness on Muybridge's part.[81]

Taken as a whole, the forty photographs in this *Locomotion* self-portrait give the impression less of a submission of the photographer to the gaze of the industrial manager than of Muybridge visually taking up space in his own project, as one man extended into an army of workers acting in concert. By virtue of the automatic and instantaneous camera mechanism, the hand hired to produce 'analytical sets of photographs' is visually distributed and multiplied ten times over, as if extending out in time and space.[82] Notably, the blacksmith motif appears in other significant motion studies and early cinematic projections. Edison's *Blacksmith Scene*, in which three men, fully clothed, are filmed hammering an anvil, taking a break to drink and then returning to work, was the first commercial film produced in the Black Maria in April 1893, and was included among the small number of films shown at the first public exhibition of the Kinetoscope at the Brooklyn Institute of the Arts and Science on 9 May 1893.[83] A year later, in 1894, Etienne-Jules Marey, along with Charles Fremont, a civil engineer, produced a chronophotographic study of a pair of blacksmiths in Marey's laboratory as part of Fremont's investigations into the conservation of energy during human labour. However, with the use of multiple exposures on a single plate, the arm movements of a blacksmith, studied explicitly for the skill involved in the wielding of the hammer on anvil, proved difficult to study for the *lack* of motion in space needed by the skilled smithy, resulting in a blurred, overlapping image that proved too indistinct to properly to decipher.[84] Preceding the work of Marey and Edison, Muybridge's decision to perform the skilled gestures of a blacksmith, a profession that was nearly entirely lost to industrial methods of steel production by the end of the nineteenth century, carries a

80 – Ott, 'Iron Horses', 428. For Marta Braun's discussion of this image, see Braun, *Eadweard Muybridge*, 153–54.

81 – Marta Braun views Muybridge photographing himself as a narcissistic tendency, in which he shows himself as 'strong and rugged, part of the Wild West where such implements served to build railroads and miens and to tame the wilderness for framing'. Marta Braun, 'Animal Locomotion', in *Helios: Eadweard Muybridge in a Time of Change*, ed. by Philip Brookman (Göttingen: Steidl/ Corcoran Gallery of Art, 2010), 271–83 (274).

82 – Marks, 'Mechanism of Instantaneous Photography', 20–21.

83 – Noam Elcott, *Artificial Darkness: An Obscure History of Modern Art and Media* (Chicago: University of Chicago Press, 2016), 43.

84 – Doane, *Emergence of Cinematic Time*, 54.

symbolic resonance of nostalgia for the earlier forms of buffing, coating and gilding gradually eliminated from the production methods of lens-based media with chronophotography and, eventually, cinema.

The decision to perform these actions naked, however, signals that something more than a nostalgia for the good old days of daguerreotypy and wet collodion is at play. In the last quarter of the nineteenth century, institutions like the University of Pennsylvania were responding to a need to shore up the seriousness of the work done on their campuses. Only a decade prior, the chemist J. Lawrence Smith had complained in his 1873 address to the American Association for the Advancement of Science (AAAS) that 'so-called universities' failed to produce any original investigations.[85] In 1883, a year before the commencement of the motion studies, the physicist Henry A. Rowland, in 'A Plea for Pure Science', disparaged the '400 institutions', calling them a 'cloud of mosquitoes, instead of eagles', where professors were 'burdened down with the work [of teaching]' and had no time for independent research.[86] In an 1888 prefatory note to an account of the *Locomotion* work, the University's provost, Dr Pepper, characterised the project as an expression of the role of the university as a site where 'original investigations conducted by the mature scholars composing its faculties are an important part of its work, and in a larger conception of its duty should be included the aid which it can extend to investigators engaged in researches too costly or elaborate to be accomplished by private means'.[87] What might the 'mature scholars' have thought when they discovered the principle director of this elaborate and original research investigation was running around naked, playing at blacksmith and leapfrog in front of the cameras?

This naked display of his physical form for the camera in a place of sober, scientific research suggests that there is something satirical at play here, as if Muybridge was lampooning the sobriety of the academy that financially supported the completion of *Animal Locomotion*. Having already chosen a particularly clumsy means of motion-capture, Muybridge seems to be rubbing salt into the wound, running around naked on the campus of his benefactors who, having invested tens of thousands of dollars, had 'gone too far to back out'. While some scholars have situated Muybridge's self-portraits amidst the burgeoning 'physical culture' of the day – he does identify himself as an 'ex-athlete' – the static, stationary frames of Muybridge hammering an anvil have more Hephaestus than health about them.[88] In the final frame of the first row of the series, inconsistencies in the development or capture of the frames illustrate a shift in tonalities that begin to obscure the bottom of the final frame (figure 16).The careful numbering of the plates that appears at the bottom left of the anvil pedestal sinks into obscurity, as the numbers bordering the wall behind Muybridge likewise are blurred and fall into darkness. Rather than a precise rendering of the human form, the photographer's physique seems to meld with the light and dark shadows, as if sinking into the photographic surround. The eccentricities of the human body and spirit, de-robed of any sartorial markers of time or class, defies the serious sobriety of science, lending these frames more a quality of timelessness than of time captured.

85 – J. Lawrence Smith, 'Science in America and Modern Methods of Science', *American Naturalist*, 7, no. 10 (1873), 577–602 (579).

86 – Henry A. Rowland, 'A Plea for Pure Science', *Science*, 2 (1883), 242–50 (244).

87 – William Pepper, "Note," in *Animal Locomotion: The Muybridge Work at the University of Pennsylvania. The Method and the Result* (Philadelphia: J. B. Lippincott Company, 1888), 5–7 (7).

88 – Dr Pepper established a new department of physical culture at the University of Pennsylvania in the summer of 1885. Elspeth Brown stated: 'The goal of the new University of Pennsylvania gymnasium was not principally to build strength, a concern of later athletic programmes, but to build physical health and vigour'. Brown, 'Racialising the Virile Body', 645.

The Spirit of Glitch

The scratches, blurred figures and missing plates that populate the frames of *Locomotion* gesture towards the gap between the scientific ambitions of the project and the materials and people that such ideals attempted to discipline. In a detail of the final four frames of Plate 247, the naked woman depicted lounging across two chairs, whose name we know is Catherine Aimer, identified in Muybridge's prospectus as a young 'unmarried' woman, leisurely leans her head back as the plume of smoke obscures the outline of her face (figure 17). Sarah Gordon has noted that

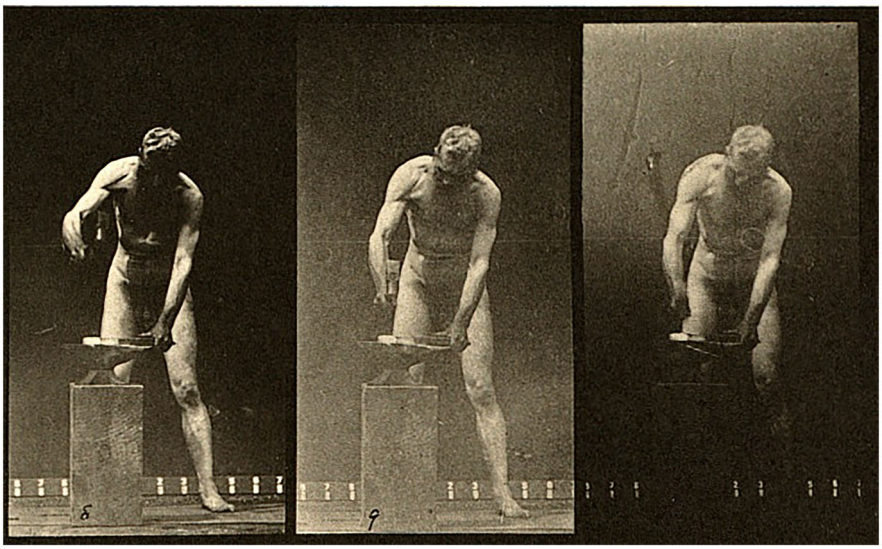

Figure 16. Detail from Figure 15, Eadweard Muybridge, Plate 491 in *Animal Locomotion*, 1887. Collotype. Boston Public Library.

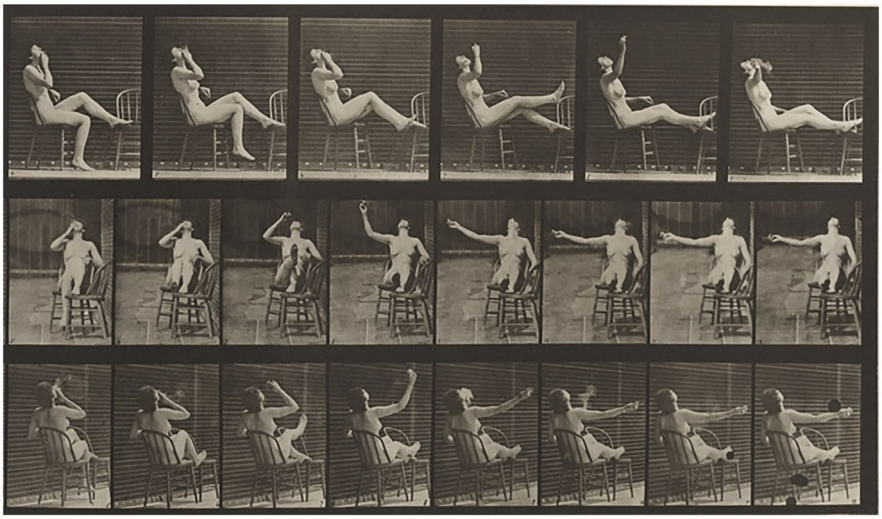

Figure 17. Detail from Figure 3, Eadweard Muybridge, Plate 247 in *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts. Patrons' Permanent Fund.

Muybridge's pictures of smoking women depict 'the gratification of engaging in an illicit behaviour', for, in the 1880s, the activity was still widely associated with 'debauchery and lesbianism'.[89] The picture of a woman taking a drag of her cigarette is decadent not only for the fact of a woman taking part in a socially prurient behaviour, but also for the way it 'drags' movement to a halt amongst the frenzy of gestures that occupy the other locomotion studies. It is a moment of pause amidst the scientific study of movement. Rather than rising from the chair and entering into motion for the camera, this woman actually sits down and stops moving in order to enjoy her cigarette. In the final two frames, missing spots of emulsion produce further lacunas, blips in the stream of visual data amidst the already significantly blurred images. The frames in the top row of the whole sequence in figure 3 show only nine images, whereas the bottom two rows show twelve images each, indicating there must have been a failure to adequately record three frames in the first bank of cameras.[90] By insisting on maintaining his labyrinthine photographic apparatus despite the objections of members of the oversight committee, these examples show how *Animal Locomotion* responds to the strictures of scientific research by actually courting moments of mechanical and chemical error. From the

89 – Gordon, *Indecent Exposures*, 126–27.

90 – Braun has noted that only in six exceptions did Muybridge deviate from his system of twelve lateral and twelve foreshortened views, meaning that any sequence seen with fewer than twelve views at any angle outside those exceptions belies a missing phase. Braun, 'Scientific Fictions', 5.

Latin root '*erro*' meaning to wander, to roam, to stray, the 'errors' of the *Locomotion* project – cracked plates, fogged frames, irregular intervals – wander off the path of abstract science into the messy spontaneity and resistance of matter. Such moments of slowing down, of irregular image-capture, damaged frames and overall resistance to conformity with the regime of mechanical objectivity, situate Muybridge alongside some unexpected company.

In *Photography and the Art of Chance*, Kelsey details the role of glitch in the work of Julia Margaret Cameron as a key means of critiquing what she deemed the dull monotony of the average, commercial products of the mid-nineteenth-century professional photographer. At a moment when the typical photography studio could be relied upon for a clear crisp image, one that had focus placed squarely on the sitter's face, providing an overall clarity of detail, Cameron was known for printing from cracked negatives, trimming her prints haphazardly and fostering blur with her use of long exposures, a situation that plagued her physically taxed subjects who were not permitted the use of a headrest on which to brace themselves. Cameron, not unlike Muybridge, admitted to seeking a certain degree of fortune and fame through her photography, but she was also nevertheless unwilling to steep to ordinary commercial work.[91] As curator Julian Cox describes, Cameron's indulgence in spills, stains and thumbprints marring her negatives reveals 'the exigencies of her own labour, as though leaving traces of her hand convincingly demonstrated that her work was made very consciously and by an artist rather than a machine', an impulse that Muybridge, legally denied ownership of his own labour in his stop-motion work in Palo Alto, surely would have related to.[92] As Kelsey writes, 'technical advances and professional practices had made photography precise and predictable, shrinking the role of chance, the aesthetic potential of the medium has receded', so the drip, stain and cracks in the glass become not only assertions of the photographer's authorial presence, but also reassuring signs of humanity in the face of mechanical modernity.[93]

Where Cameron has more often been identified with a resistant, feminine unruliness and Muybridge with a decidedly masculine desire to overcome the limitations of matter, to stop time itself, the glitches evident in both Cameron and Muybridge's bodies of work evince a secret affinity between these otherwise opposed figures.[94] For Kelsey, the 'accidents' of Cameron's material messiness 'come to signify ambition and defects to signify distinction', distinguishing her art with a 'wayward originality'.[95] As Helmut Gernsheim describes in a 1975 monograph on Cameron, the drips and cracks lend a 'spiritual quality' to the work, a quality decidedly missing from the technically precise products of a commercial studio.[96] The wayward spill or crack, eschewing machinic perfection, returns to the medium a modicum of the human spirit, reaching for something just beyond our grasp. As Kelsey puts it, 'The glitch is a sign of both the resistant materiality of existence and the yearning to overcome it'.[97] The errors in Muybridge's locomotion studies and Cameron's wet plates indicate that both photographers were reaching beyond the possible for an unknown potential.[98]

In *Animal Locomotion*, the unpredictability of the motions of the bodies placed before the camera becomes more complex, unpredictable and even instinctual as the plate numbers increase.[99] Male and female figures that appear clothed earlier on in the project are now seen naked, and motions in plates are more frequently described as 'miscellaneous' and 'abnormal', where finally, by the last hundred plates, Muybridge turns to photographing non-human animals in an ultimately doomed attempt to photographically capture the explosive movements of animal instinct. Plate 781, the concluding statement of the project, depicts a group of chickens being scared by a torpedo (figure 18). The unruly chickens, made even more so when subjected to the terror of an exploding torpedo, run off in three separate directions. In a detail of frame eight from the plate, and indeed in most of the

91 – Kelsey, *Photography*, 70.

92 – Julian Cox, *Julia Margaret Cameron: The Complete Photographs* (Los Angeles: J. Paul Getty, 2002), 54. Quoted in Kelsey, *Photography*, 69.

93 – Kelsey, *Photography*, 72.

94 – Carol Armstrong, 'Cupid's Pencil of Light: Julia Margaret Cameron and the Maternalization of Photography', *October*, 75 (Spring 1996), 114–41.

95 – Kelsey, *Photography*, 70.

96 – Helmut Gernsheim, *Julia Margaret Cameron: Her Life and Photographic Work* (Millerton, NY: Aperture, 1975), 70. Quoted in Kelsey, *Photography*, 69.

97 – Kelsey, *Photography*, 94.

98 – For more on the distinction between the possible and the potential in related to time-based art, see King, *Virtual Memory*.

99 – Marta Braun describes this hierarchy of movement that governs the larger structure of the volumes of *Animal Locomotion* thus: 'The scientific "logic", in other words, follows a covert sociological hierarchy, from the movements of the highest subject – the nude male – through women, children, and the crippled to the lowest, namely, animals. It also moves from the more visually intelligible to the more obscure: the more difficult pictures, in which the movement is hardest to determine, are placed toward the end of each volume, where they are less noticeable'. See Braun, 'Animal Locomotion', 271.

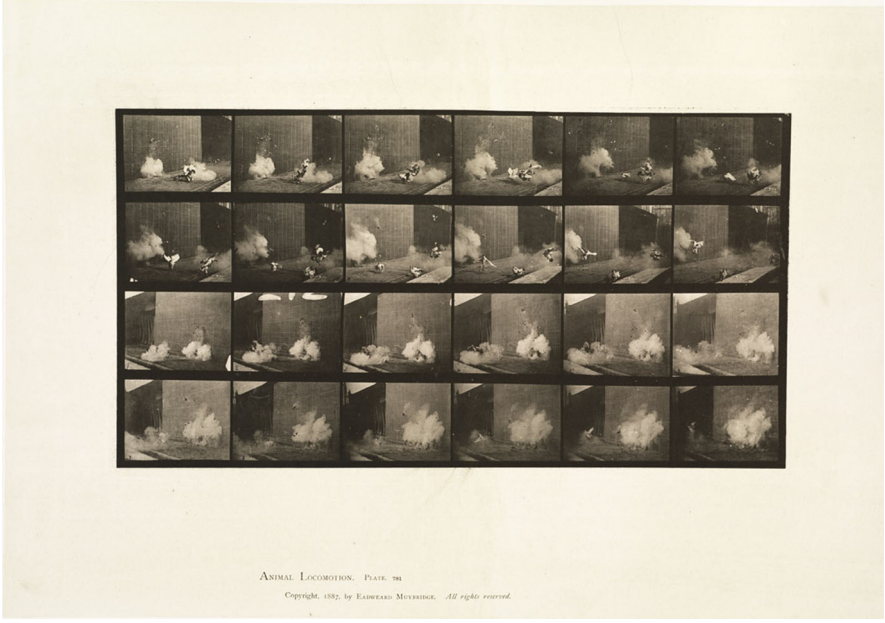

Figure 18. Eadweard Muybridge, Plate 781 in *Animal Locomotion*, 1887. Collotype. National Gallery of Art, Washington, DC. Photographic History Collection, Smithsonian National Museum of American History.

Figure 19. Eadweard Muybridge, Plate 34 in *Animal Locomotion*, 1887. Collotype. Boston Public Library.

frames captured, the chickens do not even appear against the black and white grid intended to track minute motion through the sequence but fly off the gridded backdrop. Plate 781 dramatises the risk Muybridge was taking every time he chose a new subject and type of movement to capture. As the many missing plates and cracked negatives of the *Locomotion* work indicate, each sequence was a photographic gamble where success was never guaranteed. Would the horse decide to leap mid-trot? Would the glass negative survive intact? Would the plate develop properly in the darkroom? In this final image, Muybridge reaches far beyond what could be materially contained as animal instinct exceeds scientific capture.

In a remarkable sequence filed under Plate 34, in which Muybridge has photographed a woman walking and carrying a fifteen-pound basket on her head, a different kind of glitch, distinct from the slow, messy, watery qualities of Cameron's wet plates, appears (figure 19). Pictured naked from the side and back, the figure is posed as if for a pastoral scene from antiquity, forming a curious juxtaposition with the backdrop which sets the ancient task of carrying water against a starkly modernist black and white grid. This strangeness is amplified when the viewer realises

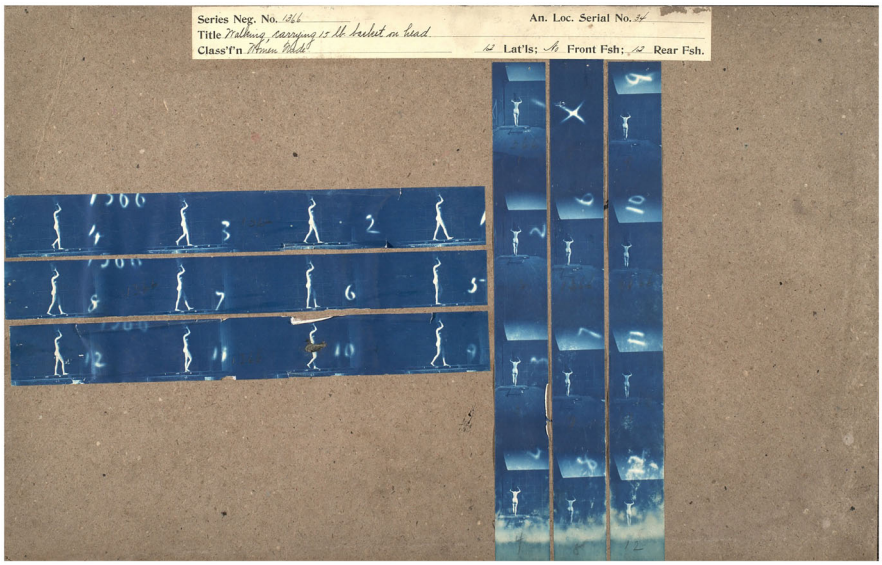

Figure 20. Eadweard Muybridge, proof for *Animal Locomotion*, 1885. Cyanotype. Credit Photographic History Collection, Smithsonian's National Museum of American History, Smithsonian Institution, Washington, DC. Gift of The Philadelphia Commercial Museum, 1962.

the fifth plate in the second row of images is missing the figure altogether. In the cyanotype proofs for this image held at the National Museum of American History, which provide an invaluable record of the kinds of interventions Muybridge made in arranging his final series for printing, the fifth frame is printed blank with an 'X' marked over it (figure 20).[100] The lack of any photographic trace in this frame possibly indicates that the shutter failed to release on this take. But unlike in other sequences, Muybridge does not take the tactic of expanding the second row of images to neatly fit within the rectangular composition. He also does not print the black frame that would have resulted from a transparent negative had the shutter failed. In the fifth frame of the second row of images, Muybridge has inserted a view of the platform in front of the black and white checkerboard backdrop without any figure present, a choice that produces a sudden a blip in the visual matrix.

Notably, the term 'glitch' does not appear in the American dictionary until 1958, defined as 'a false or spurious electronic signal'.[101] As the cyanotype proof for Plate 34 indicates, it was the shutter that failed to release, indicating this was a failure in the electric signal sent from the contact motor to the photographic camera. Yet the 'empty' frame of Plate 34 is more than an electronic glitch in the apparatus. Close inspection shows that the image depicts the end of the platform, as it drops off mid-way through the bottom of the frame (figure 21). In the cyanotype contact print, we can see the fuller mise-en-scène, where the woman is walking forward on a raised wooden platform that cuts off just two feet to her right. It seems probable that Muybridge used an area of one of the negatives from this motion sequence that had been cropped out and reprinted it as a stand-alone frame in the series. Why would Muybridge, when he has proven capable of visually obscuring these inconsistencies in the Locomotion work, choose to insert this frame devoid of any figure in the middle of a motion sequence? It is a question almost impossible to answer, but the effect is an acknowledgement of the remixing, rearranging and ultimately irregularly captured and composed series of movements. Reading the frames left to right, it is as if the camera, perhaps fatigued by the constant work of capturing photograph after photograph, has strayed from the movement it was meant to be capturing. Seen in the context of the nearly twenty thousand individual images comprising the project, this 'blip' arises like a breath of fresh air, a moment of relief from the visual excesses of *Animal Locomotion*. Like a rest note in a musical score, perhaps this frame is not so much a glitch but, rather, a deliberate

100 – See Braun, 'Muybridge's Animal Locomotion'.

101 – The term 'glitch' in fact did not come into use into well into the twentieth century. The term itself is derived from the Yiddish, *glitsh*, for slippery place, and from *glitschn*, 'to slide or glide'. Radio announcers began using the term to refer to mistakes made on-air, but by the 1950s the term made its way to the new media of television, where it was used by engineers to indicate technical issues in televised broadcasts. It was not until the 1960s that glitch entered the mainstream lexicon via NASA, as John Glenn noted in his 1962 book, *Into Orbit*: 'Another term we adopted to describe some of our problems was "glitch". Literally, a glitch is a spile or change in voltage in an electrical circuit'. Although the precise origin of the word and its entrance into mainstream lexicon will remain obscure, the clear connection between glitch and electronic waves is evident in all three early uses of the term. See Jim Vespe, 'It Was John Glenn Who Popularized the Word "Glitch"', *Smithsonian Magazine*, October 2019, ⟨https://www.smithsonianmag.com/air-space-magazine/just-right-word-180973113/#:~:text=Glitch%20is%20derived%20from%20glitsh,to%20refer%20to%20technical%20problems⟩.

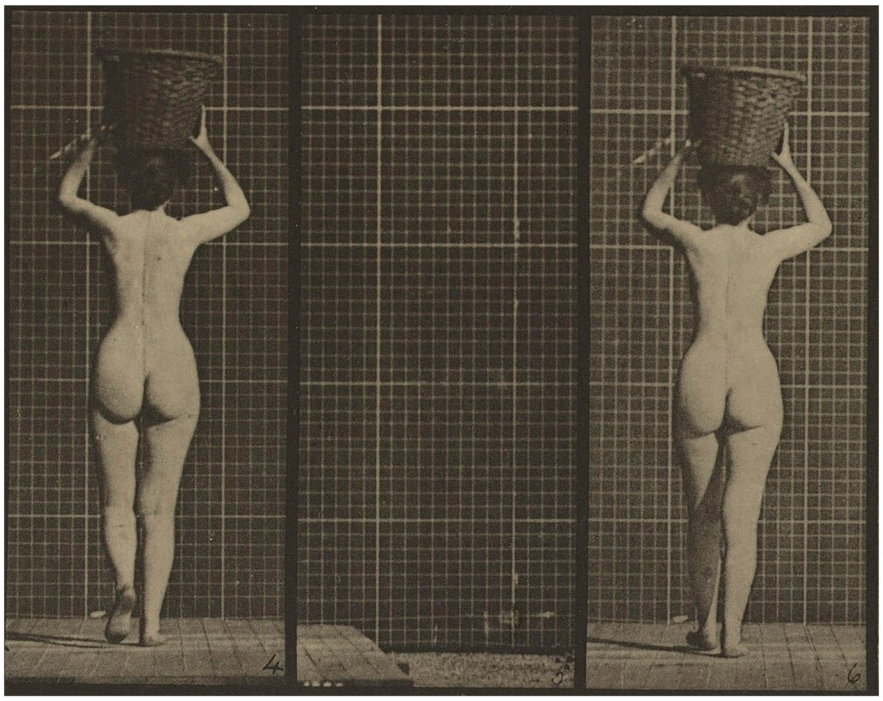

Figure 21. Detail from Figure 18, Eadweard Muybridge, Plate 34 in *Animal Locomotion*, 1887. Collotype. Boston Public Library.

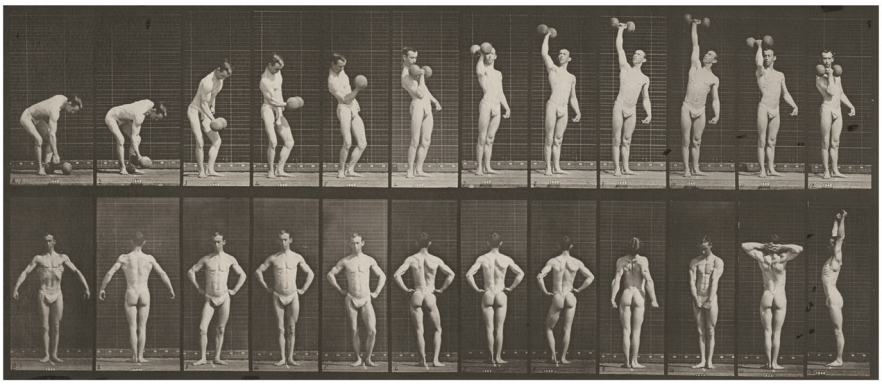

Figure 22. Eadweard Muybridge, Plate 321, *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts.

moment of pause, a gesture towards the gaps at the sides of and in between the frames in which no movement is happening.

Photo Ludens: *Muybridge's Aesthetics of Inoperativity*

In addition to the visual pause in Plate 34, Muybridge openly utilises the rupture between frames inherent in his method of chronophotography by choosing to depict certain inoperative movements that exhibit no other purpose than the pure visual pleasure of being seen. Take for example Plate 321, which depicts twenty-four lateral views of an athlete performing two different gestures: the first row depicts the partially clothed model lifting a fifty-pound dumbbell, and the second row shows the model posing (figure 22). In the first series, we follow the familiar sine wave of a fluid gesture of motion as the model first bends down and then raises the dumbbell with his right arm. By contrast, the sequence of 'posing' movements does not follow a

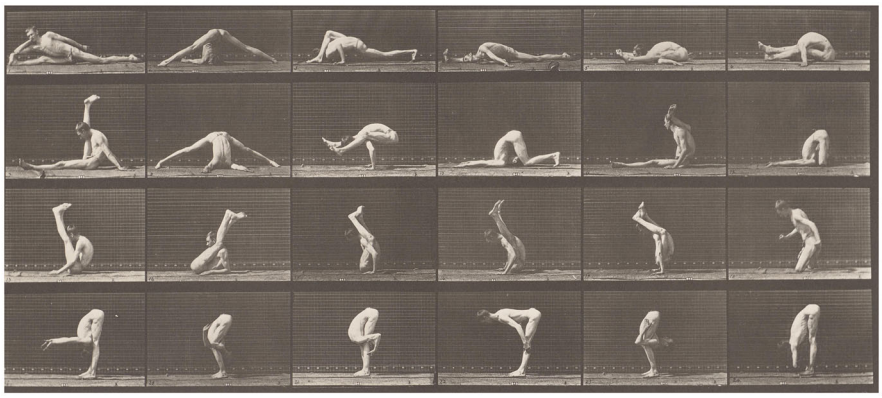

Figure 23. Eadweard Muybridge, Plate 510 in *Animal Locomotion*, 1887. Collotype. Philadelphia Museum of Art.

prescribed series of sequential gestures. The first and second images of this sequence show the model with his arms stretched outward and standing erect, first from the front and then from the back in the same position.[102] In the final four frames of this plate, we see the athlete posing in four distinct states of static composure, flexing his muscles down toward the ground and up in the air from front, back and side angles. Here, the muscular body reintroduces enigmatic aporias that ultimately frustrate the desire to know and dissect the intricacies of animal locomotion. Such formal qualities of discontinuity between frames are taken to an extreme in Plate 510, where Muybridge has captured the various poses of a contortionist (figure 23). Rather than reading like a chronological series, the contortionist's act of corporeal display shows the body in such unfamiliar positions that the plate appears more like a miming of letter shapes, spelling out an indecipherable code, a puzzle in which the pieces refuse to synthesise a final picture.

Such sequences press on the definition of chronophotography defined by the International Congress of Photography as 'the processes and methods that permit of obtaining a series of photographic negatives at regularly determinate intervals of time'.[103] Muybridge's cast of circus performers illustrate how the photographer could tweak the format to operate as a demonstration of a series of privileged moments as opposed to what Gilles Deleuze describes, in reference to Muybridge, as 'any-instants-whatever', meaning that any frame was plucked mechanically from the flow of time by the unthinking click of the camera shutter with no regard for the particular beauty or visual composition of scene at that moment.[104] In the 'any-instant-whatever', the camera does not care what is before the lens, and would indeed go on clicking even after the subject had departed. By contrast, the contortionist and bodybuilder both perform motions that could be executed in any order whatever, obviating the need to create a series of images captured at regular intervals. These energetic and inscrutable poses are 'useless' in the sense that they cannot answer the questions the supervising committee wanted them to: mainly, how does the body move from one state to another? Rather than investigating how the body moves through an empty Newtonian space and time, these images liberate the chronophotographic body from the rules of chronological time and homogeneous space. The posing athlete and the contortionist illustrate discontinuity as a formal category that underwrites all serial motion studies, which necessarily produce only a sample of discrete instants from what was a continuous and durational temporal span. This is not clock time, nor is it a 'physiological time', as Ott has described, but something else entirely.[105]

102 – Beginning in 1879, Muybridge used his cameras to capture a single frozen gesture seen from six points of view, where models were captured with five or six cameras placed in a semicircle, all of which were set to trigger simultaneously. These were among the pictures Muybridge made while on vacation. Marta Braun has posited that these views of a single instant may have been inspired by the photosculpture method of Françoise Willème. See Braun, 'Muybridge, Authorship, Originality', 46. For a lengthier discussion of these images, see Brooke Belisle, 'The Dimensional Image: Overlaps in Stereoscopic, Cinematic, and Digital Depth', *Film Criticism*, 37/38, no. 3/1, Special Double Issue: Genealogical and Archaeological Approaches to 3-D (Spring/Fall 2013), 117–37.

103 – 'Chronophotography', *Scientific American Supplement*, no. 742 (March 1890), 11860.

104 – Gilles Deleuze, *Cinema 1: The Movement-Image*, trans. by Hugh Tomlinson and Barbara Habberjam (Minneapolis: University of Minnesota Press, 1986), 5–7.

105 – Ott, 'Iron Horses', 421.

Figure 24. Eadweard Muybridge, Plate 187 in *Animal Locomotion*, 1887. Collotype. Pennsylvania Academy of Fine Arts, Philadelphia.

In the many scenes of spectacular stoppage, the *Locomotion* plates emphasise what one commentator described as the Dionysian capacities of Muybridge's images:

> Imagine what would have been the surprise of the Doctors Rush had they visited the campus the University of Pennsylvania in 1885 and seen – well protected from the merely curious by a high fence – young ladies cavorting about *in naturalis*. It was not, however, a reinstitution of the Dionysian mysteries in Quaker Philadelphia, but a serious, pioneering scientific project.[106]

106 – Edwin Wolf II, 'Muybridge and Zoopraxography', *Library Company of Philadelphia Annual Report* (1961), 19–24 (19).

Indeed, Muybridge pictured many young women cavorting about seminude in transparent garments, such as in Plate 187 (figure 24). In this sequence we see the movement of a model performing 'fancy dancing', a course of movement with no clearly prescribed set of sequential gestures. Like the Dionysian Mysteries, in which drugs, dance and other trance-inducing intoxicants were used to remove inhibitions and social constraints, in the confines of the photography shed, the repetitive gestures of the camera produce a fantasy space that liberates the female model from the scenes of feminized domestic labour depicted elsewhere in the *Locomotion* studies.[107]

107 – As Sarah Gordon writes, most of the *Locomotion* plates feature female activities that naturalised Victorian societal norms, showing women 'performing domestic chores, caring for children, serving others'. Gordon, *Indecent Exposures*, 126.

The 'fancy' descriptor could equally refer to the verb 'to fancy'; to form a conception of, to portray in the mind, to imagine. This image of fancy dancing, one that evades the regularising and sanitising impulses of the laboratory, gestures to the human capacity for imagination, of play and creative activity. Rather than reading Muybridge's many images of women in the nude or semi-clothed in transparent fabrics as only expressions of a voyeuristic, erotic desire, we may understand these images as defiantly inoperative gestures that counter the operative, simplified and dully repetitive motions of scientifically optimised labour. In Plate 187, the dancing lady, which we might liken to a Dionysian maenad, takes in the non-productive ritual of dance, making her a compelling emblem whose fancy dance accentuates the competing forces behind the stop-motion project. The bursts of energy such as the

hops and twirls of the fancy dancer, serve less as visualisations of orderly, mechanised time than as examples of the weightless sign-gesture, opening out onto a non-homogeneous time and space, set apart from and even disruptive of the everyday rhythms of linear temporality and industrial production. In Plate 187, the viewer's visual fascination rests less with the movements of the model's body than in the diaphanous folds of her Grecian garment, recalling the movements of water, smoke and other natural phenomena of diaphanous delight.

In choosing to illustrate the stop-motion series of a dancer, Muybridge has provided a potent symbol for a kind of movement that is both non-productive and anti-industrial in nature. As Giorgio Agamben has described, the gestures of dance reveal what he calls 'the media character of corporeal movements', where gestures are kept suspended in the course of their own performance, unaddressed to any specific end or goal.[108] In other words, there is not a 'purpose' for the execution of these gestures outside the act of making the gestures visible themselves. They are not operative like the motions of the carpenter, who moves his saw back and forth to cut down a piece of word to create legs that will support the table that can then be used to gather around. The performance of the gestures, their own coming into appearance, *is* their purpose. They are not directed to a purpose outside themselves. Such process-oriented gestures, in which nothing is produced but motion itself, are suspended between desire and fulfilment. In distinction from 'making' or 'acting', dance concerns only its own exhibition. Nothing is being produced, nothing is being improved, but rather 'something is being endured and supported', or enjoyed.[109]

Where for Agamben the aesthetic gestures of dance are concerned only with their own performance, the same mentality may extend to any of the motions performed before Muybridge's camera. Take Muybridge's self-portraits performing manual labour. Where in another context the gestures of effort of swinging a pick-axe or shovelling dirt would have been performed with some productive goal in mind, in the space of Muybridge's photographic shed such gestures are performed solely for the click of the camera shutter. Like the dancing maenad, Muybridge, even in the guise of manual labourer, performs gestures without productive impetus or usefulness. Like the labourers on the shop floor of Taylor's Midvale Steel Factory, who could be easily rearranged and manipulated by the manager, the models performing in front of Muybridge's cameras enact their gestures with no connection to any goal or outcome. The bricklayers are not building walls or house facades, the blacksmiths are not constructing new tools and Muybridge is not working on building a chair or other wooden structure. Each performs the gestures in a sphere of 'pure mediality' like that of the dancer, where each movement of the hand, arm or leg is performed without a concrete 'end' goal.[110]

Where, on the level of subject matter, we can easily distinguish between 'operative' and 'inoperative' gestures – dancing versus bricklaying – in the making of the *Locomotion* work, all gestures in front of the camera are made for the purpose of making visible. In this way, all of the movements depicted throughout *Animal Locomotion* are inoperative. More than just a tongue-in-cheek description, the afore-cited invocation of Dionysian ritual draws attention to how Muybridge's chronophotography refigures the meaning of his repeated frames and rearranged plates as more than a clever means of smoothing over the mechanical failures of his cameras and negatives. These gaps and rearrangements are visual elaborations that build harmony within the total composition, where a repeated frame eschews a linear chain of cause and effect, while nevertheless fulfilling a larger, even ritualistic purpose of making the varied aspects of corporeal life visible; as if to say: 'I am here'.[111] In the makeshift studio on the grounds of the University of Pennsylvania, Muybridge has not so much cordoned off a sanitised sphere of research than he has drawn a magic circle for ritualistic performances to take place outside industrial

108 – Agamben, 'Notes on Gesture', 58.

109 – Ibid., 57.

110 – Jackie Smart has made a similar argument for the uses of televised dance; see Jackie Smart, 'The Disruptive Dialogue of Dance for the Camera', *Journal of Media Practice*, 2 (2001), 37–47.

111 – In this reading, the temporal remixings echo a notion of time and space that is decidedly dreamlike. But a psychoanalytic reading of Muybridge's compositions reveals less the Freudian mystic writing-pad, as theorists like Mary Ann Doane have surmised, than a Jungian notion of non-linear, but still purposive, dream imagery. Carl Jung's discussion of the temporality of dreams in 1936 similarly notes that we should be wary of imposing our own assumptions about linear cause and effect when it comes to dream analysis: 'Because dreams enter into consciousness *one after the other*, we conceive them with the help of the temporal category and relate them to one another in a causal way. It cannot be excluded, however, that the true order of the first dream enters into consciousness only much later. The seemingly chronological series is, as it were, not the true series. If we conceive of it this way, we make a concession to our concept of time. There are dream sequels into which another motif suddenly inserts itself, only to be left later to make room for an earlier motif. The actual arrangement of dreams is a radial one: the dreams radiate from a centre, and are only later subjected to the influence of our time'. Carl Jung, *Children's Dreams: Notes from the Seminar Given in 1936–1940*, ed. by Lorenz Jung and Meyer-Grass, trans. by Ernst Falzeder (Princeton, NJ: Princeton University Press, 2008), 10. Original emphasis.

clock time, one in which the human element – of the photographer as an author of the image as well as the subjects seen before the camera – can still do things the machine cannot. The messiness and spontaneity of both the materials and pictorial subjects of the locomotion studies provide a reassuring presence of humanity, maintaining mysteries that defy the penetrative eye of industry. In this sense, the beating of time performed by the hand in Plate 535 transmutes the weightless, repetitive gestures of the instantaneous photographer pressing the shutter release button into the rhythmic and recursive motions of a music conductor drawing out the rhythm of a performance without end.