

The Photographic Work of E. J. Marey

Marta Braun

In the nineteenth century, the concept of historical transformation came to dominate the natural sciences. Through the discoveries of geologists, paleontologists, and zoologists, it had been proved that the earth and its inhabitants were not fixed elements in a static order ordained by divine providence. The dimension of time now had to be added to the perspective in which these were viewed. Darwin's *On the Origin of Species* (1859), to take a familiar example, demonstrated that man had a history reaching far beyond what would be accounted for in the Bible, while Lyell's *Principles of Geology* (1830) showed that the history of the earth was a history of continual evolution and change on a hitherto unimagined temporal scale. Nature, then, for the nineteenth-century observer, was no longer perceived as a fixed entity, but as something to be studied as evolving within a continuum of time.

But by the century's close, time was no longer just the container within which the transformation of nature and man occurred. Time itself had become one of the primary objects of scientific investigation. The study of movement, or, to put it more succinctly, the mechanical transcription of movement, played a central part in this investigation. The dissection and recording of the components of human and animal locomotion became a method of stopping time and reducing it to a tangible entity. Translated into images of movement, time became quantifiable in an empirical sense, in the same way that space, translated into linear perspective in the fifteenth century, was thought to be rationalized and made quantifiable. Time, then, was reduced to a measurable system of signs by reducing the language of movement to the method of notation.

The earliest attempts to construct machines that would convert motion into graphs and numbers were synonymous with attempts to forge a new science: physiology. It began in Germany where a group of young scientists, including Helmholtz, Ludwig, and Du Bois Reymond, set out at mid-century to create a kind of organic physics, a new physiology based on quantitative and experimental analyses. In their theoretical framework, organic functions were reducible to physics and chemistry, and as physics and chemistry they could be transformed into visual and mathematical data. Such a transformation required that a mechanical apparatus be substituted for the senses of the observer.

The initial attempts of the Germans were brought to

fruition by Etienne-Jules Marey (1830–1904). Marey was born in Beaune, a town in the Burgundian region of France. He had trained as a doctor in Paris but had the good fortune (extremely rare at the time) to attend lessons in experimental physiology, and it was in this unorthodox field that he decided to make his career. But, although Marey was a French physiologist, he nevertheless found the mechanistic conception of his field, as it was proposed by the Germans, more to his liking than the vagaries of ideas about “vital force” that still held some currency in France. In part, perhaps, this was because Marey was an enormously gifted tinkerer and understood that, within the German framework, physiology could be made into a unique combination of medicine and engineering. To this he dedicated his life, first refining the instruments of his predecessors—sphygmographs and kymographs—and then developing others on his own—odometers, myographs, pneumographs, and so on. These instruments, which he invented to see, touch, and hear for himself as well as mark down what was sensed, were the means by which physiology would become an exact science, the unquestioned equal of all the physical sciences.

Marey's accomplishment, however, lay not only in the invention of instruments and the refinements to those made by others, but in his adaptation of machines used for the most part in other fields and for other purposes. The most stunning example of the latter was his use of the photographic camera. Marey understood that photography, continually modified according to his needs, could be honed into an essential tool for the visualization of motion.

Marey and Muybridge

In the histories of the photographic investigation of movement, Marey's name is usually coupled with that of Eadweard James Muybridge; they are both known as pioneers in the recording of movement by means of the camera. They were exact contemporaries and may have been responsible for each other's work.¹ Both were involved in the technological or mechanical side of their medium; both investigated the broadest possible spectrum of terrestrial and animal locomotion; the work of both photographers had explosive repercussions in the world of art and science; and finally, although the imagery generated by the two men is different, we connect both their names with the invention of a revolutionary visual language that is still current today.

Perhaps because he was an Anglo-American (and our most widely used history textbooks are written by English-speaking authors), Muybridge is better known than Marey. In fact, Muybridge has been the subject of numerous articles, a successful exhibition, and three full-length monographs (Haas 1976, Hendricks

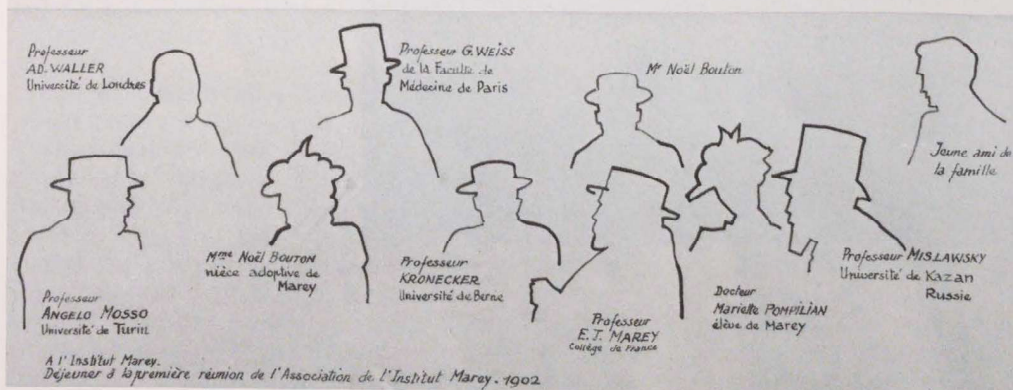
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Étienne-Jules Marey (1830–1904). The photograph was probably made in 1869, when Marey was elected to the chair of "Organized Bodies" at the Collège de France. Photograph courtesy of Professor A. Fessard.



Marey surrounded by family, friends, and distinguished colleagues at the first reunion of the founders of the Institut Marey, two years before his death. Photograph courtesy of Professor A. Fessard.



1975, MacDonnell 1972, Mozely 1972). His flamboyant and rather eccentric character (Muybridge is always introduced with the story that he murdered his wife's lover), the connection of his work with Leland Stanford and the early pioneering history of California, and the availability of his prints in a great number of public collections have created a vivid and quasi-legendary historical figure. Marey's photographs have never been available to collectors or museums; they were literally the raw data produced by scientific experiment and as such were kept in his laboratory. Perhaps for this reason his historical picture has always been underdeveloped by comparison. Although he was Professor of Organized Bodies at the Collège de France (France's highest bastion of intellectual achievement), president of the Academy of Medicine, Commander of the Legion of Honor, Esteemed member of the Academy of Sciences, and president of the Institute bearing his name, Marey's life does not seem to be the stuff from which romantic legend is created.

Marey's Contributions

Marey himself published 281 works, of which 9 were full-length books, yet the only one readily available in English is a translation of *Le mouvement* (1894).² His other translated work, *Animal Mechanism* (1874), has long been out of print. No full-length monograph has been devoted to him in any language, and those critical articles that have been written are few compared to the ones on Muybridge. The one recent exhibition of his work, in Paris in 1977, has an excellent catalog and bibliography (Fritzot 1977), but it has not been widely available and remains untranslated into English.

Our knowledge of Marey remains limited also because the study of his photography grows out of critical assumptions that accept his technological methodology only as part of a larger teleological history of photographic invention and stress the artistic value of his imagery by detaching it from its original context, which was rooted in positivism and nineteenth-century scientific thought. Thus, no inquiry as to the order in which Marey produced his photographs has seemed necessary.

Until now, the major clues to dating Marey's photographs came from his own illustrated reports of his experiments, which he published in the *Compte-Rendus* of the French Academy of Sciences and in the popular scientific journal *La Nature*. The editor, Gaston Tissandier, was a close friend of Marey's and also was the first to publish Muybridge's instantaneous photographs of running horses in 1878. Marey wrote four books, (Marey 1885, 1890, 1892, 1894) that explained and illustrated his chronophotographic method, but these were written thematically, grouping

together experiments that were often done over a number of years. Also, toward the end of his life (Marey 1899, 1900), Marey rearranged the real chronology of his photographic inventions: in order to provide a logical transition from the fixed plate camera to the film camera, he placed the photographic rifle (which employed a moving plate) between the two in time. Inevitably, some historians have followed his false lead.

Given the comparative obscurity into which Marey and his work have fallen, it was understandably exciting when nearly all his original negatives came to light in January 1979. This was an extraordinary discovery, because at last it became possible to work out a definitive chronological account of Marey's photographic experiments.

Chronology of Marey's Experiments

All the records of Marey's nonphotographic research into locomotion, as well as his photographic instruments, negatives, prints, and documents, were originally housed in the "Station Physiologique," the physiological station in the Bois de Boulogne on the edge of Paris. This laboratory, created for him by the Ministry of Public Instruction in 1881 and attached to his chair at the Collège de France, was torn down in 1975³ to make way for the construction of the Roland Garros tennis stadium (France's answer to Wimbledon). After being cataloged,⁴ all the Marey material—except for two volumes of prints and some films⁵—was sent to the Musée des Beaux Arts in Beaune. Only 133 negatives existed among all this material.

In 1979, the tennis stadium was slated for expansion and the last remaining building on the site, the Marey Institute, had to be demolished. The Marey Institute had nothing to do with photography. It was a central bureau for the standardization of physiological instruments constructed in 1902 with international public funding. Like the station, the Institute was built on land rented from the city of Paris. It was given Marey's name because he had led the commission that called for the creation of such an institute and of course because he was the preeminent figure in the field of physiological instrumentation in the nineteenth century.

The Materials

It was under the roof of this building that five wooden crates were found by the wreckers. They contained the manuscripts of his books, the receipts for every purchase made at the physiological station until 1902, a box of films (not by Marey), 550 glass diapositives that he used in his lectures at the Collège, and 1,500

glass plate negatives. Obviously these crates had been taken from the station and hidden at the Institute, although no one knows when or why. The crates were removed to the offices of Professor Albert Fessard in the Collège de France. A neurophysiologist who pioneered the first work in encephalography in the thirties, Fessard also had been the last director of the Institute. He had a lifelong interest in Marey and had been responsible for the dispersion of the material from the station in 1975. It was with his help that I began to classify the material which had been discovered and to catalog the negatives,⁶ which involved printing them all.⁷ At this point, almost by accident, another, smaller group of Marey's negatives came to light. They were in storage at the Photothèque of Paris, but their provenance was obscure and they had never been cataloged.⁸ These were classified according to the system that was set up at the Collège and printed.⁹

The Negatives

The first group of negatives to be identified was a numbered series of 13 × 18 cm. plates. These are enlargements, made by projection, of the shot that Marey considered the best of each experiment, and the source of all the prints that we know to have been made at the station from 1882 to 1889. The whole series originally must have consisted of 463, which is the number of the last negative found.¹⁰ Including those 48 negatives sent to Beaune in 1975, 295 of the original series remain intact. Some of the missing negatives, however, were described from existing prints that had been made from them. Since Marey had chosen the illustrations for his books and articles from this series, many of the images were known. Others were less familiar, since the prints made from them were never published. The whole group forms a chronicle of the activities of the station, including the installations, machines, and instruments used and the methods and subjects studied.¹¹

The rest of the negatives are of various sizes. They are the actual chronophotographic experiments in the movement of men, animals, and objects. Working on the assumption that this size variation was determined by changes in Marey's apparatus and technique, I was able to establish the progressive modifications Marey made to his cameras and to the set-up at the station as well as to determine the existence of a camera he used from 1886, about which he remained silent.¹² These changes produced at least three major groups of negatives, apart from a group of 23 circular and octagonal plates made with the photographic gun in 1882. These groups, with the dates I have assigned to them, are as follows:

Group 1. 55; 13 × 3 cm. plates made from 1882 to 1883

Group 2. 250; 9 × 6.5 cm. plates made from 1883 to 1886

Group 3. 380; 9 × 12 cm. plates made from 1886 to 1901

There were 55 additional negatives of all four sizes found in August 1983 in the possession of the Cinémathèque in Paris.

Marey as Photographer

Marey's prephotographic work was predicated on the belief that the machine provided an infallible extension and improvement of the human faculties of observation and representation. Although he had trained to be a doctor, his chosen field was physiology and his contribution to this field was the "Graphic Method": the invention and perfection of machines which themselves gathered the components of movement (imperceptible to the human eye) and translated them into graphic form.¹³ This translation of an organic language into a figurative form is the basis of Marey's interest in photography. When he began to make photographs in the early spring of 1882, he was not abandoning his Graphic Method, but simply adding a new machine to it. The camera, which seemed to inscribe in minute detail with absolute precision, left a permanent record without the necessity of laborious handwork. The photographs could be enlarged to life size, and measurements could be taken from the data they furnished. Most important, photography was a method of delineation that did not interfere with the subject's movements and demanded no motive power from the subject.

The Photographic Gun

Marey's first attempt to construct a photographic machine that would supplant his graphing machines resulted in the photographic gun.¹⁴ Based on a similar machine created by the astronomer Janssen in 1874, the gun incorporated the theoretical basis that Marey saw as absolutely necessary for any photographic analysis of movement: a singular unified viewpoint provided by one camera and one plate. The gun, which incorporated a circular plate moving 12 times per second in front of a lens within its barrel, yielded images that were akin to Muybridge's sequences—12 instantaneous serial photographs.¹⁵ But Marey's subject matter was much more limited than Muybridge's. Of the 24 negatives and 3 positives that were found, 3 are of birds and the rest picture horses and carriages taken from his window in Paris as well as views of waves and rooftops done in Naples. Probably more existed, but not many, for Marey used this gun only until the summer of 1882.

It has been thought (Scharf 1976:64) that Marey

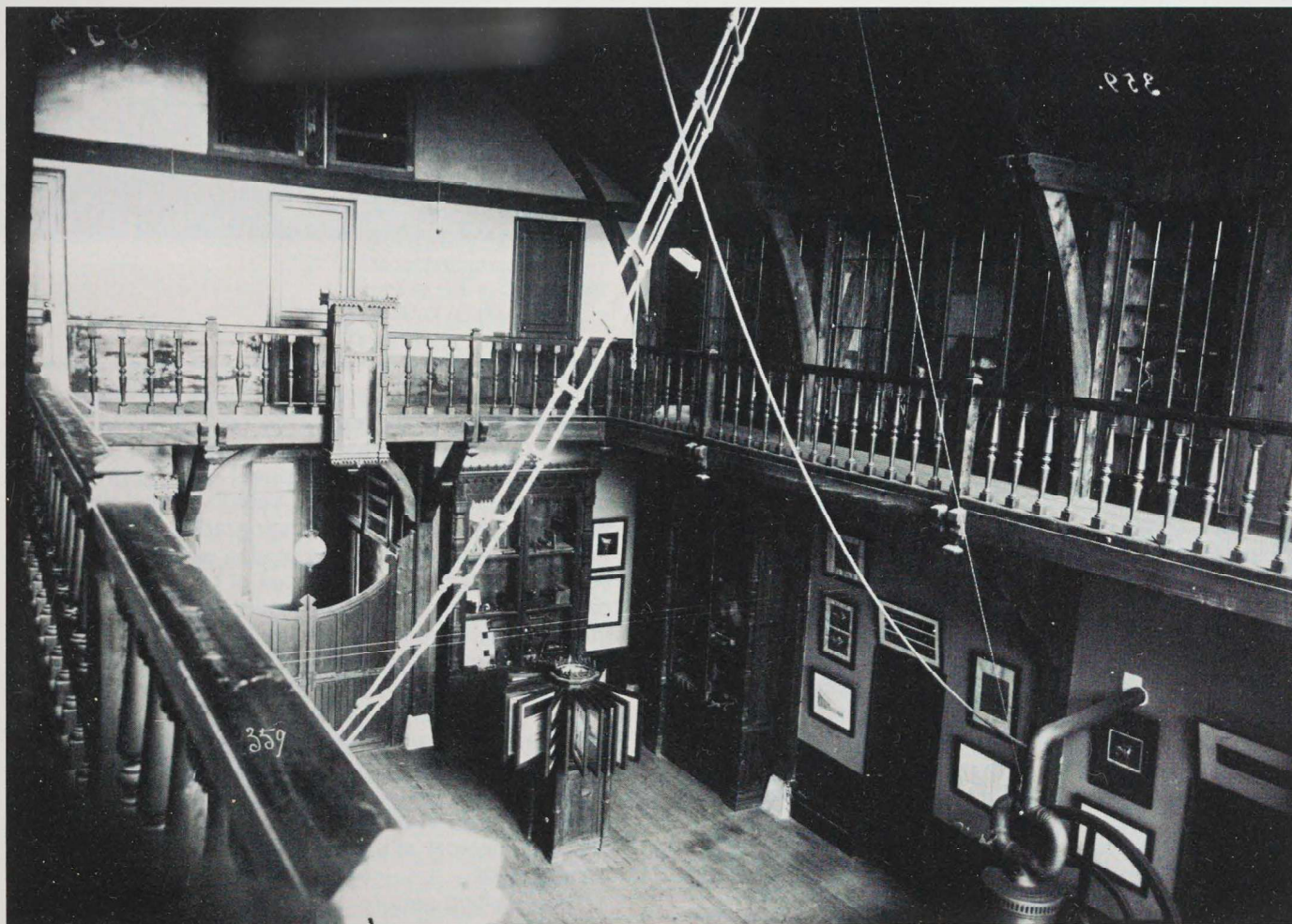


Figure 1 Interior, Principal Pavillion, Physiological Station (1887). Modern print from original glass plate negative, 13 × 18 cm. Cat. no. IIDd36 (Collège de France).

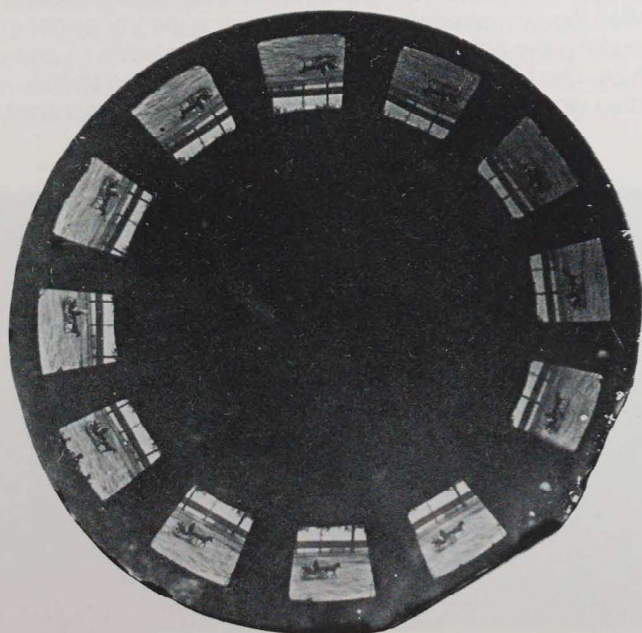
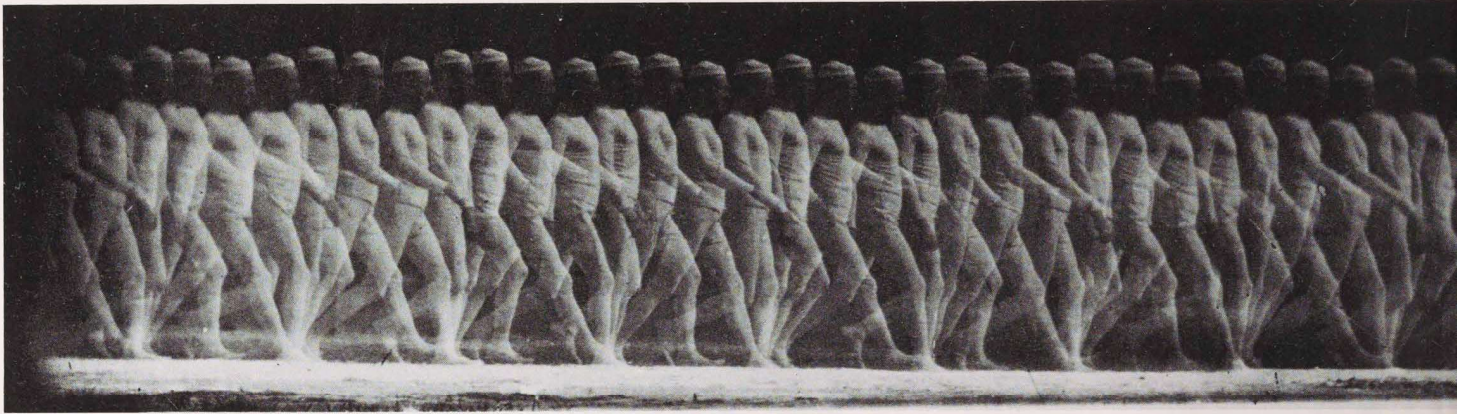


Figure 2 Horse and Carriage (1882). Modern print from original glass plate negative made with photographic gun, 7.5 cm. diameter. Cat. no. IVS17 (Collège de France).



perforated these glass discs in order to reanimate them in the phenakistiscope. The mass and weight of these plates would seem to make this notion doubtful. But the stripped emulsions from 6 plates that were found in an envelope with the other negatives may well have been used in this way.¹⁶ The appeal of synthetically recombining the same movement that had been decomposed by the camera was a fundamental one. Whether to control the results obtained by analysis or to furnish a clear demonstration of the phenomena under study, Marey's tendency to synthesize his experiments had been present from his earliest work in cardiology, when he had constructed artificial systems to illustrate each component of an experiment. In a larger sense, Marey, who was strongly influenced in this way by positivist doctrine, believed that the material of a vast synthesis leading to certain all-encompassing and fundamental laws would arise through the isolation, observation, and measurement of the constituent elements of locomotive functions.

The Single Camera and Elaborations

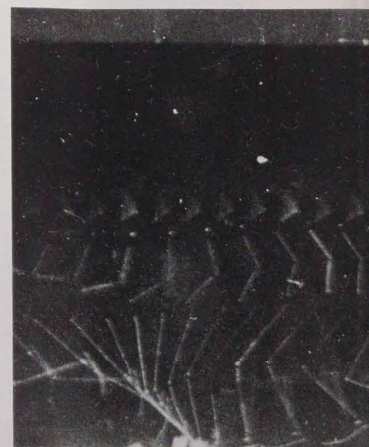
Marey abandoned the photographic gun in the late summer of 1882 for a new photographic system that

provided a kind of synthesis "in vitro": a single camera was constructed that dissected the movement into its component phases and distributed them over the surface of a single fixed plate. The first group of negatives (13×3 cm.) date from this initial phase of what he now called chronophotography. They are mainly of human subjects, but also include studies of horses and birds. In the images of human subjects can be seen both the first try-outs of the method and the gradual resolution of the problems inherent in it. At first, Marey had the subject, dressed all in white, move across a black shed constructed for the purpose. The lens of the camera stayed open while the light was intermittently cut at exact intervals by a slotted disc that revolved from five to ten times per second between the lens and the plate. Thus the motion was registered in equidistant phases, distinctly showing the trajectory of the movement as well as its component parts.

The resulting picture, however, could be confusing when the forward movement of the subject was slow. Walking, for example, caused heavy superimposition, making the articulation of the limbs impossible to analyze. Decreasing the rate of revolutions of the shutter disc would have solved this problem, but the resultant

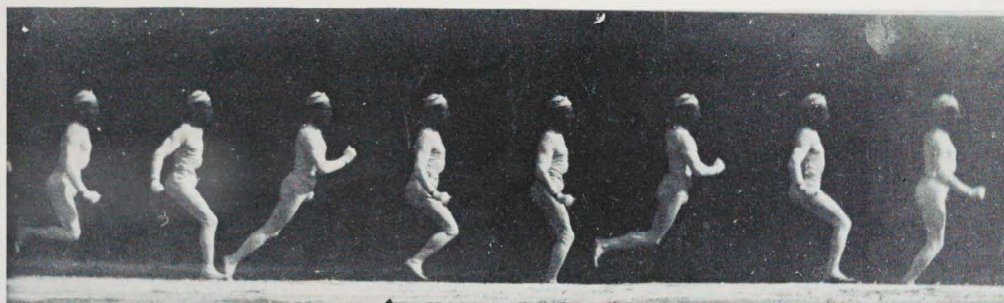
Figure 5 Human Locomotion: Run (1883). Modern print made from original glass plate chronophotographic negative, 13×3 cm. Cat. no. III Ba15 (Collège de France). The new black shed that Marey had built in the late summer of 1883 was wider and deeper than the one used previously (for Figures 3 and 4), and its back wall was covered with a black velvet curtain 2.50 meters wide. The moving figure

was dressed entirely in black, and thin wooden strips, to which were attached metal buttons, were sewn to the costume.





◀ **Figure 3** Human Locomotion: Walk (1882). Modern print made from original glass plate chronophotographic negative, 13 × 3 cm. Cat. no. IIIBa3 (Collège de France).



▲ **Figure 4** Human Locomotion: Run, Single Leg (1883). Modern print made from original glass plate chronophotographic negative, 13 × 3 cm. Cat. no. IIIBa14 (Collège de France). The subject of

the photograph is Demeny (as in Figure 3); half of his body is covered in black to diminish the superimposition of the limbs.

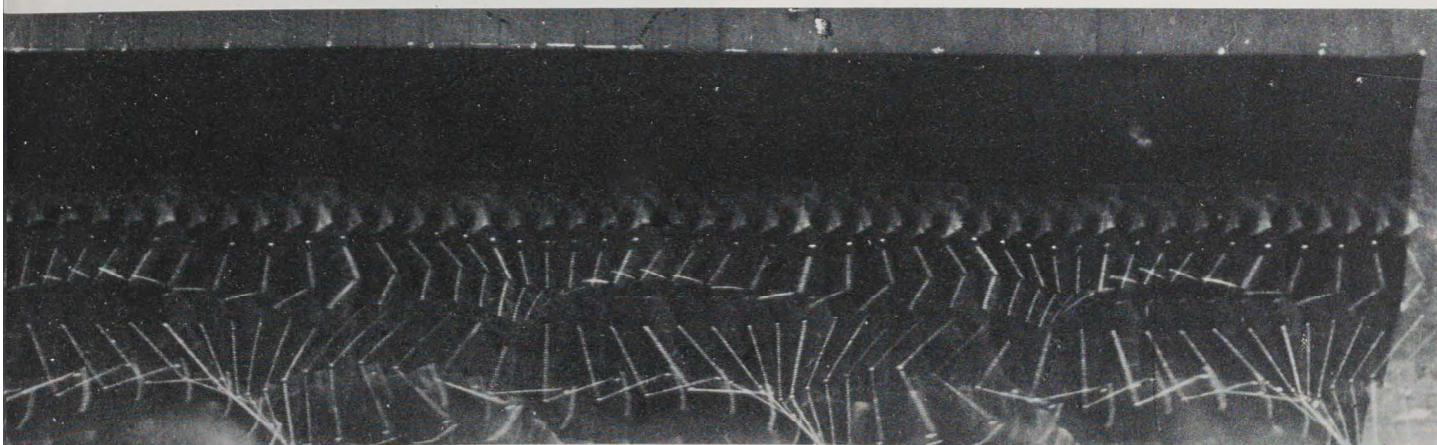
loss of the intermediary phases of the movement would not have been compensated for by the increased visual clarity.

In fact, Marey kept the mechanics of the method intact and began to work on making the subject itself provide the necessary clarity by devising a method of photographing movement in its own right, detached from the performer. He did this by removing those parts of the figure that would detract from clarity. The first step in this process was to dress the figure half in black and half in white, obliterating the distracting parts. Then, because the limbs were still unclear, he reduced the figure to a combination of lines by clothing it all in black and placing strips of wood studded with metal buttons along the legs and arms. The subject was thus, in the literal sense, transformed into a graphic notation.

By the end of the following summer (1883) Marey had also built a new black shed. It was wider and deeper than the first and a black velvet backdrop was hung against its interior wall.¹⁷ The second group of negatives (9 × 6.5 cm.) reflects this and other changes made the following year. For the experiments begun in the spring of 1884, Marey had a new camera constructed, which was incorporated into a

wagon. The wagon was set on a rail perpendicular to the black hangar so that the distance from the camera to the subject could be varied. The shutter disc was larger than before—1.10 m. in diameter—and was placed just behind the lens housing. Interchangeable discs with from one to ten slots were made for this camera, and the fifth or tenth slot was larger than the others so that demarcation lines could be inscribed automatically on the negative. The squarer negatives made during this and the following two years are sharper; often the number of slots in the disc shutter and the number of revolutions it made per second are inscribed on the emulsion.

Marey's subject matter now included ballistics: the trajectories of balls and sticks as well as the vibrations of rods were photographed, and he continued to experiment with birds, horses, and, of course, men. Among the men are soldiers from the École de Joinville, the French military academy. They mark Marey's longstanding work with the Ministry of War, where his investigations were used to improve training methods in the army. Marey also photographed his assistants: François Franck, who would take over his chair at the Collège de France upon his death, and Georges Demeny, Marey's chief aide, whose ac-



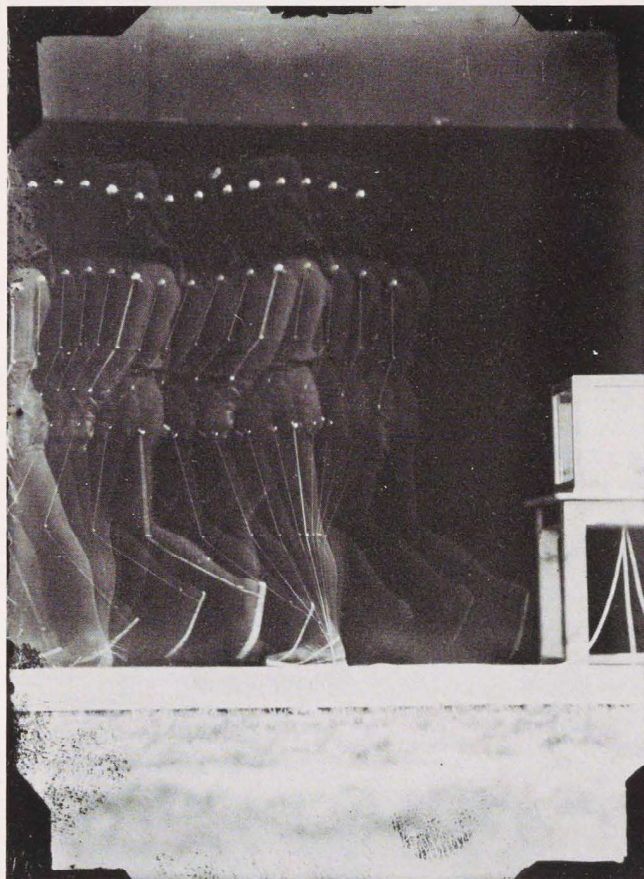
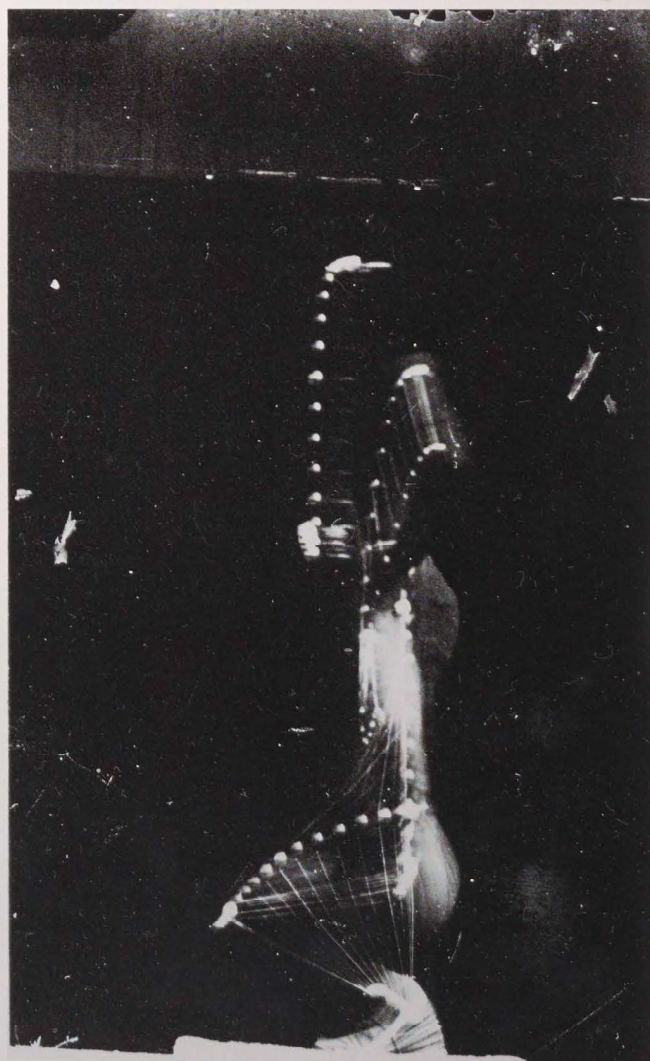


Figure 6 Human Locomotion: Walk (1884). Modern print from original glass plate chronophotographic negative, 9 × 6.5 cm. Cat. no. IIIBc14 (Collège de France). The metal bands and buttons are now sewn directly onto the costume, and a hood has been added to cover the head. The fifth slot of the shutter disc is wider than the other four, so that every fifth line and button stands out. The subject, again, is Demeny; he is attached to the dynamometer on the right of the picture.

Figure 7 Human Locomotion: Jumping in Place (September 18, 1884, inscribed on negative). Modern print from original glass plate chronophotographic negative, 9 × 6.5 cm. Cat. no. IIIBd5 (Collège de France).



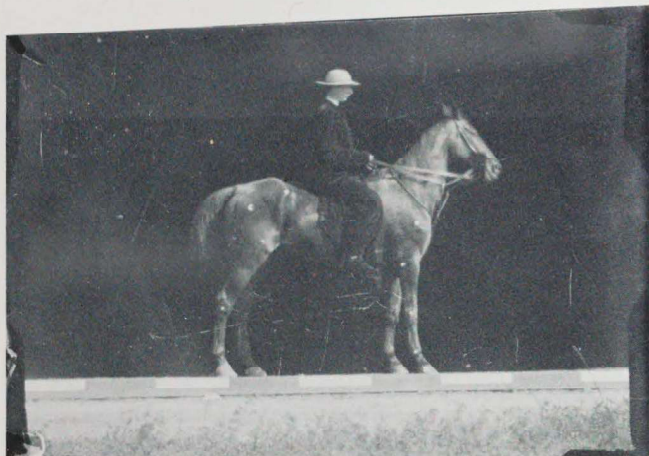


Figure 8 Horse and Rider (1885). Modern print from original glass plate negative, 9 × 6.5 cm. Cat. no. IIICbD2 (Collège de France).

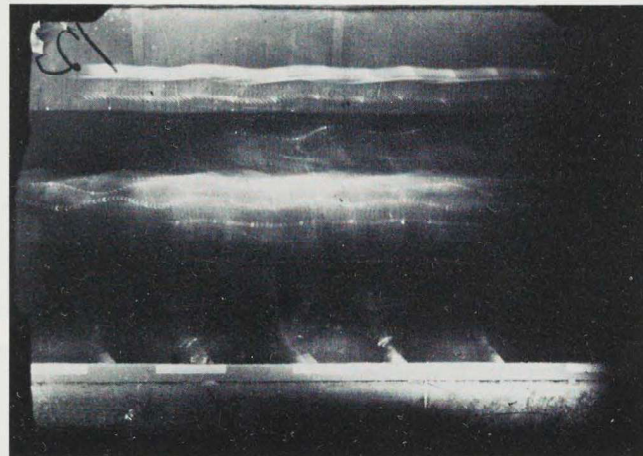


Figure 8A Animal Locomotion: Horse, Trot (1885). Modern print from original glass plate chronophotographic negative, 9 × 6.5 cm. Cat. no. IIICbD13 (Collège de France). The horse and rider from Figure 8, in motion.

tivity at the station is described in more detail below.¹⁸ Demeny was responsible for assembling the data produced by the dynamometer, an instrument to measure muscular force, to which the subjects are hooked up in many of these negatives. Another of Demeny's tasks during this period was the compilation of information given by the camera and dynamometer on the amortization of shock in different kinds of jumps and the trajectory of the center of gravity of the body during jumping. The images of these jumpers have never before been seen; they were known to us only through the reproduction of diagrams made from them, which were published in 1885 (Marey and Demeny 1885).

With his photographic study of the gaits of the horse, undertaken during this same period, Marey hoped to verify the accuracy of his nonphotographic work carried out more than ten years earlier (Marey 1873). He had both white and dark animals brought to the station and increased the blackness of the dark horses' coats by painting them with lampblack. Since wooden strips and metal buttons could not be sewn to their coats, he used small bits of paper of varied shapes in order to distinguish their limbs. Elephants as well as horses were treated this way, but because so few negatives of elephants survive, it is probable that they were photographed mainly for the purposes of a comparative analysis. Like the photographs of the jumpers, neither those of the horses nor those of the elephants were considered sufficient unto themselves by Marey—he only published diagrams that were made by hand from the projected negatives.

By July 1886, Marey had begun once again to make changes to his installation. He built a third

black shed, making it still deeper, and added vertical and lateral curtains to it that could be used to reduce its dimensions when necessary. A tower was constructed on top of this hangar, built to hold a new camera (which produced a 9 × 12 cm. negative) with which overhead views could be made. These changes can be traced to Marey's ongoing experiments with birds. Marey was obsessed with flight. He believed (inaccurately, as it turned out) that manned flight was indeed possible if the mechanical laws behind the flight of birds could only be ascertained and imitated. His photographic investigations centered on the attempt to capture the trajectory of the bird's wing with the camera, but until this time his attempts had been limited. It was not possible to coat the feathers of the bird and attach papers to its wings; it was difficult enough just to get the bird to fly in a straight line across the black hangar. However, his new camera on the tower enabled him to take his experiments at least one step further. The overhead views it produced could be correlated with lateral views to give an idea of the trajectory of the wing in three dimension.¹⁹ From the information furnished by these photographs, Marey made sculptures in wax and had them cast in bronze. Not intended as works of art, these sculptures stand as yet another mode of synthesis. In 1887, men running and jumping were also photographed from above and again the results were used for sculpture, but after these were made²⁰ Marey seems to have abandoned the overhead view and the camera was brought down from the tower to replace the one in the mobile wagon.

Although he continued to photograph birds throughout 1887,²¹ even with all his improvements,

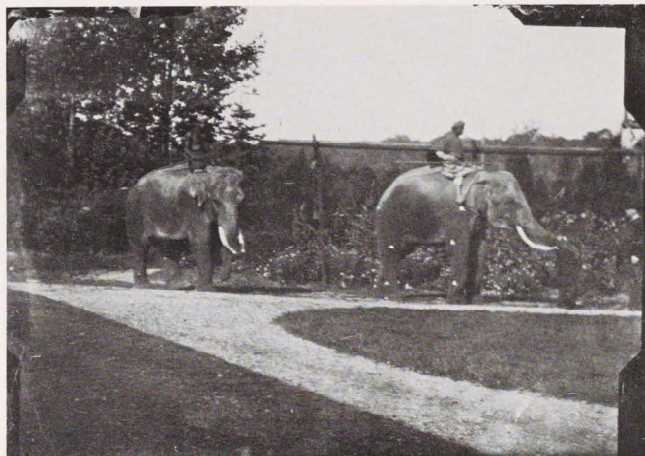
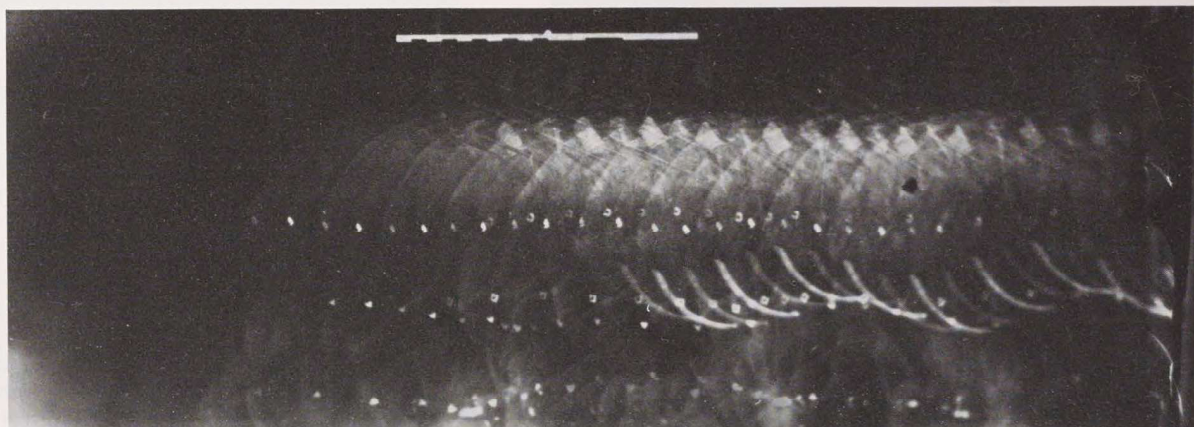


Figure 9 Elephants at the Physiological Station (1886). Modern print from original glass plate negative, 9×12.5 cm. Cat. no. IICh1 (Collège de France). The first elephant has been prepared with white pieces of paper on its joints for chronophotographic study. Marey can be barely made out on the right, holding the elephant's trunk.

▼ **Figure 9A** Animal Locomotion: Elephant, Walk (1886). Modern print from original glass plate chronophotographic negative, 9×6.5 cm. Cat. no. IICh9 (Collège de France).



Marey still could not photograph the execution of a movement that displaced only a part of the body in space—for example, a stationary figure waving a hand. As well, only those people or animals that could be made to perform in front of his black hangar could leave their image. Free flight and the movement of wild animals were outside his camera's range. Marey saw his problem. His chronophotography on a fixed plate had reached the limits of what it could do and he needed a new technology, one that would allow him the infinite possibilities of recording unlimited movement. In his search for a solution, Marey devised a camera incorporating an oscillating mirror, which punctuated the exposure by displacing the onward movement of the subject on the plate. With the exception of two negatives in which a man walks and jumps on the spot, the plates that survive from this short-lived method are all of fish and eels—Marey's first foray into aquatic locomotion, done in an aquarium he had constructed for the purposes of photographing its inhabitants.

Attempts to move the plate itself (theoretically by using the photographic gun as the model) were cut short by the advent of sensitized strips of paper on the market in the summer of 1888. These finally resolved his search. He replaced his fixed plate holder

with a bobbin of this paper and constructed a feeding mechanism for the camera that advanced and halted the strips in front of the lens in synchronism with the revolving shutter disc. The first subjects to be filmed with this new cine-camera were, not surprisingly, birds.

The mechanism that stopped and started the film (at up to 23 times per second) did not do so at equidistant intervals, making synthesis by projection unfeasible at this point. In order to synthesize the movement, Marey cut up the individual images and reattached them to strips, which he then put into a zoetrope. Even the zoetrope, however, could not be relied on entirely. It was too dependent on the subjective sensations of the viewer and was therefore inferior to the fixed plate, which directly delivered the geometric shape of the movement. Thus, while he sought to improve his cine-camera and extend its applications throughout 1889 and 1890, Marey never abandoned his experiments with the fixed plate camera. By 1890 he had developed a "double usage" camera, one that allowed the film rollers and the fixed plate chassis to be used interchangeably. The photographic negatives from this period (group 3 above; i.e., the same size as those done in the previous four years) benefited from the new shutter system created

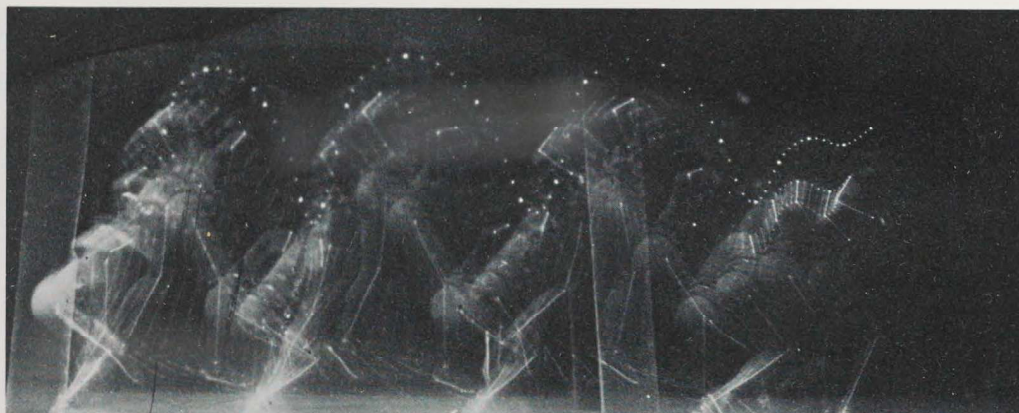
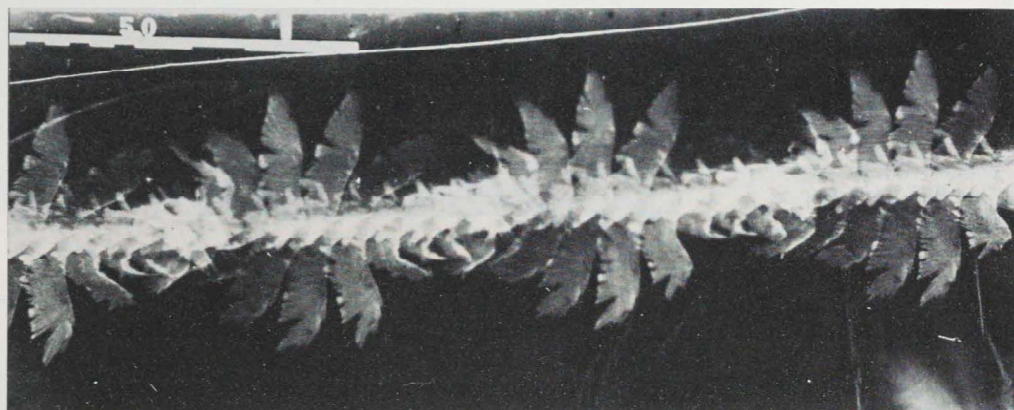


Figure 10 Human Locomotion: Repeated Jump (1886). Modern print from original glass plate chronophotographic negative, 9×6.5 cm. Cat. no. IIIBf4(2) (Collège de France). The vertical poles visible in the images dating from 1886 are the supports for the new shed and tower which Marey had built in July 1886.

Figure 11 Flight of Birds: Gull (1886). Modern print from original glass plate chronophotographic negative, 9×12 cm. Cat. no. IIICaA16 (Collège de France). The gull has been photographed from above with a new camera mounted on the tower built this year.



for this double usage camera: a second disc (with one slot), rotating in the opposite direction of the first, was added, and these were now placed directly into the lens housing. The increased clarity and control that this shutter system provided meant that it was no longer necessary to drape the figure entirely in black, and the external form of muscular change in human locomotion was now examined for the first time, in studies of soldiers and athletes (1890–1891), nudes meant for artists (1892), and even the logistics involved in riding a bicycle (1894). The publication of *Le mouvement* in 1893 in France marked the culmination of all the previous work Marey had done in terrestrial, aerial, and aquatic locomotion. After that year, the search for a way of projecting the images made with his film camera seems to have taken up more and more of Marey's time.²² The last investigations that he undertook with the plate camera, in 1900, however, moved him once again into the world of the inanimate. These were aerodynamic studies, photographs of the disturbances made by projecting planes in a miniature wind tunnel (the first of its kind), and they extended his study of the flight of birds into a study of flight itself. All 71 of the negatives from this work, which contributed so much to the subsequent development of manned flight, survive intact.

Demeny

Although the range of subjects that came before Marey's cameras was inexhaustibly varied, there were also 289 negatives among those found which, I discovered, were not by him and were cataloged apart. They were made by his assistant Georges Demeny and were attributed to him either because his special interests determined their subject matter or because they were published under his name alone.

Demeny, Marey's closest collaborator from 1882 until 1893 (when they separated bitterly over Demeny's patenting of an improvement on Marey's cine-camera),²³ was the executor of Marey's experimental conceptions. He, in fact, was the actual photographer and printer of the images made at the station until 1893. Demeny also ran the station alone from October to March every year while Marey was at his winter home in Naples. But Demeny also had his own quite specific interests. He wanted to construct a scientific basis for the training of athletes and gymnasts; he was one of the founders of physical education in France. The negatives that were cataloged separately belong exclusively to this subject area and reflect a route of inquiry that was distinct from

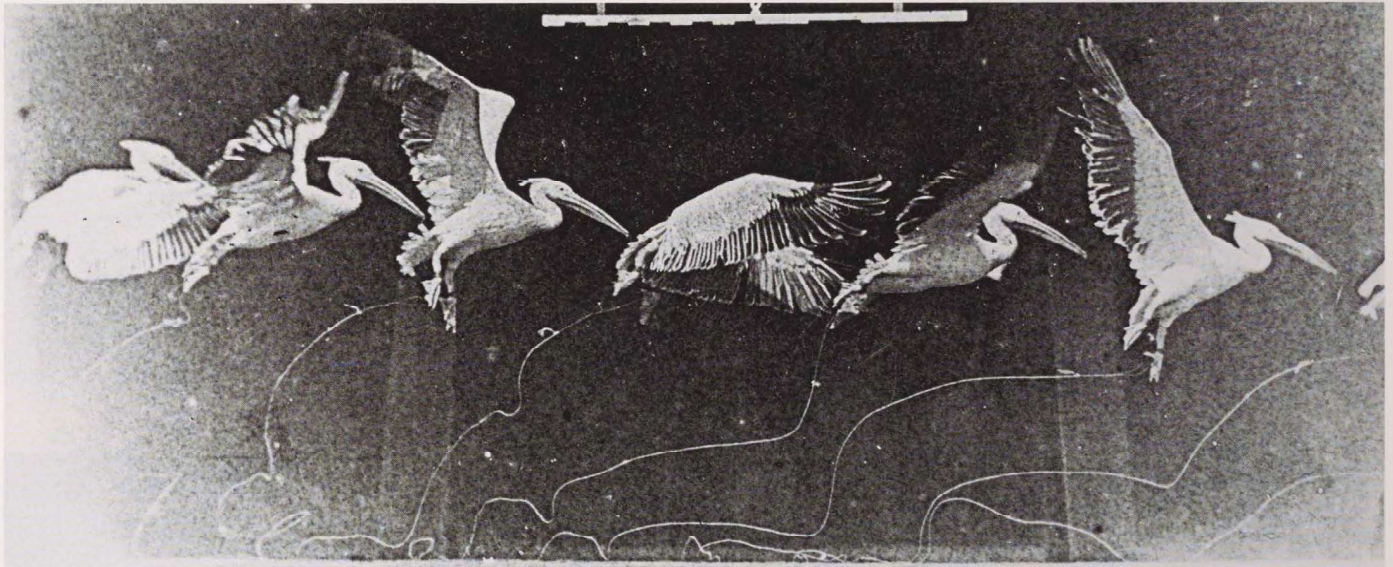


Figure 12 Flight of Birds: Pelican (1887). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. CaF2 (Collège de France). The strings leading from the pelican's feet are attached to weights in order to secure the direction of the flight.

Figure 13 Human Locomotion: Jumping in Place (1888). Modern print from original glass plate negative, 9 × 12 cm. Cat. no. IIIBw2. The chronophotographic disc shutter has been replaced with an oscillating mirror which punctuates and displaces the movement.



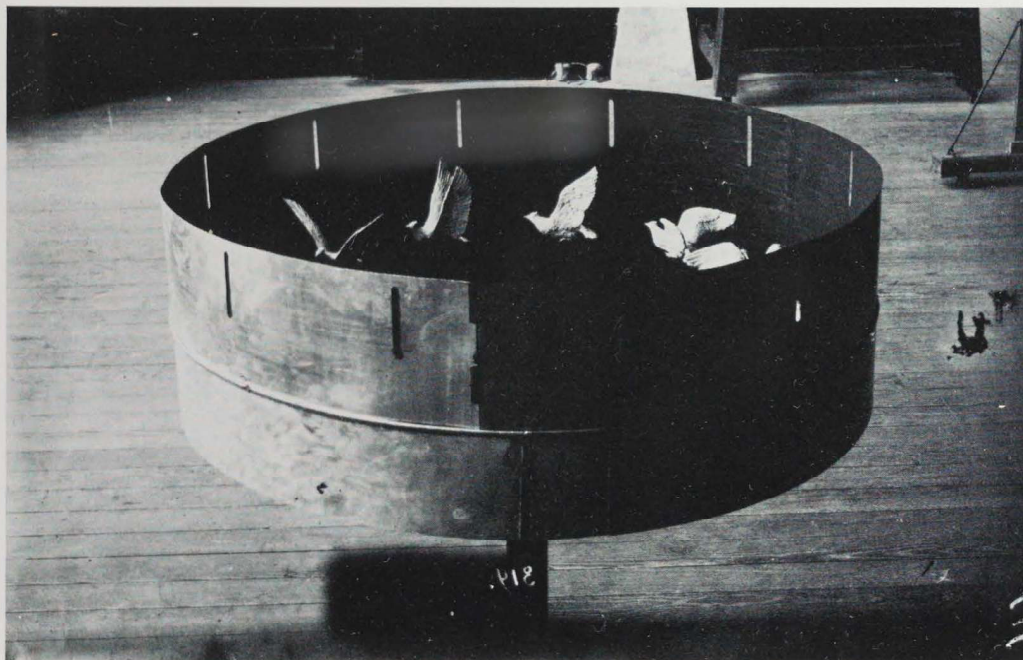
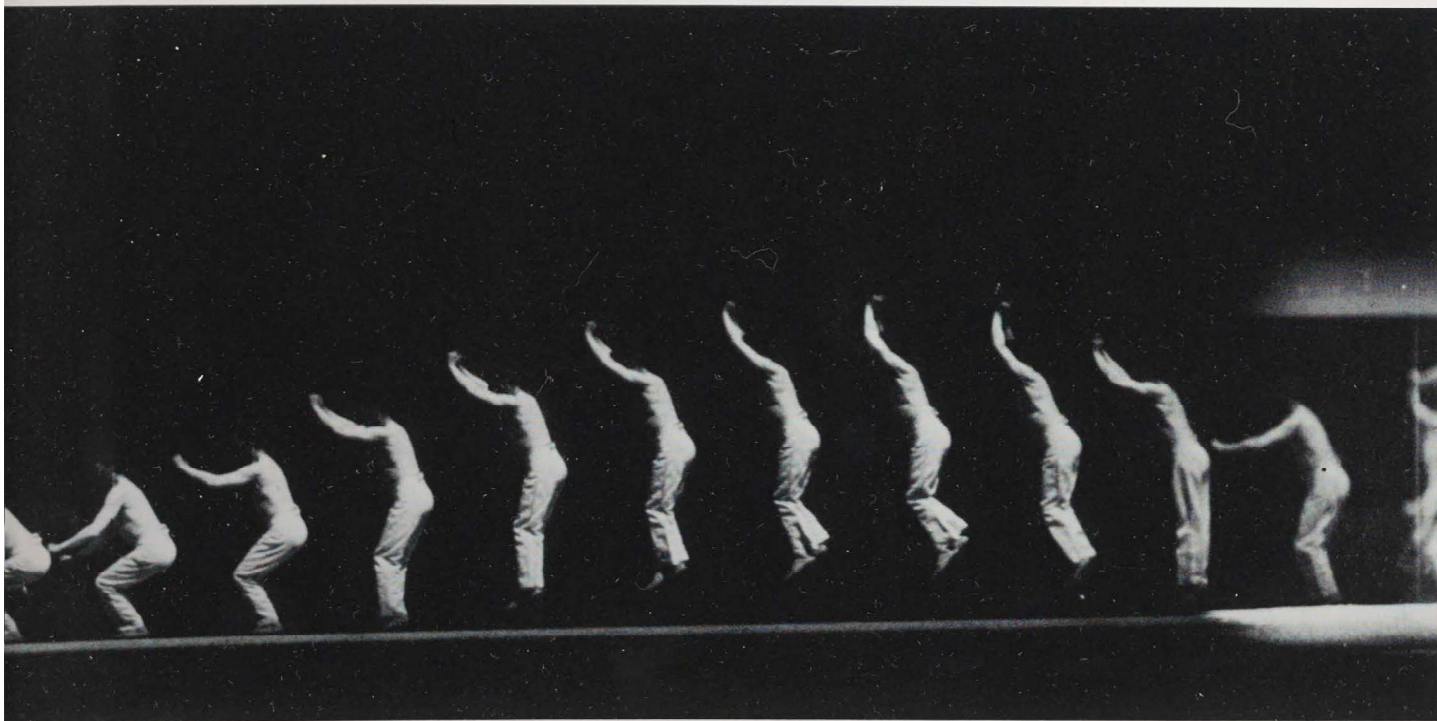


Figure 12A Zooetrope, Pigeon (1887). Modern print from original glass plate negative, 13 × 18 cm. Cat. no. IIcB1 (Collège de France). The three-dimensional plaster models were made by Marey from chronophotographs. A working replica of the zoetrope is in the Musée des Beaux Arts, Beaune.



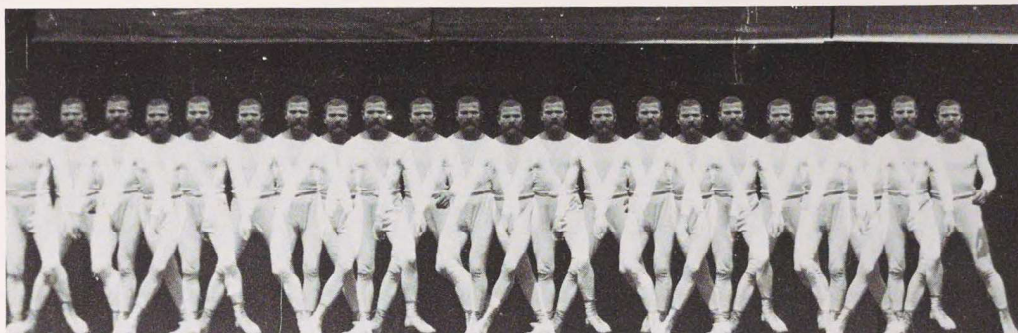


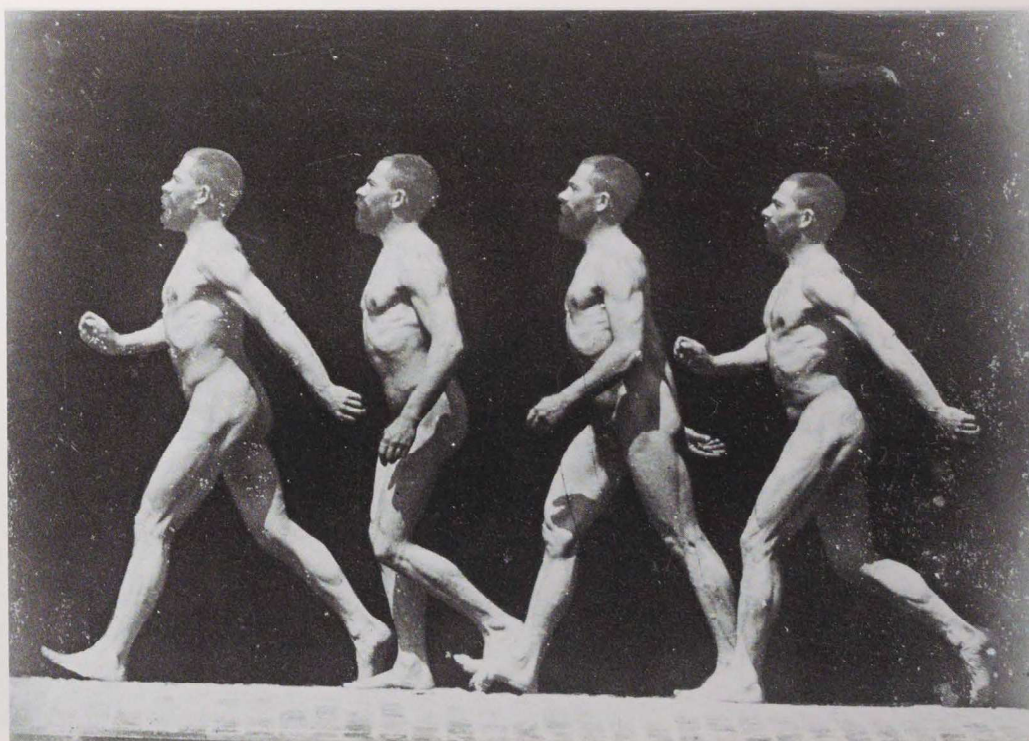
Figure 14 Human Locomotion: Walking Sideways (1890). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIIBj5 (Collège de France).

Figure 14A (right) Human Locomotion: Pole Vault (1891). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIIBl2 (Collège de France).



Figure 15 Human Locomotion: Walk (1892). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIIBz2 (Collège de France). This study is from a group of nudes for the use of artists. Others in this group were made on both fixed plates and films with the double usage camera.

Figure 15A (far right) Human Locomotion: Walking Child (1892). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIIBaa2 (Collège de France). Only two negatives from this session exist; there are no surviving prints, and the study is not mentioned in any of Marey's publications.



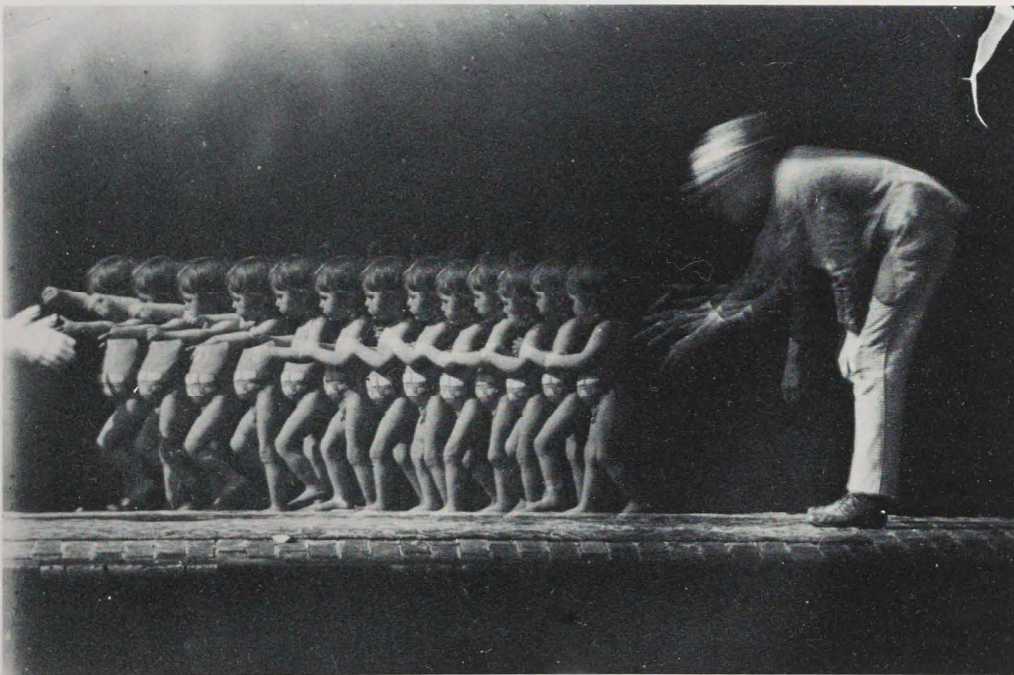
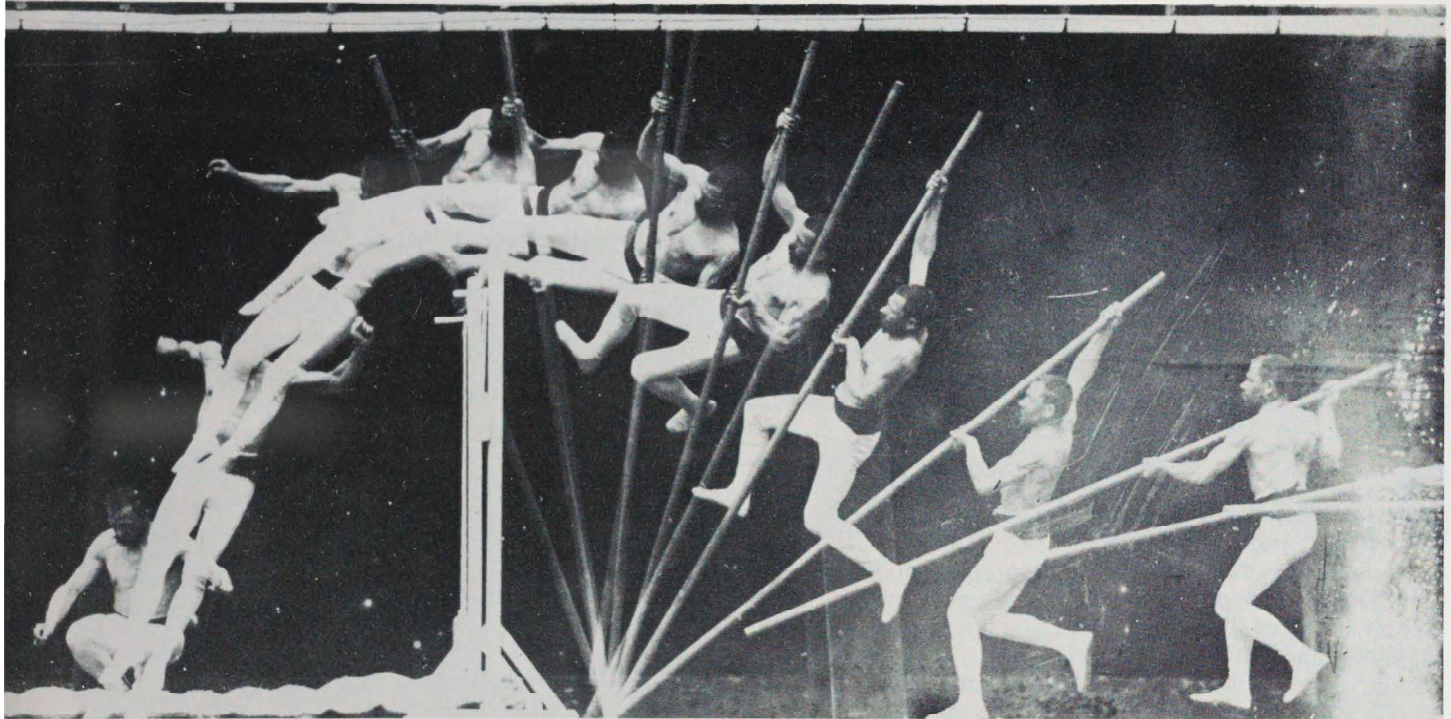
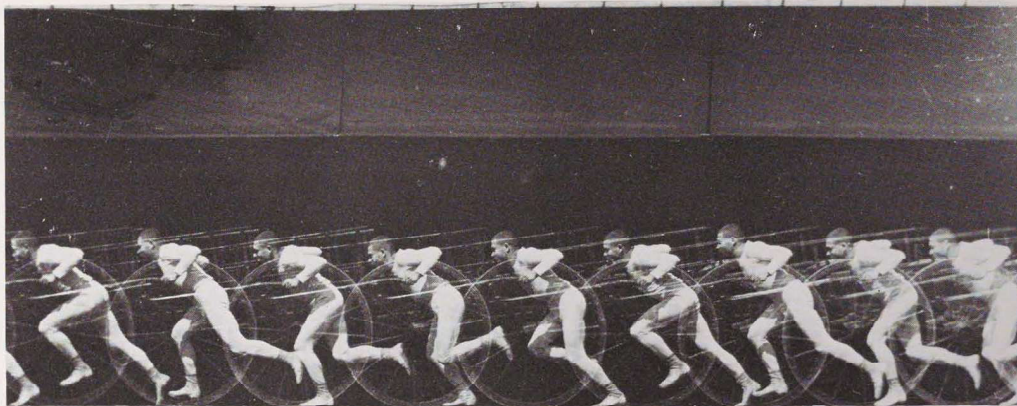


Figure 16 Human Locomotion: Pushing a Wheelbarrow (1894). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIIBaa16 (Cinémathèque Française).



Marey's. They are for the most part instantaneous, not chronophotographic, images.

However, among the chronophotographic studies by Demeny that were found, one deserves comment. It is an image of a lunging fencer and it has always been attributed to Marey²⁴ even though it first appeared in an article written by Demeny and even though Marey himself had ascribed it to Demeny in *Le mouvement* (p. 179).²⁵ This picture illustrates the essential difference between Marey's and Demeny's conceptions of portraying motion. Demeny had photographed the figure in such a way as to emphasize only the initial and final form of the movement and to blur the intermediate phases. It is this rendering of the imperceptible as blur that is totally at odds with Marey's endeavors, endeavors that Marey's own negatives demonstrate so clearly. This and other examples of Demeny's activity at the station have still to be investigated thoroughly, as does the very nature of his role there. Now that his negatives have been found, such an inquiry should be made much easier.

Conclusions

Marey's photographs, like the other products of his graphic method, were made to capture aspects of reality that cannot be perceived with the naked eye. As signs of the unseen inscribing itself, they mark the beginning of the twentieth century's foray into the invisible. To describe all the effects of that foray, however, would mean to construct a new history, one compiled from other histories which, although parallel, are not usually seen as congruent: a history in which Marey is the chief figure. Such an account would perhaps start with the history of cinema, which begins with Marey's chronophotography—the single camera and a slotted disc shutter. The commercialized industry of spectacle that was already in play during his lifetime was, however, not imagined by Marey. His interest was in the recording of what the eye could not grasp, not in the reproduction of what it normally perceived. But high-speed photography and the other scientific applications of film were clearly foreseen by



Figure 17 Movement of Air Around Inclined Plane (1900–1901). Modern print from original glass plate negative. Cat. no. IIIFa5 (Collège de France.)

him and were already germinating in his laboratory at the time of his death.

The world of scientific history would contribute the maturation of medical technology, which is rooted in Marey's experiments with graphing and photographing machines. Oscilloscopes, electromyographs, and electrocardiographs, to take some examples, are not, of course, conceivable without the prodigious electronic apparatus that is so familiar to us today. But neither would they have been possible without Marey's initial insistence on the dynamic character of the phenomena of life and his belief that machines could be constructed to seize them as they unfolded in time.

The worlds of labor management and aviation would seem to have little in common, but the theories underlying the two are both founded on applications of Marey's research. His method of separating movement from the performer, so that its form as it is described in space could be known, was the starting point for the time-motion studies carried out by Frank



Figure 19 Georges Demeny. Boxer (1891). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. IIBaa6D (Collège de France).

Figure 18 Georges Demeny. Oblique Suspension with Poles (1892). Modern print from original glass plate negative, 13 × 18 cm. Cat. no. IIBb3D (Collège de France).

Gilbreth in the United States in the first part of this century. Gilbreth was a pioneer in the mechanization of labor, making assembly-line production a reality. Marey's system of photographing the movement of a light bulb attached to the limb performing the movement was used by Gilbreth to refine the process of work. When the movements captured by the camera were analyzed, any errors that interfered with speed and productivity could be detected and corrected. Both Marey and Gilbreth studied the body as a machine, but, while Marey aimed to understand the laws governing its functions, Gilbreth studied it to rationalize those same functions and improve their efficiency.

In the field of aviation, Marey's analysis of the flight of birds and his aerodynamic researches provided a common ground for the rationalization of manned flight. The miniature wind tunnel that he had built in 1900 became the model for all subsequent aerodynamic investigations.

While the modern contours of cinema, medical engineering, labor management, and aviation were

being formed by elaborations of Marey's research methods and with extended applications of his chronophotographic analyses, the transformation of artistic perception and depiction was being effected by the images these methods produced. The familiarity of a generation of painters with Marey's photographs and the effects of the photographs on their art have already been described at length (Brun 1975, Crispolti 1972, Giedion 1969, Lista 1980, Rowell 1975, Scharf 1962, 1976). Two distinct methods of approach, however, can be pointed out. For some artists (Duchamp is the best example), Marey's photographs were an acknowledged compendium of figurative imagery that could be directly transposed into painting. In this transposition, the linear repetitive shapes of dissected movement are used as symbols for the interaction of time, space, and matter, and the canvas becomes the locus of their interpenetration.

The Italian Futurist painters also transposed Marey's imagery directly onto their canvases, but they did so while simultaneously denigrating the photo-

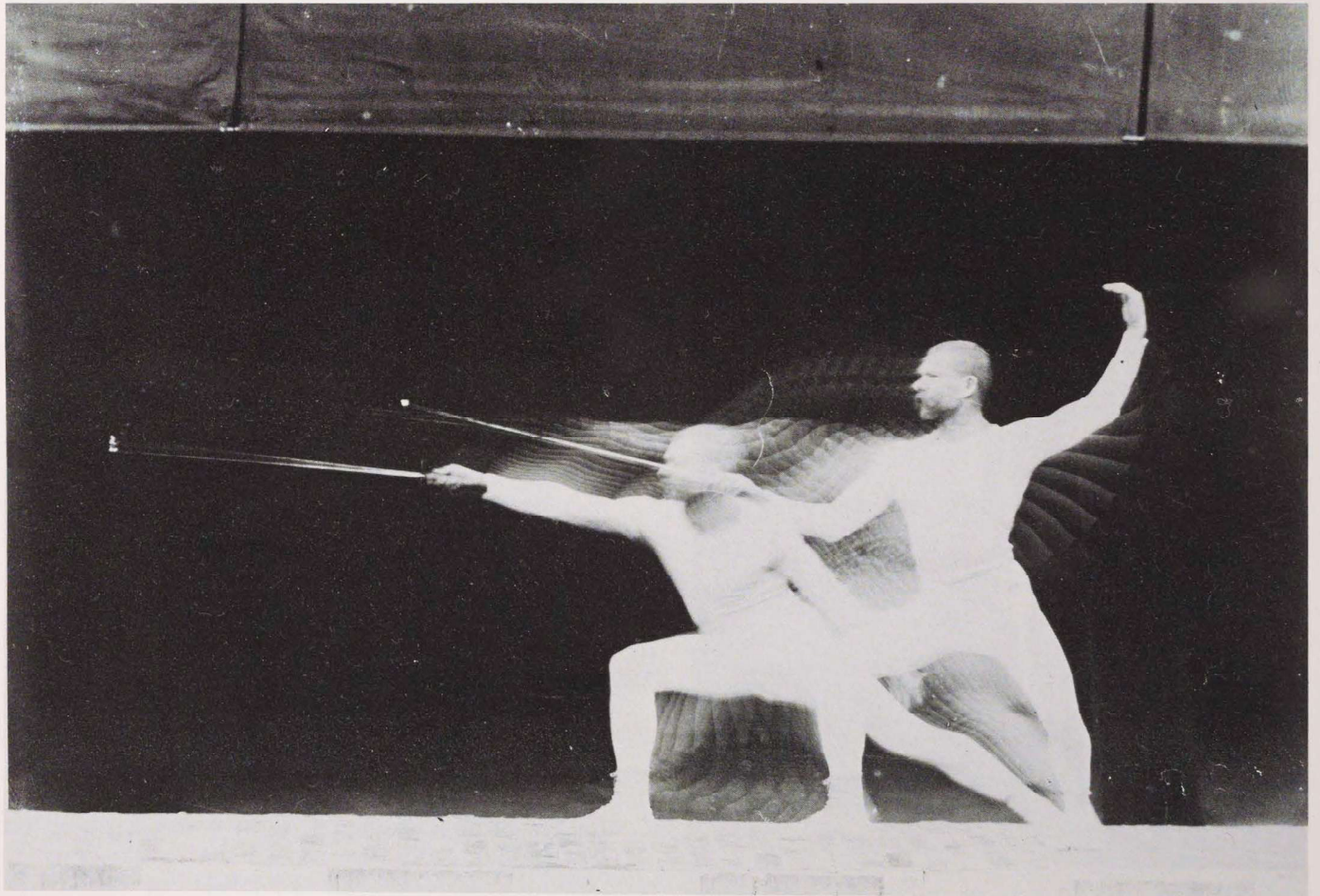


Figure 20 Georges Demeny. Fencer Lunging (1890). Modern print from original glass plate chronophotographic negative, 9 × 12 cm. Cat. no. CAIII Baa2D (Cinémathèque Française).

graphs themselves. Boccioni, who seems clearest in his response, saw his own work as an "intuitive search for the unique form which gives continuity in space." And such a search could not be carried out, he felt, by rendering the "repetition of legs arms and faces as many people have idiotically believed" (Apollonio 1973:93). For Boccioni and his colleagues, Marey's photographs were mere descriptions of movement; they did not express the emotional or psychic content of time. Thus, while it is hard to visually distinguish the Futurist descriptions of bodies in motion from Marey's—they both use the same two-dimensional linear repetition of legs, arms, and faces—conceptually, the Futurist program of giving plastic form to the dynamic sensation was created as a negative response to Marey's photographs.

The source of this negation is to be found in the writings of Henri Bergson. For Bergson (and thus for Boccioni, who studied his writing avidly), Marey's images were the perfect demonstration of what reality was not. Bergson denies the fundamental assumption inherent in Marey's methods and manifested in his pictures: that what is real can be made visible and thus known analytically. For Bergson, time, experienced as "duration," is the only reality. And this time cannot be distinguished from its content. It can be neither quantified nor made visible through the depiction of movement. Instead, it is a heterogeneous flux, indivisible and imperceivable by the routes of common consciousness.

Bergson and Marey were colleagues at the Collège de France from 1900 to 1904. They were also part of a group that met to study psychic phenomena, using Marey's instruments to record the manifestation of such phenomena. Bergson never cites Marey or his photographs directly, but it is evident that he was familiar with the work: Marey's imagery forms a recurring metaphor in his writing. He uses it to stand for the futility and incorrectness of all scientific or analytic thought which, "in its futile attempt to reduce time to a series of static moments accessible to separate study, creates fictitious entities, artificially carved out of the dynamic continuity" (Čapek 1971:90).

Bergson's new concept of time (which had its scientific counterpart in Einstein's theoretical considerations of the space-time continuum and was made manifest in literature by Joyce, Stein, Woolf, and the whole stream-of-consciousness movement) simply reframes Marey's work. It becomes the material of closure. That is, it marks the end of an epoch of scientific materialism. It is interesting, however, to see that the visual images Marey first produced, even within a conceptual framework that has proven scientifically and philosophically incomplete, still hold sway today. No other symbolic vocabulary has yet been found to describe movement or, as Marey put it, "the language of life itself."

Acknowledgment

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Notes

- 1 The exact connection between Marey and Muybridge (and Leland Stanford) is unclear. See Muybridge's letter to Marey in Mozely (1972:117; also 24, 92, and 132n).
- 2 This work was reprinted in the "Literature of Cinema" series by Arno Press in 1972.
- 3 After Marey's death in 1904, the station continued to function as a physiological laboratory under the direction of his students and assistants, and Marey's work continued to be housed there.
- 4 The main component of this inventory (cataloged by Prof. Fessard and by M. B. Marbot of the Bibliothèque Nationale of Paris) was a group of 840 prints—over half of which were duplicates—that had been compiled by personnel at the station into six albums. These albums served as the log books for the station; thus, the prints in them were the only prints made during those years. The prints were contacted from the 13 × 18 cm. negatives described in this article. The albums bore the following titles and dates:
 - I. 1882–1886 Methods and Techniques (present location, Beaune)
 - II. 1882–1886 Methods, Installations and Documents (Beaune)
 - III. 1886 Human Locomotion (Beaune)
 - IV. 1886 Methods and Instruments (Bibliothèque Nationale)
 - V. 1886 Physiological Station (Collège de France)
 - VI. 1887–1889 Various (Beaune)
 Another album, untitled and undated, which remained at the Collège de France, was made by Marey for his personal use and contains the original prints from his earliest attempts with chronophotography as well as prints that document, step by step, the construction of the buildings of the station. The prints are dated from 1882–1883 in his hand. The few negatives that remain from these early essays are discussed below.
- 5 The films were sent to the National Film Archives of France.
- 6 Fessard did not see the catalog completed; he died in February 1982. The negatives, positives, and documents were moved from his office to the archives of the Collège de France, where they remain. Help in the construction of this catalog was given by the archivist of the Collège, Mlle. Christine Delangle.
- 7 The facilities for printing the negatives were kindly provided by M. Sydney Leach at the University of Orsay, Paris, and by Mme. Ida Leach.
- 8 In conversation with M. Pierre Braquemond of the Cinémathèque Française (to which the Photothèque belongs), I was able to ascertain that the negatives had been found on a staircase in the Cinémathèque about 12 years before. No one knows how they arrived there.

- 9 A box of Marey's films was located in the basement of the Cinémathèque at the same time that the negatives came to light at the Photothèque. The films had been given to the Cinémathèque in the fifties by Lucien Bull, a student of Marey's and one of the directors of the Marey Institute. Bull also gave four films to Helmut Gernsheim. These are now housed with the Gernsheim collection at the University of Texas. From a written description sent by Roy Flukinger, curator of the collection, it would seem that one of the Gernsheim films, of a pigeon in flight, is probably the earliest of Marey's extant films. A catalog of all Marey's films will be described in a subsequent article.
- 10 The numbering system appears to be random. Most likely, all the albums noted above were compiled during the period 1886–1889, and the numbers on the negatives refer to the order in which the original experiments were enlarged.
- 11 Eighty-two negatives of the same size were also found. They were not numbered and had never been printed. Many are instantaneous images of graphs and diagrams, and all date from after 1889.
- 12 For a list of Marey's cameras, see Frizot 1977. This camera is reproduced on page 61 of the catalog but is wrongly dated to 1882.
- 13 Marey's graphing machines were constructed around the "Marey Tambour," a pneumatic receptor made of a thin membrane stretched over a drum. The tambour transmitted the vibrations made by the movement of the subject through flexible tubes to a stylus that inscribed the movements onto a revolving smoke-blackened cylinder.
- 14 The photographic gun does not represent Marey's introduction to photography. He had used a camera and collodion plates as early as 1876 to photograph the oscillations of Lippman's electrogalvanometer. See Marey 1876.
- 15 Marey had seen the results of Muybridge's battery-of-cameras system firsthand in the fall of 1881 when Muybridge visited him in Paris. Marey rejected Muybridge's system out of hand as being prone to inaccuracy.
- 16 The gelatine silver bromide emulsion was not perforated, but then it would not need to be. To synthesize the emulsion discs in the phenakistiscope would require placing them behind another disc that was slotted around its circumference and rotating both discs together in opposite directions.
- 17 Seventeen instantaneous negatives of sequential athletic poses were also made in the new shed. These were never mentioned by Marey and it is likely that they were done by Demeny (see below). Prints made from two of these negatives, however, are the last prints in Marey's small album. Two other prints in the same album, also done in 1883, show that Marey experimented with at least two other systems while working with his own chronophotography. Both systems produced disassociated series on a circular plate. The first, a camera mounted by a corona of six lenses, was suggested to him by Albert Londe. Londe was a doctor who used instantaneous photography in the study of medicine at the hospital of La Salpêtrière in Paris. The second system incorporated Marey's own slotted disc shutter, which revolved around a more slowly moving glass plate. There are no existing negatives from either of these methods.
- 18 Franck and Demeny were identified by notations on the negative that also gave the day, month, and year of the experiment. Similar notations were found on four negatives from 1886.
- 19 Muybridge may have been the inspiration for the idea of using more than one camera on the same subject, and Marey had hoped to use three cameras as Muybridge had done. But the expense, so he claimed, was too prohibitive and he used only two. An illustration in *Movement* (Marey 1895:236) shows how three cameras would have been set up if operated simultaneously. Also, the illustration shows a new set-up for the black sheds that were needed for the operation: A second shed is butted perpendicularly to the first in order to accommodate the camera making the oblique views; a velvet-lined trench is dug in front of the first shed for the overhead camera.
- 20 Although Marey himself did the sculptures of the birds (pigeon and gull), he had an academic artist named Engrand do the figures of the men.
- 21 These photographs included ducks for the first time. Gernsheim's date of 1882 for an illustration in his *History of Photography* (1969: plate 248) is therefore too early.
- 22 Marey refused to use sprocket holes and a tooth-and-claw mechanism, which would have been the answer to his problems with equidistance. Even though he knew of Reynaud's 1877 patent for perforated film, Marey wanted to be able to vary the width of his films according to the demands of the subject. So sprocket holes were not a suitable alternative for him. By 1897, Marey had constructed a practicable projector even without using sprocket holes, but the Lumière brothers had given the first public showing of films two years earlier, so that there was no possibility of Marey commercially exploiting his own film system. The complex story of Marey's involvement with the Lumière brothers and with Edison, as well as the contributions Marey made to their work, remains to be told. Marey's place in the history of cinema was the subject of a long polemic in French cinema journals of the 1920s and is briefly described in Hendricks 1961.
- 23 Documentation of this part of Demeny's history is provided by two highly biased accounts, which balance one another: his own (Demeny 1909), and a long diatribe in the *Revue de Jeux Scolaires et d'Hygiène Sociale* (Bouton, Demeny, Marey, et al. 1910).
- 24 Such an attribution was most recently made in the *Art Journal* (Henderson 1981:319).
- 25 Demeny's article with the illustration was published in *La Nature* (1890).

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