THE QUEST FOR MOTION: MOVING PICTURES AND FLIGHT
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> It is evident that this apparatus when perfected will be as much valued by artists as a means of studying motion, as it is by mere amusement seekers; but the assertion that one day we shall be able, by means of these projected pictures in association with the phonograph, to reproduce operas, and other dramatic representations, is at present, to say the least, premature.[1]

That's a review of Edison's kinetoscope from 1896. The reviewer finds the idea that this device, in cooperation with a phonograph, could project an opera or could prove to be a new device for narration far-fetched. However, he does recognize the kinetoscope's value for motion studies.

In this paper I will present a brief history of the discourses around motion studies in the mid- to late 19th century France.[2] What I intend to show is that the technology we came to call the cinema was in a fact a product of the drive to mechanization, the drive to measure, quantify and predict every aspect of life, (in other words, the drive to make the analogue digital). The way I intend to do this is by arguing that moving picture machines and flying machines, especially the helicopter, share the same technical and discursive DNA. I would even go as far as saying that the motion picture projector and the helicopter are fraternal twins.

In his book *The Vision Machine*, Virilio alludes to a fraternity between flying machines and cinematography that originates in motion studies. He starts by quoting the sculptor Auguste Rodin. Rodin argues that his sculptures show movement more realistically than a photograph does, because a photograph freezes a figure in motion at one moment in time, giving it "the bizarre look of a man suddenly struck with paralysis. . . this is because every part of their body is reproduced at exactly the same twentieth or fortieth of a second, so there is no gradual unfolding of a gesture."[3] Rodin goes on to argue that "it is art that tells the truth and photography that lies. For in reality time does not stand still, and if the artist manages to give the impression that a gesture is being executed over several seconds, their work is certainly much less conventional than the scientific image in which time is abruptly suspended…."[4] Virilio categorizes Rodin's work as "the representation of movement pushed to the limits of collapse or take-off. From here is it only a step to Clément Ader and the first aeroplane flight, the conquest of the air through mobilisation of soemthing heaveir than air which is followed, in 1895, by cinematography's mobilisation of the snapshot, retinal take-off."[5]

Like Virilio, I believe that motion studies, the birth of aerodynamics, and the birth of cinema are interrelated, though I do not believe that one happened before the other or that one led to the other. Rather, the evidence seems to indicate that the same people who were absorbed in recording, storing, and representing (or re-playing) motion were also fascinated by the possibility of mechanical flight. Most of these people conducted their experiments alone at home or perhaps with one assistant, but shared their results at meetings of learned societies, at least from the Renaissance until the beginning of the twentieth century when scientific research moved out of the home and into the laboratory and out of the hands of individuals and into the care of hierarchically structured teams. These pre-twentieth scientists often combined artistic interests (in painting, watercoloring such as that done on lantern slides, or photography), with scientific research and a healthy dose of showmanship. Although I will tell the story by examining the work of individuals, my aim is also to point out how these individuals combined their artistic and scientific interests and also communicated their findings and theories to each other through the meetings of learned societies and scientific publications. The learned societies of the 19th century, the equivalent to our scholarly conferences, were one of the principle genetic pools out of which aerodynamics and moving pictures emerge

Indirectly, this paper is inspired by Lynn Kirby's book *Parallel Tracks: The Railroad and Silent Cinema*.[6] In this book, Kirby argues that silent films – her analysis takes place primarily at the level of representation – seem to privilege the train over other forms of transportation, including the airplane. She sees the train as an apt metaphor for the cinema, with its frames, moving images, its construction of a journey as an optical experience, the radical juxtaposition of different places, the "annihilation of space and time". As a machine of vision and an instrument for conquering space and time, the train is a mechanical double for the cinema, with perceptual and ideological overlaps.[7]

Kirby sees the train as an important *protocinematic* phenomenon, a significant cultural force influencing the emergence and development of the cinema and the construction of the spectator-passenger during the silent period in both the United States and Europe. In her analysis she focuses on the films themselves, and takes the Lumière public screening in December of 1895 as the starting point for cinema, while I take it as an endpoint. It is a convention to say that cinema was born in 1895, but the inception of projected cinema as we have known it meant that something else was coming to a close. One of my goals in this paper is to convey a sense of the mental and emotional ferment that was typical of the mid to late 19th century. My argument is that the bond between aviation and cinema is much tighter, though less visible, than that between cinema and the railroad. Kirby's findings and my own do not cancel each other out; rather, the difference in the two arguments underlines differences in how the cinematic is defined.

Looking back, we notice that often the people of ideas who concerned themselves with the development of photography and projection also concerned themselves with the development of aerodynamics. Two well-known early examples are Leonardo Da Vinci, who captured the images projected by the camera obscura with his paintbrush and also drew prototypes for helicopters, and Constantin Huygens, who 200 hundred years later invented the magic lantern and conducted pioneering studies in resistance (or drag) and velocity.

ROBERTSON

In January of 1798 Étienne-Gaspard Robert, a lanternist from Liège, performed his *Phantasmagoria* in Paris for the first time Robert started out as a priest and, like many men of letters of his day, an independent scientific researcher (he published a paper on his experiments with electricity in 1789). He was successful enough as a scientist to be given the post of professor of Physics and Chemistry at the École Centrale du département de l'Ourthe, but after months of negotiations his reluctance to leave Paris won out and he turned down the post. At that point he re-tooled himself as a "physician-philosopher," anglicized his name to Robertson, and began to give "courses in phantasmagoria" as he referred to his spectacles.[8] Robertson's phantasmagoria consisted of "spectres, ghosts and the risen dead, as they have appeared to all people's throughout all time. Experience the new fluid known as Galvanism, the application of which temporarily restores movement to a corpse."[9] Robertson began his spectacle by promising to raise any dead person beloved to any member of the audience. He even got into trouble with the Revolutionary Government for claiming in print that he had a recipe for raising the spirit of Louis the XVI.[10] A year later, wary of competitors, he patented his *fantascope*, the magic lantern on a dolley track almost four meters long, with three alternate lenses (one of them a zoom lense) in a square tube. Robertson projected these images behind a scrim; by rolling the lantern back and forth and alternating between various lenses he was able to create many ghostly effects.[11]

Robertson performed his phantasmagorias all over Europe for many years, including a nine year sojourn in Russia. Much to his chagrin, the very success of his spectacles, which appealed mostly to the lower classes, made him a charlatan in the eyes of the physicians and scientists whose respect he desperately sought. However, Robertson saw himself as a man of science and identified himself as such to the end of his life. He even signed his memoires "the memoires of the physician and aeronaut E.G. Robertson".[12] His love of flight was second only to his love of showmanship; he went up in hot air balloons whenever possible, everywhere in Europe, including Russia. This combination of interest in spectatorship, projection of images, and flight characterized many men of science of his day, though most of the others described here were more successful at combining their interests in moving images and flight, such as our next example, Nadar.

NADAR

Nadar's real name was Gaspard- Felix Tournachon. Born in Paris in 1820, in the 1830s he took on the nickname Nadar, under which he published stories, essays, and caricatures. He turned to photography in the 1850s and was one of the first to practice photography as an art and not only for scientific study.[13] In 1857 he made his first ascent in a hot air balloon and then began to go up in balloons with his photographic equipment to take pictures. (Taking pictures from hot air balloons and other flying devices was so common that Frederique Dillaye, in his famous manual of instructions for photographers, spent several pages describing the proper way to attach a camera to the basket of a hot air balloon and to a kite[14]). Nadar loved the hot-air balloon and its silent ride, but was soon frustrated by the difficulties he had navigating it. After studying the motion of kites, birds, projectiles, and his favorite example, a worker who soaked his sponge in water before tossing it up to his colleague on a scaffold, Nadar concluded that controlled aerial navigation required the flying body to be heavier than air. So, along with Baron Taylor and Jules Verne he formed the *Société d'Encouragement pour la Locomotion Aérienne au Moyen d'Appareils Plus Lourd que L'Air* (Society for the Encouragement of Aerial Locomotion by Means of Machines Heavier than Air). The purpose of this society was to bring together men with the ideas and raise enough money to fund the construction of their flying machines, especially a helicopter. To raise the level of public awareness of flight and funds to build a helicopter, Nadar decided to build a gigantic balloon, the G*éant.* Completed in October 1863, it was forty-five meters in circumference and could carry over a dozen passengers in a two-tiered basket. Nadar made five ascensions in the big balloon between 1863 and 1867 and wrote two books about his experiences.[15]

Predictably, the Gèant sucked up whatever profits Nadar's photography studio could churn out. The financial "encouragement" to build helicopters never materialized either.[16]Although he never gave up his dream of flight, Nadar had to focus on his photography again, and on January 7, 1887, we find him giving a demonstration of positive and negative photographic papers developed by George Eastman and W.H. Walker in 1884 to the *Société française de photographie*, a session at which Marey was present. But before I discuss Marey, I need to tell you about Janssen.

JANSSEN

In 1873 Pierre-Jules Cesar Janssen demonstrated his photographic rifle, based on Plateau's phenakistiscope, to the Academy of Sciences. (Marey was also present at this demonstration). Janssen was an astronomer and part of a team that was travelling to Japan in 1874 to witness the passage of Venus across the face of the sun, an event that only occurs twice each century. He spent two years preparing a photographic device to register the event. The "rifle" registered images on a light sensitive wheel. His second version was able to register 48 images in 72 seconds and succeeded in taking the pictures he wanted of Venus crossing the face of the sun. These images enables him to prove one of his theories, that the solar corona was in fact an attribute of the sun itself and not an effect of looking at the sun through the Earth's atmosphere. Janssen's rifle was used to photograph solar eclipses for many years.[17]

The use of photography to study a flying body was not, of course, unique to Janssen. As Marta Braun has pointed out, what Marey was after, like Leonardo Da Vinci before him, "was above all to make the world visible; only thus, he believed, could it be measured, and only through measurement could it be truly known. Marey's world was the world of motion in all its forms, its conquest was his greatest achievement…. Marey was primarily interested in a visual description of human motion – the walk, the run, the jump, and so on – and the forces at work in their execution." [18]

If we consider the Webster's dictionary definition of aerodynamics as "the branch of dynamics that treats the motion of air and other gaseous fluids and the forces acting on bodies in motion relative to such fluids,"[19] the areas of overlap become apparent. Both sciences are interested in forces that are not immediately visible to the human eye, and both problems were addressed in the 19th century by the same people or by different people who met in the same venues, that is, these learned societies.

The aerodynamicists had their own societies as well. Here is a quote from a report of the aeronautical society in 1868:

> With respect to the abstruse question of mechanical flight, it may be stated that we are still ignorant of the rudimentary principles which should form the basis and rules for construction. No one has yet ventured to give a correct experimental definition of the primary laws and amount of power consumed in the flight of birds; neither, on the other hand, has any tangible evidence been brought forward to show that mechanical flight is an impossibility for man . . .. We are equally ignorant of the force of the wind exerted on the surfaces of various sizes, forms, and degrees of inclination; these are generally *assumed* on the mathematical laws of the resolution of forces, considered as the rigid impulse of inelastic weight and matter, and demonstrated by the aid of diagrams combined with a system of weights, cords, and pulleys, which convey but a very distinct idea, relative to the conditions of the present inquiry, where the elastic and yielding nature of the air is the cause of such unforeseen results, differing in according to the width, form, angle, and speed of the surface of the impact.[20]

What this quote makes clear is that although much theoretical work had been done – in fact, most of the mathematical theories needed for flight had already been developed – the would-be airplane builders still had no clear idea on how to accomplish their goal.

The idea that was popular in most aerodynamic circles was that concept of the ornithopter, or a flying device modeled on birds, although, as noted, some favored the idea of a rotating blade that would screw upwards, as in a helicopter. But great minds like Da Vinci before and Otto Lilienthal after favored ornithopters. And in order to build an ornithopter it was necessary to study the flight of birds.

Such studies has already been attempted, including graphic studies by Marey in 1869 and 1870 in which he produced line tracings from the flights of harnessed birds. His results were published in the journal *La Nature*, edited by photographer Gaston Tissandier, who had written a book on aerial locomotion himself.[21]

PENAUD

In 1872, Alphonse Penaud, one of the unsung heroes of aerodynamics, cooperated with Marey to build a mechanical bird (Marey had previously built a mechanical insect). It is not clear how successful this model was, but apparently more work was needed, because in December of 1873 Penaud made a presentation to the *Société française de navigation aérienne* (French Society for Aerial Navigation) that both praised Marey's work to that point and offered suggestions on how it could be improved. Specifically, Penaud suggested that instead of recording the flight of birds graphically, they should be photographed. He then reminded Marey of the presentation Janssen had made of his photographic rifle just a few months earlier. Though Penaud claimed to know nothing about photography, he also foresaw that this device would need something like a Maltese Cross.[22] Other engineers present (Villeneuve and Armengaud) made suggestions which Marey would end up applying almost ten years later.

In the meantime, Penaud gave up on ornithopters and designed a helicopter, a design he patented in 1876. He spent four years trying to raise the money to build one without success, and in despair committed suicide in 1880 at the age of 30.

Penaud's influence on Marey was longlasting in two ways. First of all, as we all know, Marey did end up building the photographic gun, a key step toward the development of the motion picture camera. But he had to wait a few years for Janssen to give him his rifle and the permission to improve upon it, and a few more years to overcome his own reluctance to abandon his graphic devices. Finally the sight of Muybridge's photographs of Leland Stanford's racehorse encouraged him to continue. He applied for a grant to further his studies of motion and in 1883 Marey was awarded money to erect a building on his *Station Physiologique*, his center for the study of locomotion. He relied greatly on his associate, Georges Demenÿ, to run the Station and continue the experiments during the six months he spent every year in Naples. Demenÿ ran the *Station physiologique* for Marey for over ten years. He began as Marey's worshipful acolyte and gradually emerged as a scientist and inventor in his own right.

When Marey witnessed Nadar's demonstration of the Eastman Kodak film, it had a great influence on his own work. Up until then he had used single large fixed plates where a series of images would all be imprinted; the overlap in these images made it difficult to decipher the motions he wished to study. But on October 29, 1888 he presented the *chronophotographe sur bande mobile*, a motion-picture camera which could register up to 20 images a second. Because the roll of paper was not perforated it wasn't possible to make the images equidistant, thus making it unreliable in the capture and projection of true motion picture images. Marey was not concerned about this because his interest was the study of locomotion and not motion picture projection. By 1890 celluloid (the result of research by inventors all over the world but mostly commercialized by George Eastman) had become widely available. Marey patented his camera for use with celluloid on October 3, 1890.

Now Marey and Demenÿ began to produce motion pictures in earnest, always with the purpose of studying locomotion. Unlike Muybridge, Marey -ever sensitive to public opinion- avoided photographing women; most of his films feature nude male athletes going through various athletic moves such as jumping, leaping, using a baton, etc., and one film was made of ocean waves.

Until 1892 Marey studied his images of locomotion by cutting them out and then attaching them equidistantly inside a zooetrope. By May of 1892 he began to feel the need for real projection, and he began to work on a *projecteur chronophotographique* in earnest. By November of 1892 many of his colleagues considered the projector he developed to have resolved the problems of projecting movement. However, Marey's projector, like his camera, did not use a perforated-film system, which made it difficult to assure a steady movement. Emile Reynaud, the magician and showman, projected bands of animated drawings joined on perforated strips of leather at the Musée Grevin. Other inventors, like the Lumières, would resolve this problem by perforating the celluloid.

It is interesting to note the role played by "pre-cinematic" optical toys in the development of motion studies and cinematography. Plateau's phenakistiscope influenced Janssen's photographic rifle. The "projecting phenakistiscope" or zooetrope, inspired the design of Emil Reynauld's praxinoscope. Reynauld's *Projections Lumineuses* ran for over 1200 performances at the Musée Grevin in Paris from 1892 to 1900. Muybridge's series of images of the horse galloping were published in the form of zooetrope strips in popular magazines for readers to cut out and re-play at home. In other words, these pre- or proto- cinematic devices (or philosophical toys, as Edwin Carels refers to them), played a role in the motion studies which led to flight as well as reconfiguring the spectator as a point of view within the field of the moving image.[23]

Demenÿ continued to work on the improvement of his master's inventions, and he was also eager to commercialize them.

By 1889 Demenÿ had become much more self-assured. He no longer needed to consult with Marey when he wrote his papers and was eager to assert his own ideas. The relationship between the two men began to suffer. However, Marey recognized that Demenÿ was coming into his own and encouraged him to speak at conferences, publish papers under his own by-line, and work on his own inventions. Demenÿ was also named "Laboratory Chief" of the *Station physiologique*.

In 1891 the Musée Grévin, a wax museum which had been exhibiting Emile Reynaud's *Theatre Optique* since 1888, invited Marey to give a theatrical demonstration of some of his films with his newly developed projector. There is no record of Marey's reply, but his reluctance to commercialize his invention had been a source of strife between him and Demenÿ for some time. However, in July of 1891 Demenÿ gave a demonstration of his *phonoscope* at the Musée Grévin.[24]

The phonoscope was a projector designed to reproduce the living manner of a subject as s/he pronounced short phrases. (One film shows Demenÿ himself saying "Vive la France"). The images were taken with Marey's *chronophotographe* and then laboriously transferred to a glass disc, from which they could be observed through the phonoscope peephole or projected. Demenÿ also gave some thought to synchronizing his phonoscope images with a phonograph but apparently never actually did so. His original intention was to use the device to teach deaf-mutes how to speak, but he also hoped to commercialize it ("How many people would be happy if they could even for one moment revisit the living features of a lost loved one!"). Demenÿ exhibited the phonoscope alongside devices invented by Janssen and Marey at the International Exposition on April 20, 1892, and received a great deal of press attention.

However, since the phonoscope could not stand on its own without a *chronophotographe* to record the images in the first place, Demenÿ could not market his phonoscope without Marey's cooperation. The relationship between the two men had eroded and Marey, upset at the attention Demenÿ was getting from the press and disappointed at the failure of his own (admittedly minimal) efforts to commercialize the *chronophotographe*, refused to cooperate. Demenÿ went ahead and founded *La Société générale du phonoscope, portraits vivants et tableaux animés* ("The General Phonoscope Company for Living Portraits and Animated Tableaux")[25] to exploit his invention in partnership with Ludwig Stollwerck, a German industrialist, and François Henry Lavanchy Clark, a Swiss businessman. Demenÿ tried to interest Marey in his company but Marey responded by firing him from his position at the *Station physiologique.*

Marey, cognizant that his *chronophotographe* was necessary for the success of the phonoscope, re-patented it in June of 1893. But Demenÿ got around the problem by patenting his own "camera chronophotographique," which was the camera of Marey's design with one improvement: by using an oval-shaped reel the film could be unwound in a more regular manner. This solution was not completely satisfactory, as the speed varied as the film unwound, but it solved the problem of dealing with Marey.

In 1894 Demenÿ patented an improvement to his mechanism, a cam that ensured a more even movement of the film through the motion picture camera. This device remained in use in motion picture cameras until 1910 and was used by the first cinematographic cameras developed by Gaumont with Demenÿ's cooperation in 1895. By approaching Gaumont and cooperating with him in the development of a motion-picture camera and projector, Demenÿ crossed over from developing devices to study movement to developing cameras to project movement.

THE GAUMONT COMPANY

Léon Gaumont, like many of the people in this story, started out in photography. Gaumont, who had been an apprentice of Carpentier's, went to work for Félix Richard's photographic supply company in sometime in 1893. On October 5, 1893, the Paris Court found Félix Richard in violation of his non-competition agreement with his own brother and forbid him to continue with his photographic boutique or to promote Carpentier's *photo-jumelle*. Once Richard found he had to retire from the business, he convinced Gaumont, his second in command, to buy the company from him for 50,000 French francs. Gaumont didn't think the company was worth that much, but Richard assured him (falsely, as it later turned out) that he would have exclusive rights to Carpentier's *photo-jumelle*. Gaumont bought the company on July 7, 1895.[26] According to Alice Guy's memoirs,[27] this occurred a few months after she came to work for the company as a secretary. When Gaumont bought the business and turned it into L. Gaumont et Cie., Guy remained as a trusted employee (her position was roughly what we would call an office manager today). And so she was in an enviable position to witness and participate in the birth of the industries of motion that characterize the 20th century: aviation, studies of human and animal locomotion, and cinema.

Gaumont purchased the rights to Demenÿ's patents for the *phonoscope* (patented in 1891) and the *biographe* (patented in 1893) after Demenÿ had tried to interest the Lumière brothers in them without success. Demenÿ's patent of October 10, 1893 became the basis for the Gaumont 60mm camera, also called a *chronophotographe*, which was perfected in the first few months of 1896.[28] According to Alice Guy's memoirs[29] it was during this period, sometime before May of 1896, that she wrote, produced and directed her first fiction film. She does not specify which camera she used, but it is most likely that she used the Demenÿ-Gaumont 60mm camera. [30]

The kinship between moving pictures and flying machines through motion studies and the drive to mechanization did not end with ornithopters and helicopters. There is also a close relationship with stiff-bodied flying machines, or airplanes. The connection goes back again to Marey. Marey, perhaps influenced by Penaud's research, had conducted some studies of air currents over curved surfaces which he photographed with the use of smoke. These photographs came to the attention of Samuel Pierpoint Langley, who got Marey a grant in 1900 to continue that line of research. Marey also built some wind tunnels, which were used as models by the Wright brothers and also by Gustave Eiffel.

Eiffel, the engineer who built the Eiffel Tower, had watched Alberto Santos-Dumont fly his motor powered precursor to a Zeppelin around it in 1906. Inspired, Eiffel spent the last twenty years of his life building wind tunnels and conducting other kind of aerodynamic experiments.

Just as Eiffel's aeronautic career is little known, so is his cinematic one. Eiffel headed the Gaumont company board of directors for a few years. In her memoirs Alice Guy relates that it was primarily through Eiffel's influence that she was able to keep her job as head of film production when a dispute arose between herself and René Decaux, the manager of the Gaumont set-building shops, in 1906.[31]

Until 1906 or so most films produced were actuality films. In their "realistic" reproduction of life these actualities could be said to epitomize Marey and Demenÿ's drive to study motion. That paradigm remains with us today, in the form of the instant football replay and of surveillance cameras that pretend to tell us if a crime has been committed or not.

A few people, like Georges Hatot at the Lumière Co. and Alice Guy at Gaumont, began to shift the paradigm away from motion studies and towards the opera that Edison had originally envisioned. Lynn Kirby claims that cinema, like the train with its imposition of standardized time zones, destroyed our sense of space and time. I disagree. With the creation of film narratives, of separate diegetic universes, cinema replaced the time and space that the railroad and other artifacts of modernity had taken away. What I see now, in the conversion from an analogue cinema to a digital and interactive one, is that both paradigms – the drive to make reality visible, as in the work of Marey, and the drive to create alternative diegetic realities, as in the work of Guy and Hatot – are coming back together. Once analogue cinema goes completely digital, the drive to mechanization might be complete.

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[1] From a review of an Edison kinetoscope screening (no author given) in 'The Month: Science and Arts' *Chambers's Journal*, 25 April 1896, as quoted in Colin Harding and Simon Popple, *In the Kingdom of the Shadows (*London: Cygnus Arts, Madison & Teaneck: Fairleigh Dickinson University Press, 1996): 9.

[2] . Similar discourses went on elsewhere, but for the purposes of this paper I will limit myself to Paris.

[3] Virilio, Paul, *The Vision Machine*, (Bloomington and Indianapolis: Indiana University Press, 1996 (1994) London: BFI Publishing):1.

[4] The quotes of Rodin are from Gsell, Pau, *Auguste Rodin. L'Art: Entretiens réunis par Paul Gsell* (Paris: Grasset/Fasquelle, 1911), as quoted in Virilio:2.

[5] Virilio:2-3.

[6] Kirby, Lynne, *Parallel Tracks: The Railroad and Silent Cinema*, (Durham: Duke University Press, 1997).

[7] Kirby: 2.

[8] Mannoni, Laurent, *Le gran art de la lumière et de l'ombre*, (Paris: Université Nathan, series archeologie du cinema, 1994): 145.

[9] From Robertson's original programme announcement, as published in Mannoni:147 (my translation).

[10] Mannoni: 149.

[11] Mannoni: 151.

[12] Levie, Françoise, "Les Mémoires de Robertson", *Ça tourne depuis cent ans: Une histoire du cinéma francophone de Belgique*, (Wallonie-Bruxelles: Communauté française de Belgique, 1995): 13.

[13] Nadar, *Revendication de la propriété exclusive du pseudonyme Nadar (Felix Tournachon-Nadar contre A. Tournachon jeune et Compagnie).* 5 parts. Includes court documents. Paris, 1857, part 2, pages 0-p. Quoted in "A Portrait of Nadar" by Maria Morris Hambourg, *Nadar*, (New York: The Metropolitan Museum of Art, distributed by Harry N. Abrams, Inc. 199 :25.

[14] Dillaye, Frédérique, *La Théorie, la pratique et l'art en photographie*, (New York: Arno Press, 1979, reprint of the 1891 ed. Published by A la librairie illustrée, Paris): 189, 193.

[15] Hambourg, *Nadar*, p. 118. The two books are *Mémoires du Géant* (1864) and *Le Droit au vol* (1865).

[16] *Ibid.*: 29-30.

[17] Mannoni, Laurent, *Le gran art de la lumière et de l'ombre*, (Paris: Université Nathan, series archeologie du cinema, 1994): 282.

[18] Braun, Marta, *Picturing Time: the Work of Etienne-Jules Marey (1830-1904)*, (Chicago: University of Chicago Press, 1992): xvii.

[19] From *Webster's Third New International Dictionary*, quoted in John D. Anderson Jr., *A History of Aerodynamics*, (Cambridge: Cambridge University Press, Cambridge Aerospace Series 8, Michael J. Rycroft and Robert F. Stengel, gen. Eds., 1998):3.

[20] *Ibid,*: 6.

[21] Braun: 37.

[22] Mannoni: 307.

[23] I am grateful to my colleague Edwin Carels for pointing out this connection to me and for his comments on an early draft of this paper.

[24] The Musée Grévin was a focus point for proto-cinematic and early cinematic exhibition. This aspect of its history has not been well examined. For example, Méliès performed his magic act there before 1888. (Méliès, Georges, in a letter to Paul Gilson dated August 9, 1929. Reprinted in Georges Sadoul's *Lumière et Méliès* (Paris: Lherminier 1985): 227).

[25] Loiperdinger, Martin and Roland Cosandey, "L'Introduction du Cinématographe en Allemagne: De la case Demenÿ a la Case Lumière: Stollwerck, Lavanchy-Clarke et al., 1892-1896" in *Archives* No. 51, November 1992, published by Institut Jean Vigo, Cinémathèque de Toulouse.

[26] Mannoni, Laurent, "Le Quatrième Centenaire du Cinéma," in *Théorème: Cinéma des premiers temps, Nouvelles contributions françaises*, No. 4, (Paris:Presses de la Sorbonne Nouvelle, 1996):32-33.

[27] Slide, Anthony, *The Memoirs of Alice Guy Blaché*, translated by Roberta and Simone Blaché, (Metuchen, N.J and London: The Scarecrow Press, 1986): 15.

[28] For more background on this, see letter from Louis Lumière to the *Ciné-Tribune* dated June 30, 1920, which quotes, extensively from correspondence between Demenÿ and the Lumières in 1894. Published in Lumière, August and Louis, *Correspondances 1890-1953* Librairie du Premier Siècle du Cinéma Series, (Paris: Cahiers du Cinema, 1994): 221-228.

[29] Guy, Alice, *Autobiographie d'une pionnière du cinéma (1873-1968*), (Paris: Denoël/Gonthier 1976): 25.

[30] See also the interview with Alice Guy in *The New Jersey Star,* August 8, 1914.

[31] Slide, *Memoirs*:31.