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Exposed to time: cross-histories of human motion visualization from chrono- to dynamophotography

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Abstract

This essay presents a cross-history of motion visualisation, especially in relation to the visualisation of human movement duration in time-based media. Our aim is to locate the object of study in a crossover discourse from chronophotography to photodynamism, which facilitates a number of discursive shifts (from analytical to nonanalytical, and from scientific to artistic visual experimentation). We argue that because chrono and dynamophotography remain unresolved fields in-between, they offer a distinct way of seeing (thinking) the body move, quite autonomous to cinematic vision (thinking), which has become congealed into a dominant disciplinary visual and academic discourse. Whilst presenting this debate as a kind of chronophotographic collection of visual histories, we present an ongoing entanglement between science and art that reaffirms the interdisciplinary and mixed-modal character of chrono- and dynamic motion vision. In particular we address the impact of classical movement analysis and Etienne Jules Marey's chronophotographic science on modern chronophotographic art (Duchamp) and Italian photodynamism. This complex historical crucible finally presents us with an enduring tradition of hybrid experimentalism in the visualization of the moving (dancing) body, which persists in digital contexts through increasingly palimpsestic, past and future-oriented work that combine chrono- and dynamophotographic visions.

Key terms: chronophotography, photodynamism, movement, time, human body, dance

Introduction

Looking back through the history of human movement visualisation one finds optical technology defining the way people see and think bodily movement. This chapter focuses on a crossover between two different technological approaches to movement visualisation: chronophotography and photodynamism. Our aim is to open up a historical dialogue between practitioners who sought to re-compose durational movement. The chapter will also address a number of key historical shifts. We will argue that the crossover between chrono- and dynamic vision can also be tracked in relation to a paradigm shift from a scientific to an artistic approach. Our aim is not to present these as separate histories, but to offer some insights into a mixed-modal and sci-art understanding of human movement. Finally, our aim is to compare the photographic techniques underlying these approaches (long exposure and time-lapse). As opposed to cinematic techniques, chrono and dynamophotography remain relatively unexplored modes of movement visualisation, at least within critical and academic discourse. Our aim is to contribute to an understanding of how these techniques helped think and articulate human movement through the novel treatment of time.

Our chapter is conceived as a nonsystematic historical analysis. We begin with an examination of foundational analytical approaches particularly in the philosophical school of Parmenides, as well as in Aristotle's work on motion and animal movement analysis. We then proceed to examine how movement analysis is embodied technologically in the chronophotographic method championed by English photographer Eadward Muybridge and French physiologist Etienne Jules Marey. We then cross over to a dynamic vision, which in our analysis accounts for a shift from a third-person and objectivist perspective to a first-person subjectivity. We discuss the migration of chronophotographic vision to avant-garde art experimentation via the work of Marcel Duchamp, before discussing how movement was

addressed in the writings of Henri Bergson, and in the Bergson-inspired work of Italian photodynamism. The essay concludes with a reflection on the legacy of these experimental modalities of movement visualisation in current digital practice.

Zeno's paradoxes

Visualising and understanding human movement is an ancient project. A history of movement analysis goes back at least to the teachings of Parmenides and the Eleatic school, which could be credited for developing one of the first major theories of Being — hugely influential in the history of ontology via Aristotle and Plato. Indeed, according to Plato the concept of Being (ousia) is directly linked to his famous problem of participation or the communion of motion and rest (kinesis and stasis). Plato went a step further by arguing that if Being partakes of motion and rest, these two terms are to be considered generic, insofar as they underlie the whole of philosophical dialecticism.[1] Parmenides and his followers, however, had argued that a synthesis of motion and rest is impossible. The Eleatics argued that the world of the real is ontologically distinct from the world of the senses (including the sense of movement). To the extent that movement belongs to sensation, it is a mere illusion of true and immobile Being. Parmenides' ontology made a further distinction between What-is (which amounts to Truth), and What-is-not, or what is believed-to-be (which amounts to mere opinion or doxa). Zeno's contribution within the Eleatic tradition is also influential on

[1] Plato wrote in The Sophist that Being, Motion and Rest can be considered amongst the most important forms in Kind (254D). Plotinus then took this idea and argued against Aristotle's notion of 'categories' by claiming that the neo-Platonist theory of Kinds presents Being, Motion and Rest as indeed the most important categories in dialectical philosophy. See Francis, M Cornford, *Plato's Theory of Knowledge: The Theaetetus and the Sophist* (New York: Dover), 273-4.

the grounds that it relegates movement not only to sensation, or to a sensational doxa, but also to the negation of rational and logical thinking. The contribution made by Parmenides' student is also foundational at the level of a novel methodology. On the one hand, Zeno pioneered the reductio ad absurdum, a technique that seeks to prove by the absurdity of a conclusion the non-validity of the argument's premise. On the other hand, Zeno's method turned sensory movement into a mental picture (e.g. The Arrow in Flight, or the race between Achilles and the Tortoise). This enabled ancient philosophers to further alienate the notion of kinesis from sense-perception. Movement analysis was hereby 're-moved', inasmuch as movement was formulated through a disembodied visual language. Movement had become a logical and even mathematical image, devoid of kinaesthetic properties.

Take Zeno's paradox of the Arrow in Flight. The optical image is of little or no relevance here. The flying arrow does not refer to an actual perception of the object in question. The problem is staged in terms of the composition of a mental image. The arrow in flight refers either to a memory of an actual arrow, or an imaginary flight. From this mental sequence, a process of formalization can be staged. Firstly, the image is presented (at least as it survives via Aristotle's controversy) as the written description of a movement. In other words, we are not dealing with a movement in process, but a movement that has already been completed. The written description of movement presupposes that the arrow is no longer moving in the present time, but only retrospectively. The act of shaping involved in the process of flying has turned into a fixed structure: a line from point A to point B. This flight is in fact represented as a dotted line, since the assumption made by Zeno is that movement is a collection of infinite points of stillness. This is why the movement of the arrow can be seen (read) as a collection of discrete and static units of length. The line drawn by the arrow has become a geometric and numeric entity. Finally, Zeno's paradoxes of movement shift from the formal visualization of the flight to a pure formalism, in the sense that the paradox can be

presented as a purely mathematical problem involving the calculation of continuous movement from discrete values.

Aristotle's method: (chrono) photographic thinking

Eleatic philosophy bears a massive impact on Aristotle's writings, particularly in what is sometimes regarded as his magnum opus, the Physics. Aristotle began with a few words on the subject of method. He proposed a systematic and scientific study of nature using a technique that moved away from what is plain and obvious, or what Aristotle called "confused masses."[2] In the context of this study, Aristotle's notion will refer to unclear forms of knowledge (especially derived from sense perception). By contrast, Aristotle argued that units of knowledge become available through elements and principles only by means of analysis. Aristotle drew on the Eleatic School to propose a method involving the step-by-step transition from sense-perception to logic by means of a clear analytical pathway. If Aristotle's view was re-moved from sensation, it is because like the Eleatics, Aristotle believed in a methodological framework derived from rational intellection, rather than sense-schemata. Movement had become a static object of thought, like a still image photographed by the conceptual apparatus of philosophy. As such, the philosopher could claim a scientific position external to movement, thereby turning the confusing faculty of seeing-as-sensing into the clarifying faculty of analytical vision.

Our claim is that this analytical view of movement can be described as 'photographic' many centuries before the invention of photography. One could argue that Aristotle described

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[2] The full quotation from Aristotle's Physics reads: "Now what is to us plain and obvious at first is rather confused masses, the elements and principles of which become known to us later by analysis" (184a21-24). See The Works of Aristotle Volume 1 (London: Encyclopaedia Britannica Inc.) 259.

apparatuses that resemble the pinhole camera or camera obscura (in his Problems)[3] and a motion capture device (described in his book On the Progression of Animals)[4] thus pre-empting the invention of modern vision technology. The assumption we are making here is that in the same way Aristotle could imagine these devices in ancient times, so technological functions can be imagined long before they are developed in actual and material terms, not least because these imaginary technologies fulfil the projective character of human vision (seeing and thinking). The fact that the projective nature of human vision may have taken millennia to crystallize into a technological apparatus does not undermine our argument in the least. Our claim is that if photographic thinking and by extension cinematographic illusionism are ways of seeing and ways of thinking based on the sequencing of stillness, these technologies reflect how analytical thinking works regardless of the invention of a

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[3] In Book XV of his Problems, Aristotle recorded basic techniques resembling a pinhole camera to demonstrate his basic understanding of optics, particularly in the crescent shape of a partially eclipsed sun projected on the ground through the holes in a sieve and through the gaps between the leaves of a plane tree. He wrote: "sunlight travelling through small openings between the leaves of a tree, the holes of a sieve, the openings wickerwork, and even interlaced fingers will create circular patches of light on the ground." Aristotle, Problems, Book XV (Available at: http://archive.org/details/workstranslatedi07arisuoft)

[4] Aristotle wrote in his book On the Progression of Animals: "The following experiment exhibits the fact. If a man were to walk parallel to a wall in sunshine, the line described [by the shadow of his head] would be not straight but zigzag, becoming lower as he bends, and higher when he stands and lifts himself up" (A.S.L. Fraquharson's translation). Because the passage in square brackets is corrupted in the original, it has been variously interpreted. Thus, in A.L Peck's translation, instead of having a shadow draw the shape of a human movement, the passage features a reed dipped in ink (see note 6).

material apparatus called the photographic camera. The material apparatus fulfils a way of seeing movement analytically that has existed, according to this analysis, at least since the time of Parmenides and Aristotle. Analytical vision tries to understand via the naked eye or via a technologically-aided instrument, a fundamental problem: how does one make discontinuous values and continuity participate in the same process? In sum, photographic technology could be described, according to this thesis, as the product of photographic thought. It is precisely photographic thinking that Aristotle makes use of in his reconstruction of (and subsequent solution to) Zeno's paradox. The paradox can be presented as a syllogism, that is, as a logical argument broken down into three parts. Could one not argue that the parsing mechanism of Aristotelian logic is analogous to the parsing mechanics of technologically re-composed movement? If so, Aristotelian logic might be then described as a kind of cinematograph made up of logical frames:

Major Premise: when the arrow occupies its own place, it is still.

Minor premise: At every moment of its flight, the arrow is in a place just its own size.

Conclusion: at every moment of its flight, the arrow is at rest.

Aristotle frequently used tripartition to systematize his theory of motion. Thus, he understood motion in terms of physical processes occurring in relation to four causes, three of which he bagged under a common category: form, source of change, and purpose. He saw three types of general motion: essential, coincidental, and in respect of something other than itself. In addition, he saw three areas of study in the theory of change: things which are not subject to change, things which are subject to change but not to destruction, and things which are subject to destruction.[5] Using this very same method, Aristotle also answered Zeno's problem by noting that the major premise of the Eleatic's syllogism is faulty. The definition of 'place' according to Aristotle's objection to Zeno, is not correct, nor is Zeno's assumption

[5] Aristotle's Physics Book II 7 a21-24.

that continuity of motion is composed of stillnesses. Rather, continuous motion is, in Aristotle's conclusion, infinitely divisible. So the arrow's flight cannot be cut up into a dotted line, for the simple reason that those dots are in turn divided up into more dots, which further divide into smaller dots, ad infinitum.

Aristotle's interest in motion extends beyond the Physics onto more local interests in the field of natural science, and more specifically, to questions related to animal parts, animal movement and animal gait analysis. Aristotle sought to understand not only the teleology of animal movement (what the end or finality of a physical movement is), but also the formal processes by virtue of which animals achieve progression. Aristotle's premise was that the reason why animals have an even number of legs is to get from one point to another. Aristotle's method once again shifted from a visual description of animal anatomies (or body parts), to the significance of the number of the parts, and to the formal arrangement of these parts. Thus, he analysed formal patterns created through locomotion. In seeking to understand the problem of quadrupedic progression, for instance, Aristotle turned the legs of a four-legged animal into an abstract geometry and basic kinematic involving joint angles, which enabled him to quantify the physical movement and visualise it formally. Further along this work, and in a slightly more speculative vein, Aristotle assumed that in order to obtain an analytical vision of movement, the human eye was not enough. Tools were necessary to enhance human observation which might enable the whole to be broken down into parts. Aristotle wrote:

> If a man were to walk on the ground alongside a wall with a [reed dipped in ink attached to his head] the line traced [by the reed] would not be straight but zigzag,

because it goes lower when he bends and higher when he stands upright and raises himself.[6]

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One could argue that the above is a primitive description of a motion capture device. If so, Aristotle's science of gait analysis can be projected out onto another history of movement, one that would only take off following the emergence of material technologies equipped with sufficiently powerful vision to detect and record movement. Aristotle was perhaps the first thinker to argue that if one could see movement (as opposed to merely visualise it in one's mind), then one would be able to break the traceform down into component parts. What these technologies would afford was a synthetic vision that, having extracted movement out of the human body, was capable of interpolating it as visual data. As a result, living movement could be abstracted and mapped onto formal descriptions (charts, tables, diagrams). Movement could be mapped onto thought. Likewise, rather than speaking of motion and capture (or kinesis and stasis) as a dialectical polarity, one might speak of a technologically-aided 'mocap' synthesis. Movement could be engineered synthetically and automatically.

Chronophotography: or how to dismantle and reassemble human motion

From Zeno's paradoxes and Aristotle's analytical philosophy we jump many histories later to the era-changing invention of photographic reproduction. As Mary Ann Doane points out in her book The Emergence of Cinematic Time, fragmentation of motion and time was historically the condition of possibility of cinematic time and instantaneous photography,

[6] On the Progression of Animals, translated by E. S. Forster (Cambridge, MA: Harvard University Press) 511.

which is cinema's "crucial substrate"[7] . Doane further suggests that pre-photography and pre-cinema labels can be used as misnomers, insofar as analytical approaches to motion suggest a photographic and cinematographic vision even before the arrival of modern visual technologies. This is why she is able to claim that "Zeno's fallacy finds its technological embodiment in the cinema."[8] The idea re-enforces a point we made earlier regarding the somewhat cinematic mechanism behind Aristotelian logic.

Following considerable industrial and technological advances in the second half of the 19th nineteenth century, the ancient vision of movement was realised in a number of novel mechanical apparatuses that could be used to capture movement instantaneously and recompose it through framed sequences. One thing pre-cinematic technologies like the zoetrope, the zoopraxiscope, the kinetoscope, and the phantoscope helped consolidate was an objectifying third-person approach to the observation and study of movement. Likewise, many modern and experimental scientific discourses emerged in this period, which made use of these novel technologies to consolidate an objectifying visual method within scientific movement analysis. One such method was chronophotography.

It is well known that chronophotography was invented by Eadweard Muybridge to solve a basic observational problem. The American industrialist and horsemen Leland Stanford approached Muybridge in 1876 because he was interested in developing a scientific approach to gait analysis after having read the book Animal Mechanism by the French physiologist Etienne Jules Marey. This book convinced the American impresario of the need to develop a method for the improvement of horseracing performance at his Palo Alto farm. Stanford commissioned Muybridge to conduct a scientific experiment using automatically-

[7] Mary Ann Doane, The Emergence of Cinematic Time: Modernity, Contingency, the Archive (Cambridge, MA: Harvard University Press, 2002), 210.

[8] Ibid., 174.

generated photographic sequences, which would help re-compose the image of a horse's locomotion, and in the process, settle the question as to whether or not a galloping horse has all legs in the air at a given point of its race. Because the naked eye cannot seize this moment, chronophotographic technology was first used to provide a solution to the limitations of naked-eye observation.

Chronophotography achieved what the Eleatic conception of movement had seen as the main problem: to wit, that motion clouds the faculty of seeing (thinking) by immersing the viewer in a world of sensory perception. We come back to Aristotle's complaint against "confused masses." Turning against the confusion of the senses, the Eleatic tradition had championed a mode of analytical vision that clarified understanding by taking a position external to movement. Chronophotographic analysis was likewise championing a third-person approach capable of objectifying motion. What Muybridge's famous 24-frame series of Stanford's running stud showed, when presented in fast-motion on his zoopraxiscope in 1877, is that technology could provide this elusive position external to movement. The photographic print or chronophotographic projection allowed the viewer to sit back and see movement brought back to life as though it were from an outsider's view.

Muybridge's invention also removed sense perception from the process, and thus further prevented scientific observation from confusion. Chronophotography would be championed as a new type of vision that, according to Etienne Jules Marey's definition, "by reason of its slowness, its feebleness or rapidity, is otherwise inaccessible to observation."[9] Specifically, photography was taking sensation away from a human sensory faculty, in order to delegate it to an automated and mechanised process. Light exposure would be captured by a sensitized plate rather than by human organs (i.e. the eye). Rather than embedding an image onto the retina, the photographic image was chemically processed and artificially delivered

[9] Etienne Jules Marey, Movement (New York: Appleton and Co., 1895), vii.

onto sensitized material (film or print paper). This materialised image would mediate between the sensory event of movement and its understanding as an object of rational thought. The material image could be reified and remobilised as a res extensa— a thing to be circulated and exchanged like money or discourse. Muybridge did not, of course, invent the sensitised plate, but rather, further removed motion vision from human sensation by delegating the action of movement to the gyration of a machine. Thus, movement was no longer located in the lived-in object, the galloping horse, but in the machine devised by Muybridge to project the image, which in due turn, would give rise to cinematographic projection. With movement now operating at a nonsensory and mechanical level, the understanding of human motion, and the analytical discourse surrounding human movement, changed in radically new ways.

[INSERT FIGURE 1 HERE]

Marey on the "science of movement"

In his 1894 book Le Mouvement, Etienne Jules Marey wrote that "the object of chronophotography is to determine with exactitude the characters of a movement … [by representing] the different positions in space occupied by moving objects i.e. its trajectory, as well as define the various positions of this body on the trajectory at any particular moment."[10] To achieve this goal, Marey combined Muybridge's chronophotographic techniques with his own experimental equipment. Perhaps the most well-known of Marey's many ingenious devices was the chronophotographic gun, an instrument capable of shooting 12 consecutive frames a second, all of which were recorded on the same film. Marey's book Le Mouvement also included research based on the use of the chronograph machine—a basic electric sensor attached to a given body-part that delivered representation of a subject's movement as dots

[10] Marey, Movement, 54.

and lines. Thus, Marey turned the movement of a walking man, a galloping horse, and a piano player, into a kind of dot line Morse code. In addition, Marey's laboratory work pioneered a technique known as geometric chronophotography. In order to limit the spatial information caught in a chronophotographic record before it became confused, Marey proposed that a study of human gait should record not the entire human body, but only key information. For this purpose, Marey had a man walk in front of his camera dressed in a black velvet suit marked with white stripes and spots on his limbs. Marey later corrected this system by substituting the stripes and spots for small electric light bulbs. Only a few years after Marey's initial experiments, this method would be refined by German scientists Wilhelm Braune and Otto Fischer producing an ancestor of today's mocap suit. Or if we turn the historical clock in the opposite direction, the technology fulfilled Aristotle's vision of a device that can make the invisible geometry of human movement visible and readable.

[INSERT FIGURE 2 HERE]

There is a reason why Marey's scientific experimentation focused on movement visualisation. Once the scientist could see movement, then he could start analysing it as an empirical object. For example, Marey conducted an experiment in which he photographed an illuminated ball flying across a black backdrop, which resulted in the visual analysis of a ball in flight (similar to Zeno's problem of the arrow). Marey wrote: "during its passage this ball leaves an impression on various parts of the sensitized plate … On examining the plate there is found a continuous curved line which exactly represents the path taken by the luminous ball."[11] Marey then added the variable of a regular time interval. Thus, he did not photograph the continuous path of the ball but a path broken at regular points in time. The two resulting visualizations provided the key distinction between a "simple trajectory" (a continuous line), and a "chronophotographic trajectory" (a broken line). Like the dots and lines of his

[11] Marey, Movement, 55.

chronographic code, geometric formalisation and discretisation enabled an understanding of movement as a kind of machine-scriptable or automatically-generated language of movement. Like the dotted line of Zeno and the zigzag trace form of Aristotle, Marey was able to give a technological embodiment and a materiality to analytical vision. Finally, it was not enough to make movement visible. Movement had to be turned into a graphic description as well. Thus, by transcribing movement into many kinds of graphic representations including charts, tables, diagrams, dot-line code, and of course geometric figuration, it could be interpreted as meaningful scientific information. This so-called graphic method enabled Marey to gain an understanding that bypassed the need for an intermediary notation system, since living movement could be recorded directly. In other words, movement did not have to be detected and represented by human beings, since movement data had now become machine-readable and machine-scriptable. Human beings only needed to interpret the data, as it was objectively transcribed from living and real-time movement by the technological medium. And because movement was converted into graphic units, results obtained from these apparatuses could be interpreted mathematically or indeed computationally. This enabled chronophotographic science to boast its own measurement technique: chronometry, which could turn the continuum of time into quantifiable and metric value.

[INSERT FIGURE 3 HERE]

Bergson, and the challenge on chrono-photographic thinking

Our history of movement analysis restarts following the publication of Henri Bergson's highly influential books Matter and Memory (1896) and The Creative Evolution (1905). Although Bergson proposed a breakdown of movement into three analytical categories (qualitative, evolutionary or extensive), he moved beyond this basic analysis to a consideration of the problem of first-person and subjective perception. He also argued for an

interval between perception of movement and pure movement, which distanced the analytical perspective from an understanding of the lived-in and inner sense of movement. Because of this gap, Bergson believed that an image of movement is taken by the mind (or its technological proxy) thus disconnecting perception from the kinaesthetic experience of movement as action. In other words, the mind only takes "stable views of the instability."[12]

Bergson upturned his inherited philosophical tradition by claiming, in a complete reversal of Eleatic dialectics, that Being is an illusion or an arbitrary snapshot of multiplicity. He also criticized human intellect for feeling "at home among inanimate objects"[13] especially dialectical intellectualism, which he considered to be the opposite of intuition— a strategy by means of which thought agrees with itself.[14] He criticised the need to see and think through solid objects, and via logistic means that "triumph in geometry."[15] It is this triumph of geometric thinking that enabled rational intellect to claim full understanding of movement from a third-person and static perspective. However, Bergson questioned how movement could possibly make sense from such a standpoint. The contrivance of the cinema, which according to Bergson is intended to simulate movement, was the perfect example of this intellectualising and rationalistic approach. Rational thinking, and cinematic rationality by extension, provided an external and artificial understanding of pure movement. He wrote:

> Instead of attaching ourselves to the inner becoming of things, we place ourselves outside them in order to recompose their becoming artificially. We take snapshots, as it were, of the passing reality, and, as these are characteristic of the reality, we have only to string them on a becoming,

[12] Henri Bergson, Creative Evolution (London: Macmillan and Co. 1922), 318.

[13] Ibid., ix.

[14] Ibid., 251.

[15] Ibid., ix.

> abstract, uniform and invisible, situated at the back of the apparatus of knowledge, in order to imitate what there is that is characteristic in this becoming itself. […] We may therefore sum up […] that the mechanism of our ordinary knowledge is of a cinematographical kind.[16]

It is well known that the Bergsonian challenge was taken up by Gilles Deleuze. Deleuze tried to rescue Bergson's concept of the movement-image (and to expand on it), in order to debate the nature of cinema and cinematographic thinking from a less antagonistic perspective. Whether or not Bergson's hostile attitude to cinema can be overcome in order to see the motion picture in a more favourable light, as Deleuze does in his two books on the Cinema, is beside the point. What concerns us here is not the status of cinema as a means of representing or indeed thinking human movement, but the forced sense of the re-enactment and re-presentation which stems from chronophotographic and cinematographic illusionism. We do not intend to continue the history via Deleuze's analysis, but to stay closer to Bergson's vitalist philosophy. The problem is not whether cinema can be rescued from Bergson's attack, nor whether Deleuze is right in recovering the theory of the movement-image so as to be able to open up a critical theory of cinema, but whether we can rescue a sense of dynamic and sensory connection with movement despite the alleged alienation produced by the cinematographic gap. What troubled Bergson is that technology found "more in the motionless than in the moving". [17] According to Bergson, cinematographic thinking leads to a point of strain. It cannot catch up with change and must reveal its own limitations, in the same way that chronophotographic sequences are limited by Marey's own admission. The chronophotographic approach is reliant upon a perpetual recommencement, during which the mind, never able to find where to rest, satisfies itself by attaching the "movement to a

[16] Ibid., 323, emphasis original.

[17] Ibid., 334.

mobile."[18] To counteract this artificiality of projective thought, Bergson spoke of the need to replace oneself within movement. In other words, he championed the idea that one ought to think not so much about movement, but through movement. He proceeded, almost sententiously: "Install yourself within change" and in so doing, "develop another faculty, complementary to the intellect."[19] This new modality of thought was intuition.

Duchamp and the crossover to chronophotographic art

Marta Braun speaks of Marey's chronophotographs as "contrived visualizations, which have no existence outside their realization."[20] It is precisely because they cannot be easily categorised as artistic or scientific objects that they possess a unique aesthetic quality. Chronophotography was particularly inspirational to the historical avant-garde, which according to Braun had "abandoned the replication of the visible world in order to give form to the new ideas of time that had been theorised by science and evidenced by photography."[21] Three artistic milestones of futurist visual art, all produced in 1912, highlight the broader cultural shift from chronophotographic physiology to chronophotographic art. Furthermore, this shift presents a transition from a study of human gait as an object of scientific analysis (a third person perspective), to an intuitive exploration of movement and time as a subjective experience (first person). This brought visual and movement artists together enabling a rich period of graphic experimentation devoted to painterly and screened representations of the

[18] Ibid., 317.

[19] Ibid., 324-5.

[20] Marta Braun, "Chronophotography: photographing movement Chronophotography: photographing movement," in Sequences: Contemporary chronophotography and experimental digital art, ed. Paul St George (London: Wallflower Press, 2009), 47.

[21] Ibid., 47.

moving (dancing) body. The works alluded to above are Gino Severini's Blue Dancer, Giacomo Balla's Girl Running on a Balcony, and a work that is often considered a landmark in modernist art history: Marcel Duchamp's Nude Descending a Staircase No 2. Severini and Balla were both engaged in the use of chronophotographic pictorial styles to represent the dynamic sensation of modern living, especially in terms of the social agitation produced by the machinic and industrial age. Equally important to these artists was the figure of the dancer and the choreographic quality of large masses of people, which featured prominently in futurist and cubist artwork of the period. But whilst the futurist lens was intent on suggesting dynamic qualities of movement and speed, it was Duchamp's work that crystallized the kind of historical crossover we are interesting in highlighting here.

[INSERT FIGURE 4 HERE]

Although Duchamp's Nude Descending outlines spatial rhythms conveying lines that are stylistically similar to the works of Severini and Balla, these lines are not intended to emphasise the dynamics of a moving figure merging into itself. The painting was not inspired by the Futurist attempt to suggest movement by means of dynamic painting. Instead, and as Mexican Nobel laureate Octavio Paz noted: "Duchamp applies the notion of delay— or rather, of analysis, to movement."[22] Furthermore, the piece was conceived in relation to the Cubist interest in seeing movement on several planes simultaneously. Like most of Duchamp's oeuvre, this piece refuses straight categorizations. Whatever its style, the work exemplifies a historical crossing: it is an artistic address to a visual discourse that is scientific in its character, and yet profoundly artistic. The work highlights an experimental and highly intuitive understanding of movement that did not settle into a technological medium (cinema), nor did it settle into a single artistic movement, let alone a cultural discourse. Instead, this kind of work remained poised between various modalities of vision (and

[22] Octavio Paz, Appearance Stripped Bare (New York: Arcade Publishing, 1990), 6.

thought). As an intrinsically cross-disciplinary and cross-discursive work, Nude Descending encapsulates that very notion this essay seeks to distil— namely, that before movement vision settled within given regimes of vision like cinema, the stylisation of movement in the visual arts could also highlight experimental and multimodal forms of non-representational and non-realistic visual discourse.

[INSERT FIGURES 5 AND 6 HERE]

Duchamp famously spoke of "putting painting at the service of the mind."[23] Given Nude Descending's distinct analytical character it will not come as a surprise that Duchamp acknowledged the direct influence of the graphic approach found in Muybridge's and Marey's movement science. According to Duchamp: "[Chronophotography] was at the time in vogue. Studies of horses in movement and of fencers in different positions as in Muybridge's albums were all known to me."[24] Duchamp wanted a "static representation of movement—a static composition of indications of various positions taken by a form in movement— with no attempt to give cinema effects through painting."[25] The work is certainly not cinematic, but entirely pictorial. The power of the work lies in the interplay between the dynamic force of the medium (painting) and the diagrammatic and analytical structure of the nude figure itself. Thus the structural composition combined with use of a palette range from yellow ochre to dark, almost black tones, coupled with the transparencies and the striking amalgam of light and dark, arguably invite a mixed vision onto the painting that demands the coexistence of two different modes of visions.

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[23] Marcel Duchamp, The Complete Works of Marcel Duchamp, ed. Arturo Schwartz (London: Thames and Hudson, 1997), 17.

[24] Ibid., 53.

[25] Ibid., 53.

Futurist photodynamism: suggesting the dynamic sensation of the dance

In his manifesto on Futurist Photodynamism first published in 1913, Italian photographer Anton Giulio Bragaglia wrote that experiments in long-exposure photography conducted by the futurist avant-garde could not be interpreted "as an innovation applicable to photography in the way that chronophotography was."[26] Instead, photodynamism was intended as a non-representational and ultimately subjective expression of futurism's concern with change, speed, and mechanization. Whilst rejecting Marey's science, Bragaglia spoke of a sci-artistic experiment that was "not interested in the precise reconstruction of movement, which has already been broken up and analyzed." Instead, continued Bragaglia, "we are involved only in the area of movement which produces sensation."[27] Even though he challenged visual objectivity and logical analysis through purely sensory means, Bragaglia claimed that the object of photodynamic art remained scientific in its scope (i.e. through is focused study of human sensation). Echoing Bergson's critique, Bragaglia claimed that cinematographic science and art raised a "superficial" and "imbecilic" mentality insofar as cinematography only subdivided movement "with mechanical arbitrariness, disintegrating and shattering it without any kind of aesthetic concern for rhythm."[28] Bragaglia attacked Marey's science on similar grounds, not least because he saw chronophotography breaking down a movement that had already been captured, and thus, immobilized. Bragaglia proceeded: "with about five extremely rigid instantaneous shots we cannot obtain even the reconstruction of movement, let alone the sensation."[29] So unlike Bergson, Bragaglia

[26] Anton Giulio Bragaglia, "Futurist Photodynamism," in Futurist Manifestos, ed. Umbro Apollonio (London: Thames and Hudson, 1973), 38.

[27] Ibid., 38; our emphasis.

[28] Ibid., 39.

[29] Ibid., 39-40.

questioned whether cinematography and chronophotography could even be considered a re-composition of movement as such.

Photodynamism argued for a modality of vision which, through the use of long-exposure techniques, could be considered proportionate to the very tempo of the captured movement. It is worth adding that, as opposed to instantaneous photography, long-exposure photography involves using a long-duration shutter speed, which enables the sharp capture of stationary elements while blurring, smearing, or obscuring moving objects. By allowing a certain period of time in the image exposure, this technique did not capture snapshots but durational shots involving continuous deformation occurring over a period of time. By introducing the variable of duration, photodynamism was conducive to a way of seeing (or thinking) the moving body that was open to a kind of topological vision. In other words, the photographic image could identify the deformational and transformational qualities of bodily shapes. Likewise, because long-exposure techniques added this durational variable to the actual capture, photodynamism dispensed with the instantaneous capture, and replaced chronophotographic simulation with a suggestion of inner, dynamic intensities. What matters in Bragaglia's long-exposure photography is not the realistic representation of a body fulfilling the expectations of optical objectivity. Rather, what counts is the sensation of that same body as it transforms itself in motion. The premise of photodynamic technique was not to capture moments in time, but through time. The premise was to move from an extensive sense (a strip of images making a chronophotographic meter), to an intensive sense, where duration is visually overlaid onto a single frame.

In turning size and speed into depictions of movement dynamics Futurist photographers also achieved, like Duchamp, a subjective perception. Bragaglia protested against critics of photodynamism, who argued the images were "unsure and difficult to

distinguish."[30] He argued that for photodynamism the desirable effect is to record the image deliberately in a distorted state, "since images themselves are inevitably transformed in movement."[31] With such an aim in mind, photodynamism was not only making a determined move away from realism, it but also the classical model of analytical vision. Rather than moving away from Aristotle's "confused masses," futurists sought to embrace the confusion of speedy masses in order to move away from rationalized vision. And whilst Marey's chronophotography argued for a limited amount of information and a reduction of the bodily image to the data necessary for its better rational and analytical understanding, photodynamism championed the overlaying of visual imagery to the point where the only faculty capable of recognising such visual complexity is proprioceptive sensation. Bragaglia concluded: "dynamic representation of reality [is] affirmed independently of formal analogies with reality."[32]

[INSERT FIGURE 8 HERE]

Insofar as photodynamic vision opened a subjective and non-optical vision of the moving body, it enabled futurists to claim a dynamic portraiture of dancers and musicians in action. The purpose of the image was not to record, to register, or indeed to archive moments arbitrarily stolen from the performance, but to suggest a sensation of the performance, and thus, to create an immersive space within which a viewer could enter into subjective relationships with the dancer or the musician. Photodynamic representations of dance and musical performance created sensory connections with performer's movements, which are rendered as dematerialized or virtual volumes. Bragaglia explained:

[30] Ibid., 43.

[31] Ibid.

[32] Ibid., 42.

> If we repeat the principal states of the action, the figure of a dancer — moving a foot, in mid-air, pirouetting— will even when not possessing its own trajectory or offering a dynamic sensation, be much more like a dancer, and much more like dancing, than would a single figure frozen in just one of the states that build up a movement. The picture therefore can be invaded and pervaded by the essence of the subject. It can be obsessed by the subject to the extent that it energetically invades and obsesses the public with its own values.[33]

The dynamic vision proposed by Futurist practitioners raised expectations for new mediated relationships between a viewer and a dancer. Instead of seeing the body in space, one could see a body dematerialized by duration. In the process, the moving body was turned into what experimental photographer Laszlo Moholy-Nagy was to call a few decades later "virtual volumes" and pure "light displays"[34] as part of subsequent long-exposure and

[33] Ibid., 44.

[34] Bauhaus artist Moholy Nagy pioneered the use of color time-lapse photography in kinetic and choreographic photography. In his 1945 work Path of motion during a dance, Moholy-Nagy used time-lapse photography to represent dancers wearing artificial lights, which enabled him to turn the dance motion into light-paths of abstract or "pure" movement. According to the artist, this technique pried open a "true kinetic representation of color-light values [that] bring the first great sensation of direct light display." Color was thus "divorced from naturalistic-illusionistic meaning" so as to be able to suggest, in more abstract terms, movement in itself, thus challenging an analytic devoid of color and sensation. See: Laszlo Moholy-Nagy, Vision in Motion (Chicago: Paul Theobald, 1947), 173.

colour-photographic experiments of the dance inspired by futurist art.[35] The aim of the futurist experiment was then to create a visual field in which a dance could be seen, as though it were, from the perspective of the dancer's own motor field. In other words, photodynamic screendance was imbued with the Bergsonian idea that in order to see (think) movement, one has to approach it no longer as an external object of analysis, but from within. One could speak of a photodynamic thinking that does not seek rationalization, but which, in the spirit of Bragaglia, seeks the more transcendental nature of the phenomenon of movement. In other words, photodynamic thought sees things whilst in the process of becoming something else. To put it differently, dynamic vision sees the durational process during which a dancer might lose, if only for a moment, a sense of bodily materiality and weight, in order to gain an ephemeral sense of levity and virtuality whilst in the act of moving.

[INSERT FIGURE 9 HERE]

Conclusion

The final frame of our history concerns the digital. Thus, our conclusion points to current practices that have sought to re-imagine the pre-cinematic and experimental forms of movement visualisation discussed above. The aim of a historical view (or cross-historical), is not to recast 19th century scientists as artists, nor to challenge the supremacy of cinematography, and thus become alibis of cinema. The point of looking back into the past is that past times often link our own present vision with the potential emergence of the new.

[35] In Herbert Matter's time-motion photo-studies; for instance Man dressing (1944), lights were fastened to the body of a man changing clothes. The technique was introduced by Frederick Taylor and Frank and Lillian Gilbreth who were inspired by Marey to produce a "taylorist" approach to photography in order to rid industrial movement from any superfluous and uneconomic effort. See Moholy Nagy, Vision in Motion, 123.

We have repeatedly spoken here of a cross-history. What we have meant by this is that the historical project involving the visualisation of human movement cannot be followed via a single line of enquiry, or following a single modality of vision. The visual discourse presented above lies in-between fields (between cinema and photography, between science and art, between analytical and intuitive modalities of thought). What is so unique about many of the mixed-modal forms we have discussed here is that they do not necessarily congeal into settled regimes of vision in the way cinema and photography did. The works of Muybridge and Marey, for instance, remain to this day unfinished histories. We conclude by pointing out the need to look back into these other histories of human movement visualisation not necessarily with the aspiration to identify what cinematic history allows us to see, but what current cinematic histories do not allow us to see. One thing that contemporary screendance blinds from public view are many of those experimental techniques that sought to expose the moving body and the dancer not so much to photographic 'realism', but to analytical and intuitive ways of connecting with movement as sensation and as thought. What these past visions allow us to see again is that screendance is not only a discourse of bodies that have been recorded and preserved so as to be seized in time for cinematic posterity. There is also a power-discourse underlying these different histories, where different modalities of vision and different technologies have jostled for their place in mainstream culture. Some have prevailed over others, thus blinding us from alternative forms of seeing the human body in movement. Why, for instance, as deformation all but disappeared from screendance aesthetics? Has Bragaglia's claim for a screendance that captures the sensation of the movement all but fizzled out in realistic and representational screendance? Finally, this historical look is also aimed at the renovation of current digital avant-garde practices, which is where we locate our own work as practitioners.

[INSERT FIGURE 10 HERE]

A digital avant-garde does not only have to remain retrospective and historicist in its attempt to bring back the old. Nor is the aim of this discussion to romanticise the praxiscopic, the zoetropic, the chronophotographic, or even, without wanting to go too far, the analog. The aim here is to recognise that the creative imagination of pioneers like Muybridge and Marey is an unfinished business, and that to this day, some of the work carried out by these practitioners remains not only discontinued but also unsurpassed, in terms of the beauty and the iconicity of the work. In seeing the dancing body through digital dynamo- and chronovideography, works like our own Labanimations (2012)[36] or Chris Joseph's Turnbaby (2002), expose not only possibilities for a re-engagement with past poetics of the movement image. Our last thought relates to how a combination of Bragaglia's photodynamism and Muybridge's chronophotography locates the experience of viewing a piece like Labanimations in an intermediate state (similar to the one identified earlier in our reading of Duchamp). This crossed-vision, as it were, can be either described as pictorial and cinematic. In this regard, in attempting to rebuild movement and reconnect with movement through vision technology, we become aware yet again of the tension between stillness and motion as a creative point of departure, which has been a spark for the human visualisation of movement since the time of Parmenides. The experience of photographic time then combines a sense of retention and a sense protension (rest and motion), which allows the viewer to observe movement without following predefined paths, whilst embarking on an endless journey of rhythms and polarities. Whereas cinema imposes its own "ordering and

[36] Labanimations (2012) is a series of three videos (1-2 min each) directed by Sebastián Melo (with choreographies and dance by Melina Scialom), based on a videographic concept by Nicolas Salazar-Sutil.

demarcation of time,"[37] chrono and dynamophotography invite a perception that echoes with what Barthes has already described as a personal journey into movement visualisation, which is somehow never completed:

> If I like a photograph, if it disturbs me, I linger over it. What am I doing, during the whole time I remain with it? I look at it, I scrutinize it, as if I wanted to know more about the thing or the person it represents.[38]

Experimental re-interpretations of photodynamism have led digital media practitioners like Chris Joseph (aka Babel) to speak of "videodynamism."[39] One could also speak of chronovideography and other digital versions of the kind of visual histories discussed in this chapter. Other kinds of digital palimpsests might even allow us to see simultaneous histories or various temporal snippets of history at once, in the way Nude Descending does. What we are suggesting here is not the re-invention of temporality. After all, natural temporality is by definition cyclical, periodical and self-renovating. However, there is a need to refresh temporality from the predictability of filmic screendance. There is a corollary here regarding the use of new technologies that open up the possibilities for further exploration and re-invention. Examples of this might involve stroboscopy,[40] or in more

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[37] David Green and Joanna Lowry (eds). Stillness and time: Photography and the moving image. (Brighton: Photoworks / Photoforum, 2006), 18.

[38] Roland Barthes, Camera Lucida: Reflections on photography (New York: Hill and Wang, 1981), 99.

[39] See Paul St. George, ed., Sequences: Contemporary chronophotography and experimental digital art. (London: Wallflower Press, 2009).

[40] The electronic strobe light stroboscope was invented in 1931, when Harold Eugene Edgerton ("Doc" Edgerton, from MIT) employed a flashing lamp to study machine parts in motion. Edgerton later used very short flashes of light as a means of producing still

current technical treatments of temporality, stereoscopy and slit scan. Likewise, the use of generative video, transmedia, user-responsive and net art videodynamism can enable rich explorations of computerised temporality. If different techniques and technologies open up ways of seeing time in less prescriptive and linear ways than what cinematic time can afford, then the question of what new media affords instead must remain open-ended. Whilst the futurist experiments of Bragaglia were concerned largely with form and deformation, the direction of the digital cannot be singled out quite as clearly or as generally. The hybrid and palimpsestic forms that surface within contemporary visual practice favour not only a media-rich representation of temporal transformation, but also a historically-rich layering. What we have highlighted here is that current visual discourses stem not only from a single historical lineage, but several. Some of these histories get mixed up in digital fusions while others are iterated and recycled in iconic visual quotes. Whatever the case, Marey's subjects continue to run on in myriad digital and kinetic artistic re-workings. Muybridge's horse and his dance wheel run on, re-sequenced through random user-generated interactions such as Babel's digital zoetrope. They dance on, exposed to time past and time future.

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photographs of fast-moving objects, such as bullets in flight. Stroboscopic photography or strobe photography presents a new historical visual discourse that opens a different technique and technology of motion vision (thought). We would need more scope than the one afforded in this essay to trace this very different cross-history from a dynamo- to strobophotographic vision of movement. Herbert Matter's used stroboscopic scientific photography to represent the movement of dancers in the early forties, particularly in his Figure in Movement (1941), quoted in Moholy Nagy, Vision in Motion, 249.

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