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In 1883, the Anglo-American photographer Eadweard Muybridge (1830–1904) was invited to the University of Pennsylvania to undertake a large photographic study of human and animal locomotion. The invitation came from the university provost, William Pepper, through the auspices of American painter Thomas Eakins, the university's professor of anatomy. Muybridge's 1878 photographs of Leland Stanford's racehorses had impressed Eakins who had adapted them for his painting »A May Morning in the Park« (1879) and brought them to Pepper's attention. Pepper, in turn, put together the money to fund the project and put the grounds outside the university's veterinary hospital at Muybridge's disposal.

The 1878 photographs that Eakins had been so excited about were the culmination of a project Muybridge began in 1872 for the former governor of California, Leland Stanford. Then, Muybridge worked with a single camera in an unsuccessful attempt to capture the moment in the horse's gallop when it was unsupported by its legs. Taking up the work again in 1877 – in the meantime he had murdered his wife's lover, stood trial for the crime, was acquitted and traveled for a few years photographing in Central America – he worked with twelve cameras, side by side, their shutters triggered sequentially. The next year he was successful in capturing each phase of the galloping horse's stride with a series of instantaneous photographs made by his battery of cameras. The photographs were astonishing. They showed the limitations of retinal vision and celebrated the supremacy of machine-gathered data. They were acclaimed worldwide.

Muybridge patented his method of triggering the camera shutters with Stanford's knowledge, but there is still some question about who actually originated the idea and execution of the apparatus. In 1899, Muybridge wrote: »It occurred to [me in 1877] that a series of photographic images made in rapid succession at properly regulated intervals of time, or of distance, would definitely set at rest the many existing theories and conflicting opinions upon animal movements generally.«[1] But Leland Stanford, responding to the lawsuit Muybridge initiated in 1882 over the publication of his photographs (as lithographs in J. B. D. Stillman's

1 Eadweard Muybridge: Animals in Motion. An Electrophotographic Investigation of Consecutive Phases of Animal Progressive Movements, London 1899, p. 2.

The Horse in Motion, a book overseen by Stanford) claimed under oath that the idea for the cameras was originally his and, more importantly, insisted that one of his railroad engineers, John Isaacs, was solely responsible for the mechanical functioning of the cameras – the shutters, the electromagnetic timer and even the wires stretched across the animal's path.[2]

In 1879, Muybridge devised an apparatus unquestionably of his own devising, the Zoopraxiscope, to demonstrate the accuracy of his photographs. A combination of projecting lantern, rotating glass disk upon which were a number of paintings, and a counter-rotating, slotted disk geared to operate at equal speed, the Zoopraxiscope gave the illusion of movement. And while his fame as a motion picture pioneer rests on this machine, it is important to note that Muybridge projected paintings made from his photographs with the Zoopraxiscope, but never the photographs themselves.

Muybridge demonstrated his Zoopraxiscope in California and then took it on a European lecture tour. In Paris, in September 1881, he was feted by French physiologist Etienne-Jules Marey who nonetheless found the photographs produced with the battery of cameras disappointing. »Apart from the fact that the sharpness of the images was insufficient,« Marey wrote, »the photographs were missing the one thing that made the pictures of the gait of the horse so interesting, a series which showed the successive positions of the animal.«[3] Muybridge had failed to represent the trajectory of the movement. He »could not avoid errors which inverted the phases of the movement and brought to the eyes and spirit of those who consulted these beautiful plates a deplorable confusion.«[4] Marey himself, in 1872, had already substantiated the theory of unsupported equine transit in his experiments with pneumatic sensors attached to each hoof of a moving horse. He had traced these and other movements of bodies with graphing machines of his construction. His tracings, sinuous graphs made by a stylus on a smoke-blackened cylinder, provided the two components of movement, time and space, in a graphic form that could be easily measured.

The publication of Muybridge's photographs, however, inspired Marey to take up photography and he quickly developed his own apparatus to produce the optical equivalent of his graphic method. Marey used an ordinary camera but with its lens left open. Behind the camera lens Marey put a rapidly rotating metal disk, which had from one to ten slots cut into it at even intervals. Marey had a man all

2 See Robert Bartlett Haas: Eadweard Muybridge 1830–1904, in: Anita Ventura Mozley (ed.): Eadweard Muybridge. The Stanford Years 1872–1882, Stanford 1972, p. 27.

3 Étienne-Jules Marey: Développement de la méthode graphique par l'emploi de la photographie, Paris 1885, p. 12.

4 Id.: La Chronophotographie (Conférence du Conservatoire National des Arts et Métiers), Paris 1899, p. 8.

dressed in white move in bright sunlight between the camera and a black background. As the man moved in front of the black background, he would be in a different location each time a slot in the rotating shutter exposed the glass plate, creating a sequence of images. The faster the disk-shutter rotated, the more images would layer on the same plate since less time would elapse between exposures and the subject would cover less ground. This was a revolutionary method of photography but totally in keeping with the principles Marey had established for his graphic method. The slotted disk shutter translated the movement without loss or diminution into a visual language of fluid, overlapping forms from which measurements could be taken. He further improved his apparatus by working on the subject, not the camera, blacking out the figure and placing white buttons on its joints. This technique resulted in an image of pure movement detached from the performer and a photograph totally without precedent.

Muybridge was familiar with Marey's single camera system. In correspondence, the two men had exchanged sketches of cameras and when Muybridge finally began his work in Philadelphia, he was re-introduced to Marey's camera, this time in an apparatus used by Thomas Eakins. Eakins was a member of the commission formed by the University in March 1884 to oversee Muybridge's project. Composed of nine doctors and professors of the University, the commission was »appointed to supervise the entire affair and thus insure its thorough scientific character«.[5] »As I,« Muybridge wrote, »am neither a physiologist nor an anatomist, they are assisting in the work to give it additional weight and value.«[6] Eakins worked side by side with Muybridge in the late summer of 1884. Like Marey, Eakins wanted enough images to create a visual correspondence to the duration of a movement. With his version of Marey's camera – it incorporated two slotted discs geared at different rates of speed – Eakins photographed both the male and female nude against a marked-off black background. His method, according to the University engineer and commission member William Marks »yielded a means of measurement as near scientifically exact and free from sources of error as we can hope to reach«.[7]

Eakins tried to persuade Muybridge to experiment with the Marey-wheel camera, but Muybridge had his own ideas. He wanted to replicate the success of his Stanford photographs and assumed that the technology that gave those pictures their authority and reputation then would continue to serve him now. But as we know from Marks and others, Muybridge's cameras did not work when he reprised the solution that had served so well in California: the shutters were »too clumsy

5 W. D. Marks / H. Allen / F. X. Dercum: Animal Locomotion: The Muybridge Work at the University of Pennsylvania. The Method and the Result, Philadelphia 1888, p. 5.

6 Mr. Muybridge's Photographs: Interesting Pictures to Be Taken of Wild Birds and Beasts in Motion, in: Philadelphia Ledger (August 12, 1885).

7 Marks / Allen / Dercum: Animal Locomotion (as note 5), p. 3.

and slow«.[8] It took until the end of the summer to produce functioning shutters for his cameras – again he was assisted by university engineers – and to construct two portable twelve-lens plate holders and shutter systems for two other single cameras. The twelve single cameras – called the laterals – were placed parallel to the subject, the two single multi-lens cameras made what he called ›foreshortened‹ views: one was at sixty and the other at ninety degrees to the subject. University engineers also devised a circuit breaker to ensure the successive electrical contacts automatically and simultaneously for all cameras and at equal intervals, long or short, as desired. At this point, fed up with an investigator whose methods, he felt, were not as scientific as his own, Eakins left Muybridge to work by himself.

Muybridge photographed his subjects through August 1884 and began again in late May 1885 working until the end of October. The next eighteen months he spent assembling the individual images into the sequential arrangements of lateral and foreshortened series that constitute *Animal Locomotion*. As I have shown elsewhere, the sequential ordering is critical, because it dictates our perception of the relationship among the single images.[9] The sequence endows its component parts with movement because we believe any sequence to be orderly, logical and progressive. It is the sequence that cues us, in fact, to believe that the action represented was ongoing and that it took place exactly in the order in which we see it reproduced. Thus our perception is directed by our belief in this structure to fill in the missing parts – the gaps between the separate phases of the movement supplied by each single image. The sequence invites us to cooperate in creating the illusion of motion even when there is none. Our faith in the sequence allows us to suspend our disbelief.

But Muybridge's sequences hide gaps and discrepancies, for example, when the position of the figure in the lateral and foreshortened views, supposedly taken simultaneously, is not the same. From his notebooks and from the *Prospectus and Catalogue* he published for the purpose of selling *Animal Locomotion* plates, we know that Muybridge had difficulties with his apparatus.[10] The cameras would either not go off in the correct sequence or fail to go off at all, negatives fogged or were broken, and some exposure times and intervals were not recorded. Muybridge's assemblages of the lateral and foreshortened series are the ways in which he compensated for these problems.

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8 Letter of Thomas Anshutz to J. Laurie Wallace, August 1884, Archives of the Pennsylvania Academy of the Fine Arts, Philadelphia.

9 Marta Braun: Muybridge's Scientific Fictions, in: Studies in Visual Communication 10/3 (1984), p. 2–22.

10 Eadweard Muybridge: Animal Locomotion. An Electro-Photographic Investigation of Consecutive Phases of Animal Movements. Prospectus and Catalogue of Plates, Philadelphia 1887.

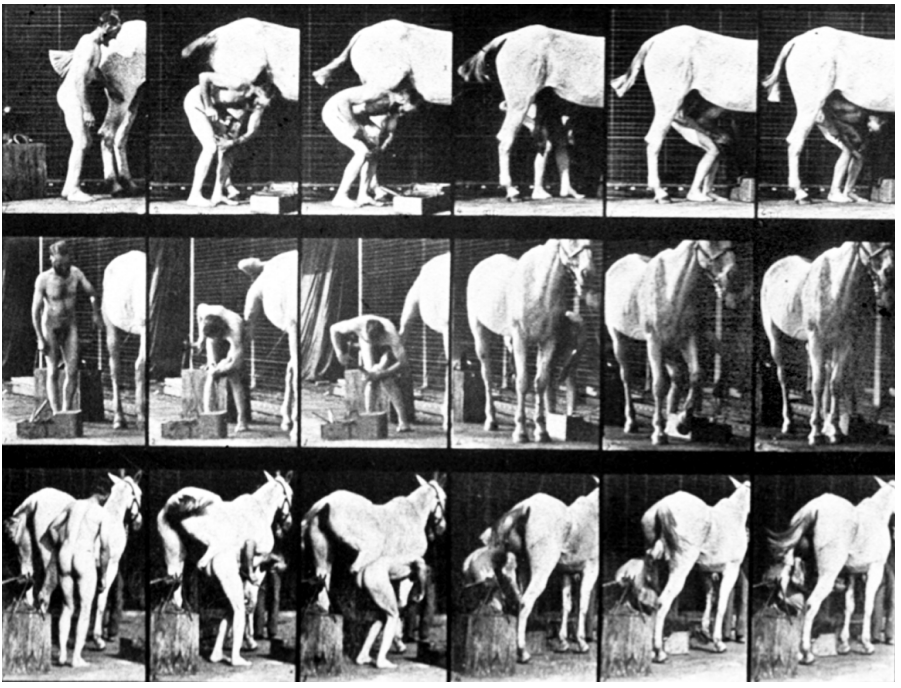

Fig. 1: Animal Locomotion Plate 508 »Shoeing a Horse«, Collotype, 1887.

In Plate 508 »Shoeing a horse«, the blacksmith has changed position to such a degree that we must surmise that a phase or phases of the movement have not been recorded. And the expectation that the missing phase in the lateral series would have been caught by the camera in a foreshortened series is frustrated: The views match up both in the pose and in the numerical order.

If the arrangements of the laterals and foreshortenings in the final prints hide the problems Muybridge had with his apparatus, the cyanotypes make those problems visible. The cyanotypes – images made with iron rather than the usual silver salts and similar to blue prints – were found in the Smithsonian Institution in 1999. They are made from Muybridge's original negatives and thus the first and formulating stages of *Animal Locomotion*. Using them as a guide, Muybridge created a composite glass positive from his negatives, and from the glass positive a gelatin negative from which he struck the final collotype print. Muybridge's negatives are lost, so the cyanotypes constitute the only evidence we have of what he originally photographed. The cyanotypes are strikingly different from the published *Animal Locomotion* collotypes; they reveal the painstaking labour Muybridge undertook to realize each plate.

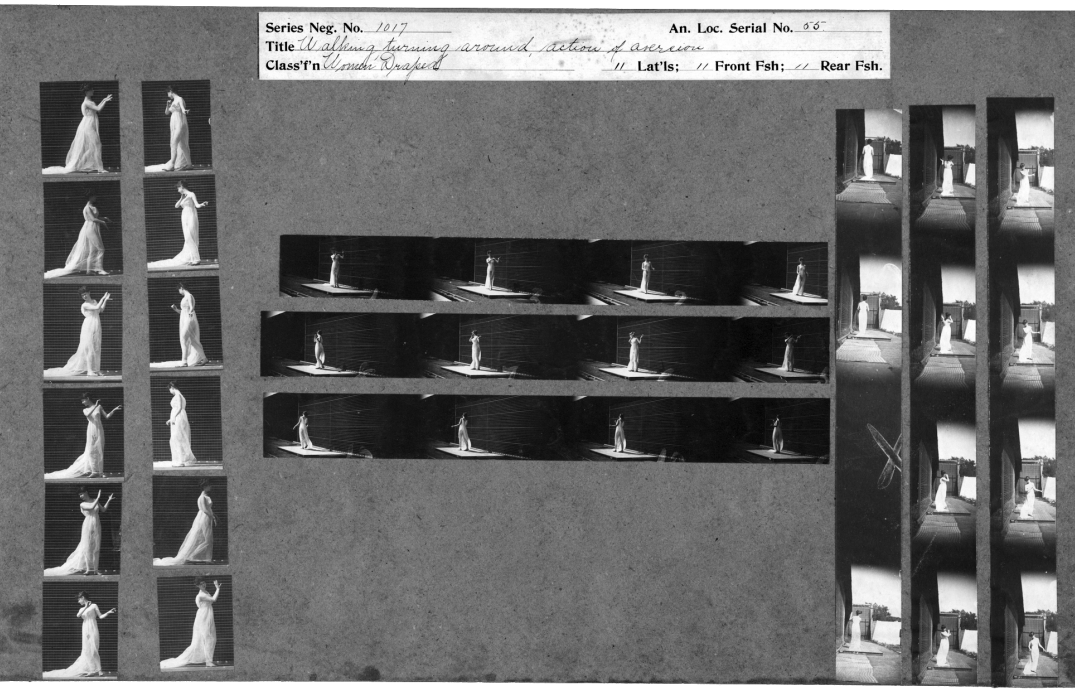

Fig. 2: Cyanotype for Plate 55 of *Animal Locomotion*, National Museum of American History, Smithsonian Institution.

Muybridge's cropping and enlarging are the first difference we can see between the facts presented to the camera and the picture of them he presented to the viewer. The cyanotypes make visible what has been eliminated in the collotypes, revealing the project's sites and working methods, camera placements and positioning, the details of the outdoor studio, the black and white grid (we can see now that it is actually a mesh of white threads), the white reflectors, and the as yet unnamed assistants. The whole technology of construction is exposed in the cyanotypes, and all of it is concealed in the final print. Here, in its most primitive form, is that urge to erase all traces of the apparatus. In Plate 55 »Walking and turning around, act of aversion«, for example, all the images match vertically, but the cyanotype reveals that the seamless grid actually conceals a gap: the third phase of the movement has been removed in each series of views.

A camera misfiring was responsible for the discrepancy in the position of the handkerchief between the third lateral and the third foreshortened view of Plate 202 »Dropping and lifting handkerchief«. To Muybridge it didn't matter that the position of the handkerchief was different in the lateral and the foreshortened view. What was critical was the *appearance* of congruency of the images in the print, the

appearance of a logical progression. In his catalogue Muybridge warned the viewer this way: »[I]n some instances it will be found that the number of phases of motion from each of the respective points of view do not correspond, some being omitted. This arises from the loss of negatives during manipulation. The subject being, perhaps, one of interest or importance, and impossible to duplicate, it has been included in the work notwithstanding the deficiency.«[11] But the viewer, warned to expect that an image in a sequence might be missing, would still have been surprised to find that such forbearance was expected for plates that were composed of disparate series such as Plate 299, »Playing with a ball« in which three quite different sequences have been assembled to make a single plate.

It is because the cyanotypes bear both a plate number and a negative series number – the number that Muybridge gave to each picture taking session, that we can reconstitute the original order in which he took the photographs, an order that is quite different from the order in which the plates were published. As published, *Animal Locomotion* resembles a nineteenth century atlas of human and animal movements. Its 781 plates, divided into eleven volumes, trace a logical progression from the simple walk to the run and jump and even more complex motions involving props. Muybridge's models – first the male, then female, child, disabled – are both nude and fully clothed. Finally, each of the 781 collotypes bears a number that can be used to identify, in the *Prospectus and Catalogue*, both the action photographed and, in the case of the men, women and children, the number of the model.

We can see that the first images Muybridge took, before his battery of cameras was working properly, were not sequences at all, but a kind of tracking shot made with six cameras placed in a semi circle around his subject. The shutters were synchronized to go off at the same time and the result is a sculptural presentation of a single pose, often assembled with others to make a striking vertical reading of images. Muybridge had devised this six-camera technique five years earlier at the end of his work for Stanford. In Philadelphia, he revived it to capture the motifs that obsessed him and would be repeated throughout the work: fluttering drapery, the frozen gesture extended, the holding of a lamp, but most importantly a picture that can be made only by a camera: the image of water frozen as it leaves a pail, the suspension of the body in space. Four of these early images are of Muybridge himself, naked with sinewy muscles, walking, sitting, sprinkling water and using a pickaxe.

With the first battery of twelve cameras, the first athletes appear. They were sent to be photographed by commission member and provost of the University, William Pepper, who wanted to develop a modern system of physical education and hygiene that could produce vigorous, evenly developed bodies that would

11 Ibid. p. 11.

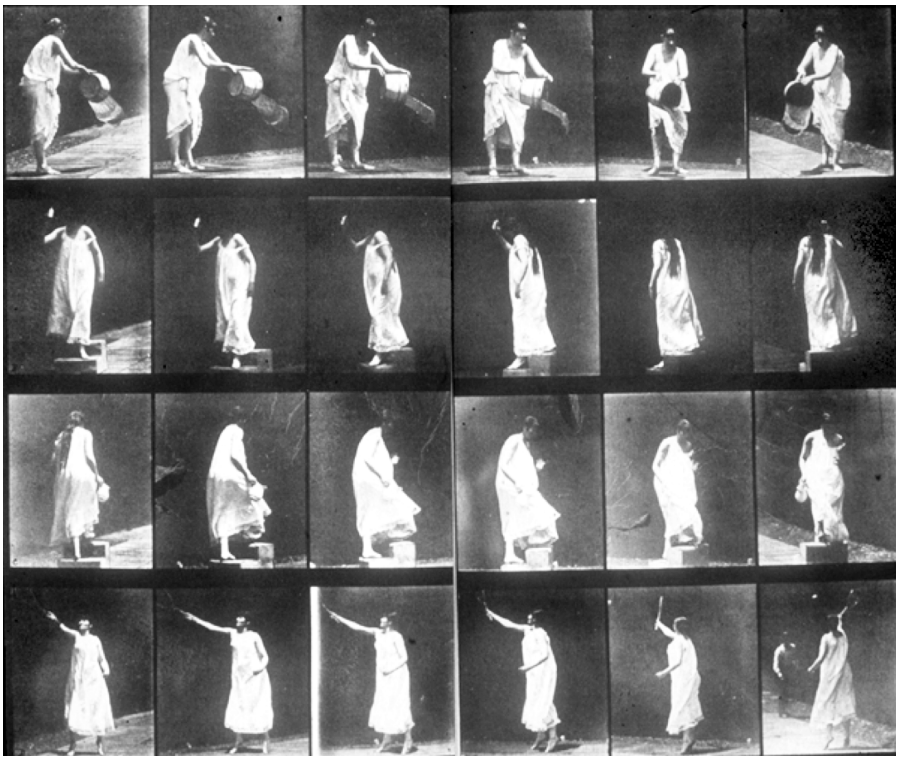

Fig. 3: Animal Locomotion Plate 524, A: Throwing Water from a bucket; B: descending step, C: ascending step, D: lawn tennis. Collotype, 1887.

withstand neurasthenia, or ›American nervousness‹, the result of the inhuman pace of modern life. For Pepper, the university athlete's physical prowess would be a manifestation of his moral superiority, representative of the values of the American way of life, especially if the athletes were amateurs, not professional sportsmen and Muybridge's photographs of the university's best athletes were intended to demonstrate the success of Pepper's methods. We also see the earliest cases of pathological locomotion, patients of committee member Dr. Francis X. Dercum. At this point markings have been made on the floor to aid in measurement.

Reconstructing the chronology of the work shows us that the grid appears for the first time in the background when the »mulatto and professional pugilist«, as he's described in the *Prospectus and Catalogue*, Ben Bailey, comes to be photographed.[12]

12 Ibid. p. 12.

Bailey was probably brought before Muybridge's cameras by commissioners Harrison Allen, Joseph Leidy and Francis Dercum himself who would become in 1889 the founding members of the American Anthropometric Society, an anthropological sub discipline that used the measurement of physical difference, such as skull size, to define racial types and hierarchies. Of 95 models who appear in *Animal Locomotion*, Bailey is the only black man. The grid is borrowed from that of British ethnologist J. H. Lamprey. Its simultaneous appearance with Bailey transforms him from a subject into an object, part of the taxonomy of race constructed by *Animal Locomotion*.

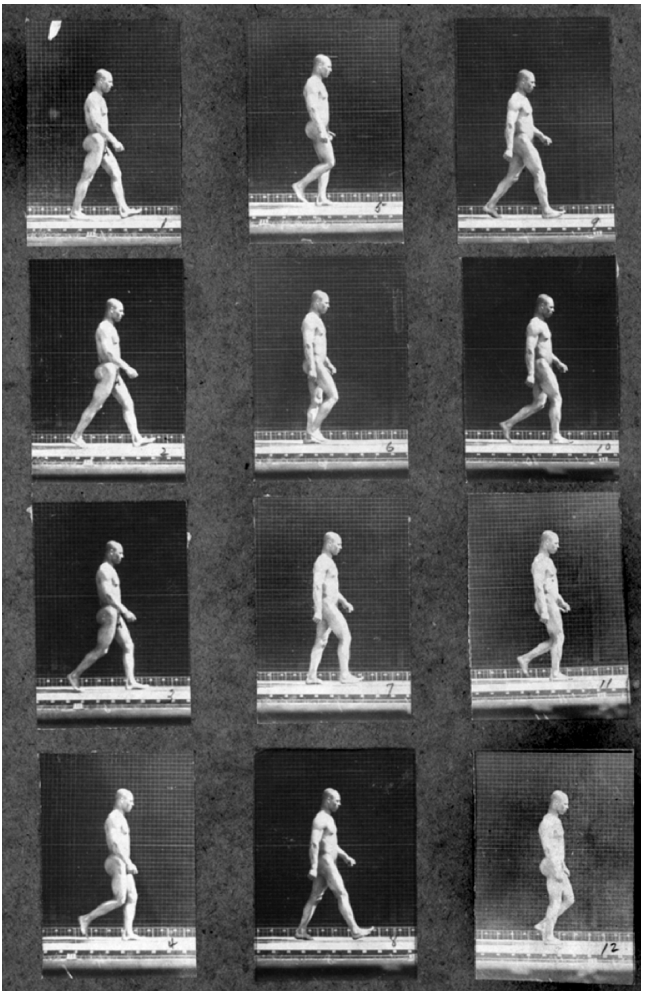

Fig. 4:
Walk, Male, Nude, Cyanotype for Plate 006 of *Animal Locomotion*, 1885. National Museum of American History, Smithsonian Institution.

Muybridge kept notebooks from the 2 of June 1885 until October when he stopped taking pictures and began the assembly of the plates. The commissioners paid little attention to what was going on. Dercum continued to send patients and Pepper athletes. But beyond the eyes of his commissioners, Muybridge focused on devising miniature narratives for his models including the »peasant girl«, »walking in a gale«, »stepping over brook with fishing rod« or »Euphrosyne«. It is in sequences such as these that we can understand Muybridge's preference for his apparatus. Rather than the overlapping abstractions of movement produced by a Marey-wheel camera, Muybridge's apparatus allows us to focus on the gestures and poses depicted in each frame of the plate; these individual frames raise the single image to the level of a work of art as each sequence extends into duration the spectacular nature of what his cameras can do.

Muybridge's choice of apparatus and the sequences of photographs he produced with it place *Animal Locomotion* firmly and ambiguously between art and science as well as between cinema and photography. The technology that made moving pictures available to us has nothing to do with Muybridge. Rather Muybridge's cameras and the sequences he made from them make visible his obsession with the depiction of narrative in the still image and his determination to use stop action photography made by single cameras so that he could expand the drama and spectacle of that gesture across the plate. The Marey wheel technology available to him would not produce these results. Muybridge understood the binary of acting and posing – the one unfolding in time as in the theatre or, as we are aware today, the cinema, and the other suggesting the stillness of photography or painting – and he exploits both in his work. Muybridge engages with the idea of performance *for* the image and performance *as* image. His cameras condense, displace and distill separate phases of movement into a fixed image that the viewer consumes both as a pictorial whole and then piece-by-piece as the eye and mind roam across the plate, assembling meanings. The images exist in an idealized realm of fantasy in which everyday laws of time and place may not clearly apply, just as they describe a social past, a social world that is lost to us. Muybridge's cameras produce a tension between the photograph as a record or evidence and an ideal narrative organization that conjures up an imaginary dimension. This tension is the aesthetic virtue of the images; it defines Muybridge as an artist and is most acute around the depiction of the human figure. Once the original production of *Animal Locomotion* is reconstructed, we can see that the interests of Muybridge's committee differ from the photographer's and the images he produced at their behest – the athletes, soldiers, disabled men and women and the animals – differ from those that he made for his own aesthetic ends.

Muybridge sold *Animal Locomotion* by subscription at one dollar per plate and although he succeeded in finding purchasers for many individual plates, he only

sold 37 complete sets. He gave the negatives and remaining prints to Pepper in the hopes that he could sell them to repay the $40,000 the University had advanced, about $800,000 in today's money.

In 1897 Muybridge returned permanently to his birthplace in England. He published two volumes in which he summarized his Philadelphia work, *Animals in Motion* (1899) and *The Human Figure in Motion* (1901), both made up of selected sequences and images from *Animal Locomotion* (1887). They sold well going into seven editions, but neither has been cited in the competing claims about the origins of cinema or even the more current issues of gender and race that preoccupy Muybridge scholars. By 1901, motion pictures, their technology clearly evolved from Marey's single camera, were firmly entrenched in the scientific laboratory, with its high-speed film and biological or astronomical subjects, as well as the theatre or fairgrounds with its vaudeville acts and other attractions.

But in the *Human Figure in Motion* Muybridge married his dead media to a new technology, the halftone process, and with it produced a new form of narrative.

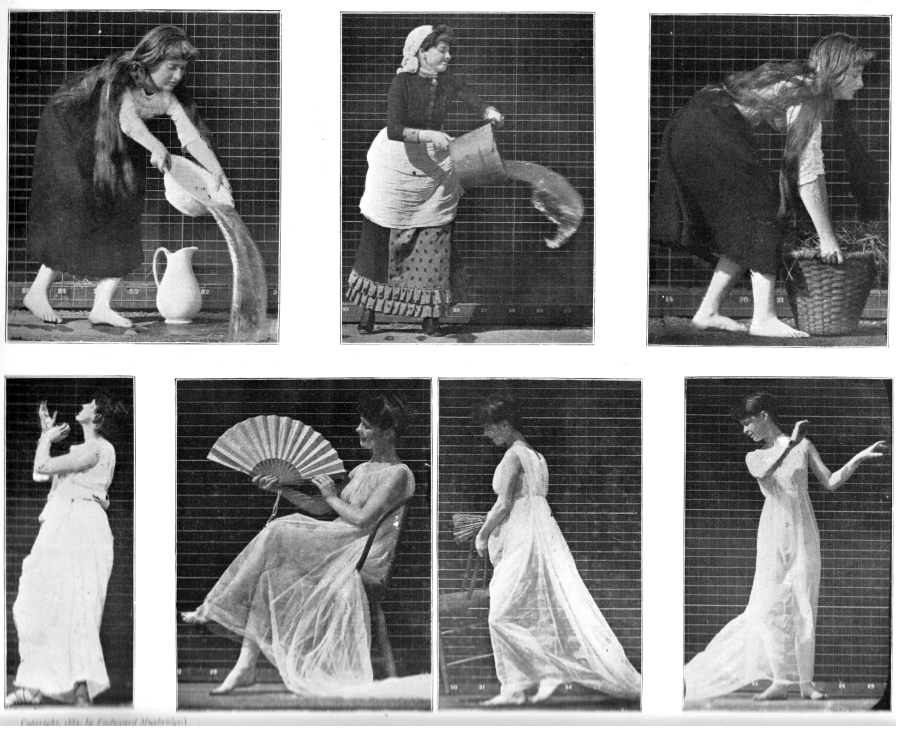

Fig. 5: »Miscellaneous Acts of Motion«. Page 257 of Eadweard Muybridge: The Human Figure in Motion, London 1901.

Patented in America in 1893 and increasingly used in newspapers and illustrated journals, the halftone allowed photographs to supplant woodblock prints in the illustrated press and heralded the modern picture magazine that would emerge around 1912. Muybridge's choice to re-issue his photographs in book form suggests he has a new viewer in mind: the reader. The first 172 pages of *The Human Figure in Motion* are reduced sequences of men, women and children from *Animal Locomotion*. But in the following 78 pages, with the title *Miscellaneous Phases… Selected From Various Seriates; And Reproduced On The Same Scale As Originally Published In Animal Locomotion*, the logic of the sequence has been almost completely abandoned. Muybridge has organized images from unrelated series into dynamic layouts, each picture affecting the reading of the one next to it or above or below it so that the reader can focus on the spectacular nature of the gesture and pose and the relationships between one image and another.

Here again we find pictures of the water, buckets, and basins that were so privileged in *Animal Locomotion*. But in this last incarnation of his project, Muybridge not only confirms his choice of apparatus, he points to a new use for it – the modern magazine – and a new viewer, a reader rifling through the pages in no particular order, stopping and starting at will, seeking not just information but the visual pleasure he had always known how to provide.