Man as a Drunken Town-musician

Friedrich Kittler

The sciences are on stage again.[1] This self-referential assertion is less trivial and less timeless than it sounds.

Not knowledge, but science could certainly only have existed since the Greek vowel-alphabet connected an alternating interface between the elements of letters and the elements of nature. As Jesper Svenbro has shown, what for the ionian philosophers of nature arose out of itself in fact only arose from writing. Therefore, everything which can be called science must be able to appear as text. The elements, whether Heraclitus' or Mendeljew's, are first given only in the sign of their names, and thus in Latin they have become 'data.'

Yet this basic relation between knowledge and writing has been so deep-seated that it has scarcely reappeared. Almost in the same historical moment when Galileo directed all modern physics to the reading of that book which Nature was supposed to have written herself in geometric or, subsequently, algebraic signs, the modern novel and modern theater stepped in as evidence that modern readers and spectators enjoy the effects of those fictions most of all when they are altogether free of science. Not only the age of Goethe, but first and foremost the one to whom this age owes its name bears eloquent witness to that effect, despite his love for mother nature and her open secrets. Goethe claimed that the intuition of nature could only take place however as far or as much as fortunate eyes were able to intuit and to see. Still, that elementary technique of culture

[1] What follows is the revised version of a lecture given at the Freie Universität Berlin in the series of lectures *Stages of Knowledge in the Sciences* organized by Helmar Schramm in 2000/2001.

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common to all sciences, called mathematical codification, remained forbidden.

When, in 1826, Karl Friedrich Naumann, one of the founders of modern crystallography, sent his latest publication from Leipzig to Goethe, one of the most ambivalent thank-you notes ever written was drafted in Weimar: "the important document sent to me by Your Honor," wrote the aged Goethe with the usual bureaucratic ceremony, "arrived at a good moment, and I immediately read it with great pleasure repeatedly up through page forty-five. At this point, however, I am standing at the limit which God and nature wish to define for me as an individual. I am dependent upon word, language and image in the truest sense, and completely incapable, to act in any way whatsoever through signs and numbers, with which the most talented spirits make themselves easily understood."[2]

On that January day in 1826, the aged Goethe did not read any further for reasons which Francesca and Paolo, or Lotte and Werther could never have dreamed of. At the first mathematical symbol, the first "quanitity," as it is later called in the letter to Naumann, his reading came to a halt. Through "signs and numbers," as they do not belong to alphabetical language, the reader saw himself robbed of all "qualities" with which "God and nature" were supposed to have endowed his "individuality": "Word, language and image in the truest sense." This is how German poetry, when it called out its own three media by their proper names, completely forgot the fact that it too was always already over its designated limit. A "page 45," together with the printed page number, is not only part of Naumann's crystallography, it can also be found in Goethe's *Faust.* It therefore does not help very much to privilege the operations of literature over those operations due to which the sciences are not only able to codify their own methods, but also their results and thus parts of the so-called nature.

Concepts of the text that stress a pure alphabetics while discarding its numerics (to take up Derrida's attack upon a supposedly europewide phonocentrism and reformulate it somewhat more technically), have revenged themselves bitterly on their authors. Goethe had to pay a price for choosing a true German university professor as the tragic hero almost for the first time in the history of German theater. In addition to that, and according to his very personal model, he had

[2] The letter from Goethe to Friedrich Naumann dates from January 24th, 1826, in *Briefe und Tagebücher* vol. 2 (Leipzig: Insel-Verlag n.d.) 441.

to pay an even higher price for granting this Doctor or rather Magister Faust with a passion for the innermost secrets of nature, a nature which punished loathsome measurings or even numeration of her exterior with contempt. This is precisely why Emil Du Bois-Reymond, a leading physiologist at the Friedrich Wilhelm University in Berlin,[3] appeared before the admiring academic public with all the gold and taffeta of his new rectorship in order to demand the immediate end of the age of Goethe in a lecture antiphrastically titled "Goethe und kein Ende": "Goethe and No End." Science as such therefore staged a court where—in a neat reversal of Galileo's trial—it threatened its enemies with excommunication and inquisition. Goethe's "Theory of Colors," which Du Bois-Reymond claimed to be a failure in the field of physics, did not retard scientific process in Germany any less than Faust's intuition of nature did, bereft as this intuition was of all mathematics. It is high time to check whether the so-called naturalists, the immediate contemporaries of Du Bois-Reymond and Claude Bernard, did not in fact write his tirade or mandate into literary deeds without further ado. In any event, the great physiologist himself did not do so; instead, Du Bois-Reymond, after he bid farewell to Goethe's "Word" and "Language" in the name of science, turned to the realm of the imaginary, which Goethe had celebrated as the "image in the truest sense." In 1890, a small written piece on "Natural Science and Fine Art" ("Naturwissenschaft und bildende Kunst") issued forth from the pen of the Berlin Emeritus.

If there is ever to be something like a history of media studies, Du Bois-Reymond's almost forgotten writing should appear in the canon of its holy texts next to Ernst Kapp's "Principle Characteristics of a Philosophy of Technique." Du Bois-Reymond's text writes the history of art from a perspective which has only recently been occupied again by Samuel Edgerton or Jonathan Crary. The phenomenality of appearances, as it occurs in canvasses and statues, in painting and plastic art, is everything but an unmediated beginning. In order for styles and works of art to even appear, epistemological knowledge must first have established the field of their colors and forms. Du Bois-Reymond cuts across, however provisionally it may be, the history of specific sciences in order to couple fifteenth-century geometry with the possibility of paintings in linear perspective, or to

[3] The Friedrich Wilhelm University was renamed as the Humboldt University in 1949.

couple sixteenth-century anatomy with the possibility of muscle's becoming marble, and finally, the physical theories of color from Newton through Helmholtz with the history of painterly *colorito* as a whole. At the end of his essay, however, this course of a history of science, not yet curbed by any modern artistic impulse, makes the transition from static to moving pictures, which is a brand-new idea in 1890. Five years before the Lumière brothers will raise Edison's playful peep-box theater to the status of a mass-image medium, Du Bois-Reymond presents, if you will, the very first history of film. This history has the unique feature of not describing moving pictures as animation or the surpassing of Daguerre's half-hour exposure times, as has become commonplace and self-evident since Hugo Münsterberg's scarcely less-forgotten psychotechnique of film. Du Bois-Reymond's history does not begin at all with diorama painters or magic lantern players, but rather on a really elementary threshhold: with the scientific history of moving. In the process of elaborating the thesis that without modern geometry there would have been no paintings in linear perspective, Du Bois-Reymond's brief history of art ends with the statement that there would be no moving pictures without the analysis of modern mathematics.

Today, one could make just the reverse statement: one could say that without moving scientists there would be no modern analysis. Geometry first became analytic, and that means cinematic, when an officer on leave, who happened to be a burgeoning philosopher, first dreamed of movement as such in his winter quarters on the Donau. "Larvatus prodeo"—masked, I go forth—remained Descartes' device, even when he no longer wore the uniform. But what has hindered empirical movements from achieving mathematical and philosophical honor in the same way seems to be precisely the steady motion of Descartes' subject which he conceived of as a geometrical point and which analytic geometry since Descartes transposed into the ceaseless movement of a curve-defining point in a field of coordinates. Furthermore, empirical movements remained a domain of dance-instructors and their choreographies, or of the drills of officers educated in Hessen-Nassau and Hessen-Orange to whom the young Descartes owed his drilling- and fencing-skills.[4] Mathematical analysis, on the other hand, moved those dimensionless points, to which the

[4] See Wolfgang Schäffner, "Körper im Takt. Zur Geschichte symbolischer Maschinen im 16. und 17. Jahrhundert" in *Kaleidoskopien* 3 (2000), 188–205.

swinging pendulum or flying granades were reduced for the sake of simplicity, through every possible adventure of maxima and minima, of turning points and null-points, of velocity moments and forces of acceleration. Only in the truly novelesque case of that lying baron, who had the privilege of performing the analysis with his own body, did a cartesian subject ride along on the parable of a granade's trajectory. Once again the text of the novel, in Münchhausen's case as in Descartes', relied upon the certainty—unshakeable because imagined in the Donau winter quarters—that dreamed motion or faked flying remained as inescapably true as only the *Cogito* itself otherwise could be.

This blessed time of the founding fathers in which consciousness and analysis, thinking and differential calculus were one and the same ended bitterly. The reason was simple: not all trajectories of motion in physical empiricism were permitted to be ascribed to the cinematics of a single point. What Huygens had achieved in the case of the swinging pendulum already failed in the case of a vibrating string whose innumerable points are elastically coupled and thus, in other words, enjoy uncountable degrees of liberty. Not even cartesian subjects would have been in a position of being or thinking all points of the string at the same time in order to discover the secret of a single tone from the violin. All that remained was for mathematical analysis to bestow this secret unto a new, no less mysterious theory: to the partial differential equations in brazen opposition to the usual ones. Newton's usual differential equations still sufficed for solar systems, since the stars which were part of those systems do not enjoy a single degree of freedom; but not everything that moves is as simple as in astronomy. In the case of violin strings and bell tones, drumskins and water surfaces, and even windstorms and electromagnetic vibrations, only partial differential equations successfully modelled the countless parts moved in all their dimensions.

Thus the course of modern science finally arrived at physiological, day-to-day motion. In 1836, a monograph from Wilhelm and Eduard Weber appeared which was almost without precedent: the "Mechanics of the Human Walking Apparatus. An Anatomical-Physiological Investigation" (*Mechanik der menschlichen Gehwerkzeuge. Eine anatomisch-physiologische Untersuchung*).[5] Eduard Weber had at that time just been

[5] Weber, Wilhelm and Eduard, *Über die Mechanik der menschlichen Gehwerkzeuge, nebst der Beschreibung eines Versuchs über das Herausfallen des Schenkelkopfes aus der Pfanne im*

summoned to the University of Leipzig as professor of medicine; his brother Wilhelm, on the other hand, was already a professor of physics in Göttingen since 1831, where he had just two years later, together with none other than Gauß, made the first electric telegraph run. That alone suggests that the medical subtitle of their joint book is pure understatement. All the anatomical and physiological findings concerning knees, hips, leg muscles and joints gathered in the first part only serve the higher purpose of founding a mathematical physics of legs in just as strict a sense as Newton had demanded for the physics of celestial bodies.

At least the anatomical and physiological investigations—or in other words, the experiments both on corpses' legs in Leipzig and on living legs in Göttingen—make it clear from the start what the degree of freedom is, which a system of hips, knees and heels enjoys. Every joint, as writers of computer animations would formulate it, or rather, program it today, is a three-dimensional transformative-matrix whose rotations in turn transform the next subordinate joint. At the end of the day, however, the matrix-product from all these turns and displacements produces such variable values, or leg positions, that one is threatened by the appearance of sheer incalculability. "It can perhaps be questioned," so the Weber brothers admit, "whether a theory of walking and running can be provided at all since we are not walking machines, and these movements are altered in many ways by our free will."[6] That merely appears to be the case, however. In 1836, no cartesian subject inhabits the curves or functions of his own limbs. On the contrary, "man binds his movements to certain rules even if he cannot express these rules in words. These rules are based totally on the structure of his body and on the given external conditions. They thus can be deduced from both structure and external conditions."[7]

All the preliminary anatomical-physiological investigations have the single goal of reconstructing a per definitionem "unconscious" walking machine first of all through measures and series of tests on the body, before the triumphant end to the book can go and present

luftverdünnten Raume, in Wilhelm Weber's *Werke,* ed. Friedrich Merkel und Otto Fischer (Berlin: Königliche Gesellschaft der Wissenschaften in Göttingen 1894), 322 [transl. by Maquet, Paul and Ronald Furlong, *Mechanics of the Human Walking Apparatus* (Berlin, Heidelberg, New York etc.: Springer-Verlag 1992), 226].

[6] Ibid., 3 [VI].

[7] Ibid. [VII].

the mathematical theory of walking and running. Everything rests on the fact that legs can provide for their own account, so that in the end they can be in the books as a differential system. In 1836, long before Marey and Muybridge, the attainment of the differential system was at first possible only in stasis, as if Daguerre's long-term exposures had found a scientifically parallel maneuver. In order to make agility at least visible as latent motion, however, the brothers cut up the corpses' hips at the precise location where "the balls of the upper-legs lie in their sockets." Just as in the drawing of a steam engine which would explain the interplay of parts in the moment of explosion, admiring readers can glimpse the interplay between the ball of the thigh bone and the socket of the joint.

> The femoral head or so-called sphere was sawn perpendicularly from in front backwards and the section was printed on the paper. The curvature of the the two parts here cannot be altered by the drawer. The picture is indeed the imprint of the object itself. The bone thus divided can be used as a wood-engraving for print.[8]

Plate IX

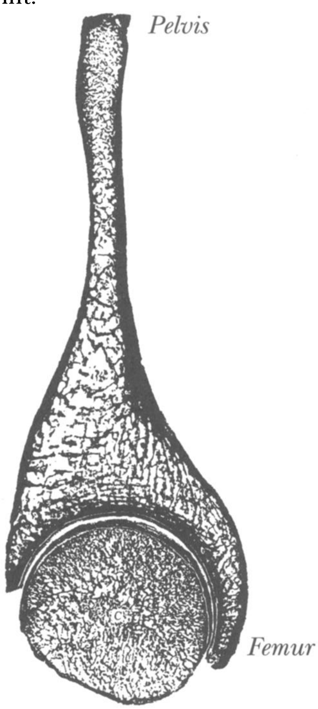

Fig. 1.

[8] Ibid., 14 Fn. [10].

The work of the Weber brothers makes anatomy leave its proud old amphitheaters, where the dissection resulted in findings that made their way to woodcuts only belatedly. Instead, just as Henry Fox Talbot's heliography did four years later, they were put onto the printed page as nature's imprint of itself.[9] Thus the free will of human drawing-hands in scientific visualization remains just as excluded as it is in the mechanics of human legs. On this worldly scene of all religions and dances of the dead, the skeleton appears on the stage of knowledge and points no longer to allegories of death, but rather to nothing more than its own animation.

In order to transpose the latent movements that occur around leg joints, or degrees of freedom, into actual movements, the Weber brothers introduce two simple axioms. First of all, the individual bones whose interplay comprises a step should swing according to the law of the pendulum. The differential equation of every partial movement can thus already be accounted for by falling back on Christian Huygens and his pendulum clock equation from 1656. Secondly, however, the usual human gait should be a periodically iterated interplay of all these partial movements, whereby a period is clearly only counted after a completed pair of steps.[10] In any event, a summation of partial differential equations only appears as total movement according, first of all, to the three dimensions of space, and secondly, according to time. Having made these assumptions, the Weber brothers simply go ahead and copy the formula which Poisson's *Traité de méchanique* in the second, recently published edition from 1838 anticipated for such cases.[11] With this fact, the misfortune which occupies all of our computer monitors today has come into existence: instead of "word, language and image in the truest sense," "symbol and number" have taken over human gait. Cinematics in the French sense of the word, which as of 1830, and at Ampère's instigation, calculates transversal and rotational movements of steam engines, becomes cinematics in the modern sense: it calculates virtual movements in virtual, that is, visualizable spaces.

For the sake of their animation, however, both the leg and Poisson's "general" differential system must make a few sacrifices. "To

[9] See also Susanne Holl, "Ob oculos. Andreas Vesals 'De humani corporis fabrica' und der Buchdruck" in *Kaleidoskopien* 3 (2000), 334–357.

[10] Weber, 191 [128].

[11] Ibid., 217 [152].

simplify the problem we imagine that: 1) Instead of the path there are only some fixed points (similar to stones laid on the path) along a horizontal line placed as far apart as the length of a step. [...] 2) The leg is replaced by a straight solid line standing with its lower extremity on one of these points and is retained there by friction. 3) Instead of being distributed over the entire length of the leg, the mass of the leg is concentrated in one middle point of the solid line. 4) The body is replaced by a mass concentrated in the upper point of this solid line. This mass flies horizontally at an even velocity."[12] In place of the legs and their three joints, a single center of mass around the knee appears in order to swing henceforth perpetually around a dimensionless point which for mathematical reasons has formed itself "instead of the body." As Christian Morgenstern correctly remarks: "A knee alone goes through the world. A knee alone, and nothing else."

In fact: this 'nothing' is comprised of pure trigonometric functions. Sine and cosine are the two angle functions which cause this nothing to step forward; g as gravitation and p as the measure of the circle are the two constants which maintain the steps forward into a period. With knee, gónu, early Greek mathematics indicated the word for angle;[13] from the angle, gonía, arabic and modern mathematics indicated their trigonometric and thus periodic functions. At the end of this short story of sine and cosine stands the lapidary sentence:

The equation

$$g \sin \chi = - r l \frac{d^2 \chi}{du^2}$$

of Ch. 128 is replaced by an approximation, as occurs in analysing the pendulum:

$$g \chi = - r l \frac{d^2 \chi}{du^2}$$ [14]

The freedom of mathematical penstrokes thus finally conquers trigonometry itself. Because neither legs nor pendula are true wheels, that is, they simply do not create angles of any size, the periodic term

[12] Ibid., 217 [152].

[13] Johannes Lohmann, *Musikè und Logos. Aufsätze zur griechischen Philosophie und Musiktheorie*, Anastasios Giannarás, ed. (Stuttgart: Musikwissenschaftlicher Verlag 1970), 20.

[14] Weber, 223 [159].

for a differential equation can be transposed into a linear one. If need be, the sine of c is just c itself. For the sake of simplicity,[15] the Weber brothers only need to posit three further variables of their general leg-swinging equation as constants of one or zero, and paragraph 128, the "Introduction to the Illustration of Walking Figures," almost writes itself. Before computers with their explicit purpose of crunching systems of differential equations—at least numerically—have come into existence, scientific visualization can only occupy itself with mercilessly simplified formula.

In its own progress, the "Establishment of a theory of walking and running" achieves its goal when "the position of both legs" can be constructed "at the various phases of each step" and "according to these laws" or equations in order to enable "the artist" to judge "whether he sees this representation corresponding to the actual attitude of the legs during walking."[16] The new graph-producing science thus appears to subject itself to the judgement of a visual art. It ends with an oppulant appendix of tables and figures which portray two lonely legs or knees in all individual phases of walking, running and jumping in order truly to resynthesize the unity of a pair of steps.

Table XV

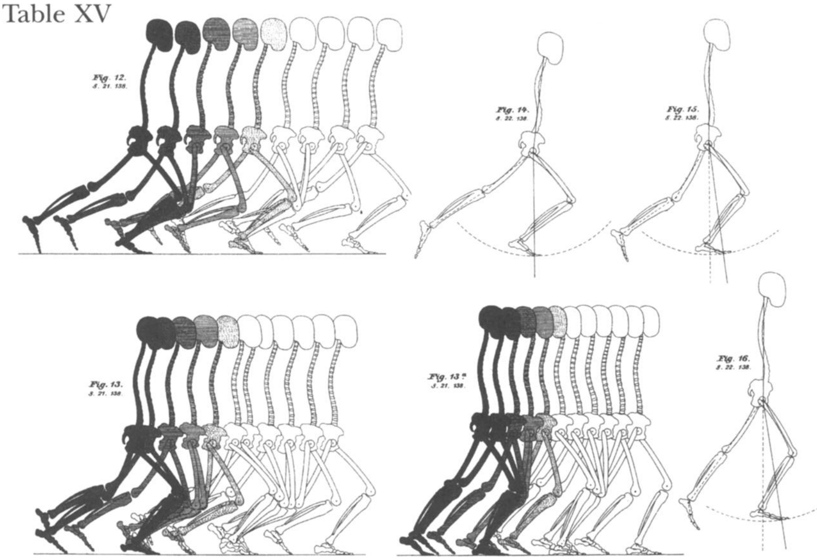

Fig. 2

[15] Ibid., 238 [172].
[16] Ibid., 209 [147].

Table XVI

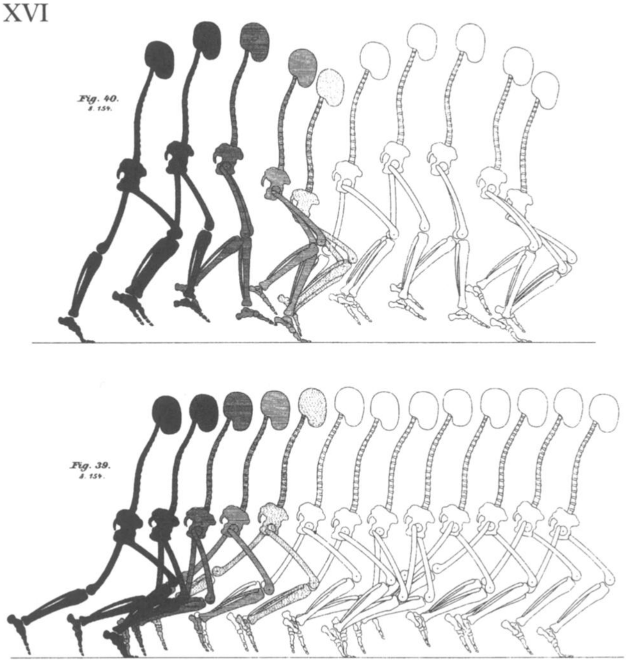

Fig. 3

Tables XV and XVI from Weber and Weber, *Mechanics of the Human Walking Apparatus.*

However, what is and remains decisive as regards scientific visualization is the fact that it is no longer subordinate to the pronounced judgments of traditional arts. The Weber brothers have three good reasons that claim as much. First of all, their entire pride rests on the achievement of having constructed "the various ways of walking" "in the various positions of every step according to theory and without drawing upon experience." Already, the fact that a movement captured in differential equations dictates those laws of movement already elevates such a theory discernably over the belatedness of literary descriptions or painterly representations. Secondly, cinematics and painting relate to each other no differently than early modern geometry and linear perspective once did. Having said as much, the Weber brothers had already brought forth Du Bois-Reymond's arguments, even in a more polite fashion.

> The positions of the different parts of the body change too quickly during walking and running to be completely imprinted on the senses and in the memory instantaneously. To capture them one needs certain instruments and indirect methods which are not available to the artist. [...] It is the same as for the science of perspectives which is so helpful to the artist when dealing with architectural pictures. One should not assert that the inner feeling of the artist is sufficient. In perspective this is never the case. [...] During walking and running one obtains no clear sensory perception of the simultaneous positions of the trunk and limbs because they pass so rapidly. Therefore, the most capable artist lacks the means directly to perceive in Nature, without any help from science, the true circumstances as they actually take place. Using perspective gives us the appearance of the truth by representing the distances in space and the positions of the body. Similarly, study of walking and running brings to our pictures the appearance of the truth in the movements of life which are depicted.[17]

Thirdly, it is decisive that artists, not to mention people in general, cannot perceive the mechanics of the human legs at all. This fact distinguishes cinematics since 1836 from linear perspective, which has been promoted to the very principle of phenomenality and thus of visibility at the latest in the work of Johann Heinrich Lambert.[18] Like the vibrations of the violin's string, the phase pictures of walking pass by too quickly to fall into perceptual times. What people can no longer see or hear, however, calls for technical media. Only "the application of the theory of walking and running," the use therefore of "certain instruments and indirect methods," "can bring the appearance of truth from the portrayed living movement into our images."

Thus let it be—for the second time after Emil Du Bois-Reymond—solemnly pronounced: it was Wilhelm and Eduard Weber, and neither Marey nor Muybridge, neither Edison, nor the Lumière brothers, who programmed the program which goes by the name of film. In "Poggendorffs Annalen der Physik"—in 1836, global physics could still be found in German technical periodicals—both of them, or perhaps really just Wilhelm Weber alone, stumbled on a "known technical device" of Faraday, which for a change did not have anything to do with their common field of research, electro-magnetic induction. Instead, it has to do with "stroboscopic disks" as they had been "used by [Joseph] Stampfer" in order to display "these draw-

[17] Ibid., 6 [3].

[18] For further information on Lambert, see Friedrich Kittler, *Perspektive, Phänomen, Medium. Von J. H. Lambert zu G. W. F. Hegel* (forthcoming).

ings" before one's eyes "in such a succession that they gave the impression of a figure walking quite normally."[19] In other words: that "certain instrument," which "brings the appearance of the truth of the copied living movement into our images" is quite simply called a stroboscope. To the great delight of Emil Du Bois-Reymond, the "mechanics of human legs" ends with how-to instructions that go far beyond the state of affairs which scientific books and their attached tables could achieve. The how-to directions of Wilhelm and Eduard Weber are designed—for the first time in the history of science, as far as I can tell, for the visualization of partial differential equations.

It is interesting to illustrate the space and time data determined absolutely according to the theory, by building and drawing the position of the limbs at each moment of walking and running regularly. There is a means of convincing oneself that this construction matches experience as well as possible despite the imperfect measurement of the body on which one must rely. This means consists of drawing a number of pictures representing the man in his successive positions during two steps. The internal surface of a cylinder or of a drum is divided into as many facets as there are pictures plus one. The succesive pictures are glued one on each facet in proper order so that each picture on its facet appears as more displaced forwards than the previous one. The middle picture seems to be exactly one step further than the first. The length of the construction must be equal to the length of a double step. The drum is rotated at an even speed during the time of a double step. The figures are observed through slits opposite in the wall of the drum. They appear as if walking or running. Their movements show a surprising similarity with the movements of a man actually walking or running. If one had never seen a man walk or run, and if one only knew the relations between his limbs, one could with the help of the theory acquire a representation of these movements closely matching experience and predict what would happen during these displacements.[20]

With this grand prediction, the book ends. On its long path, past Poisson and Faraday to the Weber brothers, Euler's mathematics of rotational movements has arrived in a rotating machine which serves as the "means" or medium of physiological-physical animation. On the smallest stage in the world, the double-step revolves again and

[19] Weber, 238 [172].
[20] Ibid., 294 f. [218].

again, removed as it is from all empiricism. Progress stands still, because it is completed. As in the differential system, the sine of 0 and 2 x p are one and the same.

At precisely the position of such completion, positivists like Du Bois-Reymond literally forget their part. His report on Weberian "mechanics" simply glosses over the "surprising agreement" between simulated and empirical walking, in order to fade in a prehistory of film in its place. After Marey's flying birdwings and Muybridge's galloping horse legs, everything is read in a completely different way. In 1890, what emerges out of the eternal return of poesy from a limited number of images of the stroboscope is the endless prose called film.

"The peculiar effect presented itself," Du Bois-Reymond writes about the Weber brothers, "the figure portraying the beginning and end of the step, where man rests for a short time on both feet, certainly looks completely as painters have always already portrayed walking people, except that in the middle of the step, where the so-called moving leg swings past the standing leg, the most strange and even ludicrous sight appears: like a drunken town-musician, man seems to trip over his own feet, and no one has ever seen a walking man in such a position."[21] Science thus becomes the alienation effect which strips quotidian and artistic perception of the fiction of totalization, in order to reveal the naturalistic truth of the drunken town-musician behind the aesthetic appearance of human walking. One may be astonished: that Du Bois-Reymond is not exactly writing about drunks at the town fair or stroboscope exhibitors is already a wonder. Indeed, Norbert Wiener began after 1920 to equate his utterly non-differentiable functions expressly, albeit metaphorically, with the pace of a drunken sailor in order to smuggle concepts like prose, series of chance, and drunken behavior into mathematics. Under such prosaic conditions, science becomes the courage to tolerate "the strangest, most ludicrous sight" of mathematical-synthesized movement long enough until empirical, that is, prosaic media techniques like film rush to the rescue. Eduard Weber, as Du Bois-Reymond continues to say, unfortunately passed away in 1871, that is, scarcely one year before Muybridge's unexpected sequential horse-leg pictures, "Herr Wilhelm Weber has however seen that after almost four centuries, instant photography declared him and his brother to

[21] Emil Du Bois-Reymond, "Naturwissenschaft und bildende Kunst" in *Reden* (Leipzig: Veit 1912, expanded edition), 407.

be completely correct. Mr. Eadweard Muybridge in San Francisco first applied it in 1872 at the encouragement from Mr. Stanford, in order to capture the sequential positions of horses in various gaits. The same thing was then shown as had been seen in the Weberian schematic drawings: images appeared as no one could have imagined seeing them in reality. Oriented toward street scenes, processions, and such things, the camera frequently captures images of people in just as strange positions, as those which the Weber brothers had assigned to them for theoretical reasons. The same could be said about the amazing series of images of a flying bird during the beat of a wing which Herr Marey aimed for through his photographic flint."[22]

I am coming to the end. Surely, it would be nice to know whether Wilhelm Weber, who died in Göttingen in 1891, could have chatted with Du Bois-Reymond about horses' legs. The ancestral gallery of our technical images would have had one more forefather, and the stage of knowledge one more hero's role. And the boredom, that every year new books appear on Jules-Étienne Marey as the scientific origin of cinema, would be ended.[23] Out of pure nostalgic love that celebrates film like Eurydice, in proportion to its disappearance, the differences between prose and poesy, between Marey's graphic method and Wilhelm Weber's movement equations, disappear too. Apparently, historians of media do not want to admit even today that augurists of virtual motion are always already in advance of the forerunners of cinema. It is not Marey's "animal machine," but rather Weber's "mechanics of human legs" that casts its shadow up to the present day.

For it is the case that, of the two goals of media techniques that the Weber brothers presented in good platonic fashion as "ideas for a theory of walking and running," they only achieved the first.[24] In the wheel of life known as the stroboscope, the cartesian subject is turned as a machine. According to Wolfgang Schäffner, the drill-regiment of Moritz of Orange is finally sublated into a mathematical concept. That is however the reason why the Weber brothers expressly forego the further elaboration of completely possible "applications" of their differential equations "toward military science."[25] The second, or

[22] Ibid., 407f.
[23] Michel Frizot, "Comment ça marche. De l'exactitude dans l'instant" in *La Revue du Musée d'Orsay* 4 (1997), 74–83.
[24] Weber, 205 [144].
[25] Ibid., XII.

rather highest, point of their goals is no longer a living being, but rather the complete and "successful"[26] formulation of all models for the construction of machines "which, like man, are carried by two supports and move forwards by alternating support and swing."[27] The fact that their mathematics reduces man's two legs to simple pendula or connecting rods thus has good reasons. Certainly, "the human spirit of invention has most recently achieved the construction of steam engines which, without being pulled by animals, move with great speed and power." But steam engines or "railroad trains" give up on soft or steep ground, or when faced with "desert" or "rivers."[28] The mechanics of the human legs would therefore only be completed when they were implemented as robotics, whereby it would no longer play a role whether "a machine moved through steam" would come "on two, four, six or more legs."[29] As far as one hears, the Japanese infantry, because of their well-known recruitment problems, is at least the most advanced at this time when it comes to two-legged fighting robots.

With this last argument, however, the inquiry of the Weber brothers is reversed just as dramatically as it is consequently. No further equation is sought in order to calculate a path from given lines and angles which once had been known as legs. Quite the opposite is the case: what is sought is an equation that derives the corresponding legwork from the given beginnings and endpoints of a spatial displacement. From the cinematics of 1836 have emerged the inverse cinematics of today, and that means cinematics as determined by computers. There is no computer graphicist who does not—according to Euler, Poisson, or Weber—have to solve differential equations of a spatial displacement. All computer animations which make their way onto our monitors by walking, flying or even shooting are products of a "prediction" from 1836: "If one had never seen a man walking and running, and only knew the proportions of his limbs, then one could with the help of theory create an idea of these movements that fits experience very well and that could predict what happens through these movements." On computer monitors, if I may continue and conclude, science steps onto the stage.

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[26] Ibid., 210 [147].
[27] Ibid., 209 [147].
[28] Ibid., 4 f. [2].
[29] Ibid., 4 [2].