Body_Machine? Encounters of the Human and the Mechanical in Education, Industry and Science

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Abstract: This paper unveils the body-machine as a key element of dynamic mental maps that have come to shape both educational praxis and research. It traces and analyses instances in which the human and the mechanical encountered each other in metaphorical, material and visual forms, thereby blurring to some extent the boundaries between them while capturing and mobilising specific forms of knowing and acting. The paper studies firstly, how certain 'orienting frames of reference' and associated 'experimental systems' managed to materialise around the body-machine and penetrate theory and praxis; and, secondly, what visual and textual sources related to a vocational school may reveal about where and how the body-machine has come to operate in education, industry and science. The paper centres on early twentieth century photographs and analyses these not only as media presenting, representing and interrogating common thought and practice but also as agents of meaning-making around the body-machine.

Keywords: vocational education and professional orientation; physical-mechanical interconnections; body-machine metaphors, images and concepts; rationalisation and mechanisation of education

> The locomotive, the steam engine and the machine are images that need no explanation of a technical order to find a parallel in the images used for the body.[1]
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> Does a thing even exist without an orienting frame of reference, into which it is "embedded", which helps make visible its connections, which makes it a thing to begin with, without which it would be a mere fact?[2]

Introduction

This paper unveils the body-machine as a key element of dynamic mental maps that have come to impact industry as well as educational research and practice. It traces and analyses instances in which the human and the mechanical encountered each other in metaphorical, material and visual

[1] Jacques Gleyse, et al., 'Physical Education as a Subject in France (School Curriculum, Policies and Discourse): The Body and the Metaphors of the Engine – Elements Used in the Analysis of a Power and Control System during the Second Industrial Revolution', *Sport, Education and Society* 7, no. 1 (2002): 10.

[2] Hans Blumenberg, *Quellen, Ströme, Eisberge* [Sources, currents, icebergs] (Berlin: Suhrkamp, 2012), 20.

forms,[3] thereby blurring to some extent the boundaries between them.[4] The trajectories followed in the paper go against the grain of strict historical chronology; they make it possible however, to explore the forms of meaning, knowing and acting that have emerged around the body-machine. The paper thus seeks to illuminate how the body-machine has given way to dynamic mental dispositions affecting concrete practices. In an exemplary fashion it connects body-machine metaphors with early twentieth century photographs of testing, registration and/or training devices, gymnastic equipment, sanitary installations, and industrial-mechanical instruments. These visual materials serve as entranceways into the 'orienting frames of reference'[5] or 'mental maps'[6] that have emerged around the physical-mechanical and helped to develop 'experimental systems'[7] which in turn have come to underlie and impact fields like education and educational research. To this end three methodological approaches to photography are combined to visually capture and analyse the interconnections of the physical and the mechanical: a first approach stresses the distinctly presentational quality of photographs[8] in that they visually demonstrate and propagate the intertwining of bodies and machines; a second approach draws upon Erwin Panofsky's work and looks at photographs as cultural representations loaded with symbolic layers of meaning in specific social-cultural contexts;[9] and, finally, a third approach, albeit

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[3] Recently, a similar endeavour has been undertaken by Petrina, albeit in a different context. See Stephen Petrina, 'Postliterate Machinaries', in *New Frontiers in Technological Literacy: Breaking with the Past*, ed. John R. Dakers (New York: Palgrave MacMillan, 2014), 29–43. In a different context still, Francis F. Lee has touched upon the topic of 'machine-to-man-communication'. See Francis F. Lee, 'Machine-to-Man Communication by Speech Part 1: Generation of Segmental Phonemes from Text'. Proceedings of the April 30-May 2, 1968, Spring Joint Computer Conference (S.l.: ACM, 1968), 333–338.

[4] More precisely, the human and the mechanical became 'inextricably related' or – to use a notion central to current socio-material approaches – 'entangled'. For an account of frequently used terms in this context (e.g., inseparability, interpenetration, relationality and, embodiment) and commingled ontological views underlying them, see Matthew Jones, 'Untangling Sociomateriality', in *How Matter Matters: Objects, Artifacts, and Materiality in Organizations Studies*, eds. Paul R. Carlile, Davide Nicoloni, Ann Langley and Haridimos Tsoukas (Oxford: Oxford University Press, 2014), 197-226.

[5] Similarly, Hans Blumenberg (*Quellen, Ströme, Eisberge*) has shown how the source metaphor has managed to have significant methodological impact on historical research.

[6] Staffan Müller-Wille and Hans-Jörg Rheinberger, *A Cultural History of Heredity* (Chicago, London: The University of Chicago Press, 2012).

[7] Hans-Jörg Rheinberger, 'Epistemische Dinge [Epistemic things]', in *Handbuch Materielle Kultur: Bedeutungen, Konzepte, Disziplinen* [Handbook on material culture: Meanings, concepts and disciplines], ed. Stefanie Samida, Manfred K.H. Eggert and Hans Peter Hahn (Stuttgart, Weimar: Metzler, 2014), 193–7. Rheinberger describes 'experimental systems' as socially, culturally, technically and epistemically defined entities constituting a kind of 'experiental space' which continuously changes as it is affected by and in turn affects scientific theory and practice. The usefulness of his concepts, however, extends far beyond the domain of science, also into the field of education.

[8] E.g., Karin Priem, 'Facts for Babies: Visual Experiments at the Intersection of Art, Science and Consumerism in Education', *Sisyphus – Journal of Education* 3,1 (2015): 18–36.

[9] See Erwin Panofsky, 'Zum Problem der Beschreibung und Inhaltsdeutung von Werken der bildenden Kunst [On the issue of describing and interpreting works of visual arts]', in *Ikonographie und Ikonologie: Theorien – Entwicklung – Probleme. Bildende Kunst als Zeichensystem (Vol. 1)* [Iconography and

followed more sporadically, analyses photographs on a socio-material level,[10] as active and interactive agents adding further threads to the web of meaning around the physical-mechanical. At a visual-material level they testify of the extent to which and ways that metaphorical and epistemic dimensions are related and variously intertwined. As its main research questions, then, the paper explores, firstly, how dynamic mental dispositions and associated experimental systems have managed to materialise around the body-machine and penetrate the theory and practice of education; and, secondly, what visual and textual sources reveal about where and how the body-machine has come to operate in the field of education broadly understood. In turn, the paper's main hypotheses are: firstly, that it required specific developments in the social, industrial-technical and scientific spheres for body-machine metaphors to become key elements of shared dynamic mental maps which – as entangled epistemic concepts – further shaped the concrete material ways that bodies, minds and machines intertwined; and, secondly, that this materialisation and the corresponding technologies, rhetoric and visualisation perhaps most markedly as of the mid-nineteenth century have helped to further consolidate, perpetuate and transform the body-machine in education and society at large.

In what follows, then, we will first trace some of the origins of the body-machine as a node of utopian-dystopian projections; next, we will investigate, through early twentieth century visual and textual materials, the powerful material/visual/metaphorical working of the 'human motor' as an instantiation of the body-machine in a range of contexts; and finally, we will explore residual traces of the body-machine in educational research. Throughout the paper, our focus will zoom in on and out of the microcosm of the *Institut Emile Metz*, which was established as a vocational school in 1914 in Dommeldange, Luxembourg.[11] As part of a wide range of initiatives

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iconology: Theories – development – problems. Visual arts a sign system (vol. 1)], ed. Ekkehard Kaemmerling (Cologne: DuMont, 1979), 185–206; Ibid., 'Ikonographie und Ikonologie [Iconography and Iconology]', in *Ikonographie und Ikonologie*, 207–24.

[10] See Elizabeth Edwards, 'Objects of Affect: Photography Beyond the Image', *The Annual Review of Anthropology* 41 (2012): 221–34. In another context Françoise Poos has referred to images as "active agents", performing in a "network of social connections" and "triggering performances". See Françoise Poos, 'Hidden Images: The Making of a National Family Album' (Photographic History Research Centre, Faculty of Art, Design and Humanities, The Montfort University, Leicester), in reference to Elizabeth Edwards, Chris Gosden and Ruth Phillips, eds., *Sensible Objects: Colonialism, Museums and Material Culture* (Oxford, UK: Berg, 2006); and, more particularly in terms of her conceptualizing such entangled threads of meaning as "meshworks", to Tim Ingold, *Lines: a Brief History* (London: Routledge, 2007); Ibid., 'Bindings against Boundaries: Entanglements of Life in an Open World', *Environment and Planning A*, no. 40 (2008): 1796–810. See also ibid., 'Bringing Things to Life: Creative Entanglements in a World of Materials' (unpublished paper, University of Aberdeen, 2010). The authors think that a strict social-material approach necessitates a separate paper that would explicitly stress and analyse the trajectories of specific images, how they materialise in different media, how they travel across time and space, interact with different audiences, participate in social life and, consequently, actively contribute to meaning making, knowing and acting.

[11] The *Institut Emile Metz* was not just a vocational school. Some of its facilities, such as its library and swimming pool, were also open to adult workers of the factory to which it was annexed. For further information on the institute, its psycho-physiological laboratory, its main protagonists and its relation to

connected to ARBED (the Aciéries Réunies de Burbach-Eich-Dudelange), a major steel company founded in 1911, it was situated at the crossroads of such interrelated areas as physical rehabilitation, psychometrics, gymnastics and hygiene. These domains are assumed to have been based on similar 'mental maps' offering conceptual space to promote human bodies as motors of progress.

The human motor as a node of utopian-dystopian projections

At the opening of the psycho-physiological laboratory of the *Institut Emile Metz* in December 1919, the inauguration speech was given by the industrial ergonomist and fatigue expert Jules Mardochée Amar (1879-1935). This speech illuminated the main principles of his work on the "human organism" in the context of labour, linking this organism to the laws of "general mechanics" and "modern physiology".[12] Allegedly "verified by a judiciously elaborated experimental technique", his principles centred upon the "'architecture' of the human body, the muscular 'motor', nutrition and energy expenditure, the productivity of the human machine, the physiological effects of work, notably fatigue, man and environment, balance and movements of the human body at work, etc. […]".[13] These principles, explored and elaborated most prominently in Amar's key work, *Le moteur humain* (The Human Motor), testify to the changing ways in which the human body and the machine became intertwined over time. Indeed, the very terms used point to a multitude of conceptions around the body and the machine, which found new expression in the specific metaphor of the human motor.

Whilst some of the epistemic traces that have come to form the layered archive behind the human motor metaphor are descended from a millennia-old Greek (and later Christian) tradition[14] and others date back to the Middle Ages or the Renaissance,[15] in the course of the

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social-educational reform; see Frederik Herman, 'Forging Harmony in the Social Organism: Industry and the Power of Psychometric Techniques', *History of Education* 43, no. 5 (2014): 592–614.

[12] Aloyse Robert, 'La méthode psycho-physiologique du travail et l'orientation professionnelle [The psycho-physiological method of work and career guidance]', in *Institut Emile Metz Dommeldange. Programme publié à la clôture de l'année scolaire 1919–1920/Programm herausgegeben am Schlusse des Schuljahres 1919–1920* [Programme published at the close of the school year 1919–1920], ed. Institut Emile Metz (Luxembourg: Imprimerie Joseph Beffort, 1920), 53–4; Aloyse Robert, 'L'apprentissage industriel et l'enseignement professionnel [Apprenticeship and vocational training]', In *Institut Emile Metz Dommeldange. Programme publié à la clôture de l'année scolaire 1918–1919/Programm herausgegeben am Schlusse des Schuljahres 1918–1919* [Programme Published at the Close of the School Year 1918–1919], ed. Institut Emile Metz (Luxembourg: Imprimerie Universelle Linden & Hansen, 1919), 47–55.

[13] Ibid., 54.

[14] See also Ursula P. Jauch, *Jenseits der Maschine: Philosophie, Ironie und Ästhetik bei Julien Offray de La Mettrie (1709–1751)* [Beyond the machine: Philosophy, irony and aesthetics in Julien Offray de La Mettrie (1709–1751)] (Munich,Vienna: Carl Hanser Verlag, 1998); Reinhard Klette and Garry Tee, 'Understanding Human Motion: A Historic Review', in *Human Motion: Understanding, Modelling, Capture, and Animation*, eds. Bodo Rosenhahn, Reinhard Klette, and Metaxas Dimitris (Dordrecht:

seventeenth and eighteenth centuries, as the steam engine[16] and the calculator were developed, other traces appear on the map, which mark the shift towards images of the energy-driven human motor and precursors of the twentieth-century data-processing biological computer.[17] During the nineteenth and twentieth century, metaphors of the human engine indeed increasingly acquired specificity through their intimate connection to industrialisation[18] and the ensuing omnipresence of steam, metal and electricity, the quest for productivity, yield and energy balance.[19] At the same time this did not prevent counter-images such as that of the 'human plant'[20] from complicating human/machine and human/motor metaphors and ensuing epistemic concepts.
In any case, the body-machine metaphor, whose manifold expressions had a material basis and in turn reshaped social, cultural and material conditions surrounding it, early on found its analogue

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Springer, 2008), 1–22.

[15] See, e.g., Anson Rabinbach, *The Human Motor: Energy, Fatigue and the Origins of Modernity* (Berkeley, Los Angeles: University of California Press, 1992), 51, 64; Jauch, *Jenseits der Maschine*; Carolyn Thomas de la Peña, *The Body Electric: How Strange Machines Built the Modern American* (New York, London: New York University Press, 2003), 23–4; Marc Depaepe, *Paradoxen van psychologisering: Over de constructie van het 'zelf' in de geschiedenis van de kennis en de wetenschap over het menselijk gedrag* [Paradoxes of psychologisation: On the construction of the 'self' in the history of the knowledge and science of human behaviour] (Kortrijk: Acco, 2009), 78–80, 88; Viktor Manzin, 'Die Maschine Mensch oder La Mettries Antimatrix [Man a machine or La Mettrie's antimatrix]', in Maschinentheorien/Theoriemaschinen [Machine theories/theory machines], eds. Hans-Christian von Herrmann and Wladimir Velminski (Frankfurt am Main, Berlin, Bern, Brussels, New York, Oxford,Vienna: Peter Lang, 2012), 233–256.

[16] Later, internal combustion engines like petrol explosion engines and electric motors contributed to the emergence of still other traces.

[17] Gleyse, et al., 'Physical Education', 6, 10–20.

[18] A worldwide bestselling author of the 1920s and 1930s, the physician Fritz Kahn, described the human body in technical metaphors and made several well-known illustrations of the human body as a factory (*Der Mensh als Industriepalast*). See, Martin Kohlrausch and Helmuth Trischler, *Building Europe on Expertise. Innovators, Organizers, Networks* (New York: Palgrave Macmillan, 2014), 106.

[19] In this context, Laurence Guignard, Pascal Raggi and Etienne Thévenin list an entire range of machines that were designed to help and assist the human body or contribute to its expansion, destruction or perfection: health machines, death machines, work machines (including machines that served to further control and record the human body, such as photography), entertainment machines and machines to enhance regeneration or control fatigue. See Laurence Guignard, Pascal Raggi, and Etienne Thévenin, eds., *Corps et machines à l'âge industriel* [Bodies and machines in the industrial era] (Rennes: Presses Universitaires de Rennes, 2011). See also Philipp Blom, *Alleen de wolken: Cultuur en crisis in het Westen, 1918–1938* [Fracture: life and culture in the West, 1918–1938] (Amsterdam: De Bezige Bij, 2014); Elspeth H. Brown, *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884–1929* (Baltimore & London: The Johns Hopkins University Press, 2005) and Michaela Vieser, *Das Zeitalter der Maschinen: Von der Industrialisierung des Lebens* [The machine age: On the industrialisation of life] (Berlin: Edition Braus Berlin GmbH., 2014) (which includes numerous visual sources).

[20] See, e.g., Luther Burbank, *The training of the human plant* (New York: The Century Co., 1907).

in imagery and, as of the early nineteenth century, photography in particular. More generally, technological developments and associated textual and visual body-motor images in the course of the nineteenth and twentieth centuries went together with the emergence of new (would-be) sciences such as labour science (which developed from closely related fields of knowledge including psychophysiology, thermodynamics, psychophysics, experimental psychology and psychometrics), epidemiology and hygiene, all of which competed with each other and other disciplines over the ownership of the human motor as an epistemic space. Sometimes engineers were said to be "strangers to physiological questions" and deprived of "the means to appreciate the degree of fatigue",[21] other times psychologists or physiologists were accused of having only speculative, unrealistic laboratory knowledge on the matter.[22] More importantly, all of these scientific disciplines were concerned with the laws of the human motor and its observability, measurability and controllability.[23]

Some key elements that connect to the way the human motor was conceptualised across disciplines can be identified in the institute's inauguration speech by Amar mentioned above. Published in 1920, Amar's speech, like his main work, *Le moteur humain*, indeed is based on associations made around the body-motor, some of which it helped strengthen and proliferate in its turn.[24] The vocabulary he used explicitly and implicitly reiterates contemporary commonplace tropes such as energy, fatigue and overburdening, adaptation, endurance, infection, constitution, efficiency, productivity and automatisation capacity, which can also be found in numerous other sources related to the institute and its key figures.[25] The report reveals the projections, utopian as

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[21] E.g., Jules Amar, *Le moteur humain et les bases scientifiques du travail professionnel* [The human motor and the scientific foundations of labour] (Paris: H. Dunod et E. Pinat, 1914), 606.

[22] Ibid. See also Rabinbach, *The Human Motor*, 247–9.

[23] See, e.g., Nancy Tomes, *The Gospel of Germs: Men, Women, and the Microbe in American Life* (Cambridge, MA, London: Harvard University Press, 1999); Alfons Labisch, 'Sozialhygiene: Gesundheitswissenschaften und öffentliche Gesundheitssicherung in der zweiten Hälfte des 19. Jahrhunderts [Social hygiene: Health sciences and public health insurance in the second half of the nineteenth century]', in *Sei sauber…! Eine Geschichte der Hygiene und öffentlichen Gesundheitsvorsorge in Europa* [Be clean…! A history of hygiene and public health prevention in Europe] (Cologne: Wiemand Verlag, 2004), 258–67.

[24] An English translation of his *Le moteur humain* was published in the same year. Jules Amar, *The Human Motor or The Scientific Foundations of Labour and Industry* (London: George Routledge & Sons, New York: E.P. Dutton & Co., 1920).

[25] See, e.g., Institut Emile Metz, *Institut Emile Metz Dommeldange. Programme publié à la clôture de l'année scolaire 1916–1917/Programm herausgegeben am Schlusse des Schuljahres 1916–1917* [Programme published at the close of the school year 1916–1917] (Luxembourg: Victor Bück, 1917), 88; Jules Amar, *Le rendement de la machine humaine: Recherches sur le travail* [The yield of the human machine: Studies on labour] (Paris: J.B. Baillière, 1910); Jules Amar, 'L'organisation scientifique du travail humain [The scientific organisation of human labour]', *La Technique Moderne* 7, no. 4 (1913): 113–8; Amar, *Le moteur humain*; Jules Amar, *La prothèse et le travail des mutilés: Conférence faite pour les oeuvres de mutilés* [The prosthetic device and labour of the mutilated: Conference held in the frame of

well as dystopian, then grafted onto the human motor which functioned as a site of inscription fuelling social, political and cultural visions, fears and promises; as an absorber of all kinds of frantic movement; as a node of concerns around, for example, the use, preservation and loss of mental and physical resources, and the presence, absence or degree of efficiency, harmony, productivity, integrity, health and nutrition. In other words, by the time the *Institut Emile Metz* became fully operational, positioning itself as of the early 1920s at the vanguard of fields like psychometrics, hygiene and gymnastics, the metaphor of the human motor, like a magnet, had attracted a specific set of intertwined concepts in such spheres as politics, the economy, medicine, psychology and education. Purposely or not it thereby acted as a neutraliser of the kind of social and cultural tensions and inequalities that were thrown into sharp focus with the rise of socialism and communism (relating, for instance, to status, hours of work, and pay).[26] Evoking connections between the dynamic laws of nature, society and industry, the human motor metaphor at the same time legitimised the assessment, registration and training of the body,[27] practices which in turn were related, sometimes in new ways, to all sorts of machinery, from test apparatuses, to sanitary installations, to gymnastic devices. Bodies became seen as both flowing, flexible, rhythmical by nature and mechanical, steerable, and subject to repetition and hardening.[28] Intimately tied to all kinds of technical apparatuses informed by various experimental systems, bodies, as human motors, over time became caught up in a web of repeating configurations. Stressing these motors' 'measurability' and 'manipulability', the latter were also to affect educational research, of which more in a moment.[29]

By the time Amar gave his inaugural speech, unprecedented and overwhelming events had come

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initiatives for the mutilated] (Paris: H. Dunod et E. Pinat, 1916); Jules Amar, *Titres et travaux scientifiques* [Scientific publications and works] (s.l.: s.n., 1919) [file: 110133v.CLVIII n°1, Bibliothèque interuniversitaire de Paris], 37–8; Aciéries Réunies de Burbach-Eich-Dudelange (ARBED), *Oeuvres sociales* [Welfare initiatives] (Luxembourg: Victor Bück, 1922), 41; Aloyse Robert, 'Autour d'une conférence internationale de psychotechnique appliquée à l'orientation professionnelle [On the Subject of an International Conference on Psychotechnology applied to Career Guidance]', in *Institut Emile Metz Dommeldange. Programme publié à la clôture de l'année scolaire 1921–1922/Programm herausgegeben am Schlusse des Schuljahres 1921–1922* [Programme published at the close of the school year 1921–1922], ed. Institut Emile Metz (Luxembourg: Imprimerie Th. Schroell,1922), 61–2, 71–4.

[26] Illustrative in this respect is the way how the human motor became incorporated in, and entangled with, the prevailing rhetoric about 'the humanising of labour', which placed the emphasis on the positive effects of the mechanisation of labour for the workers and, as such, placated opposing labour movements and supported the durability of social arrangements. This also applied to 'energy', as Raf de Bont has demonstrated. See Raf de Bont, 'Energie op de Weegschaal: Vermoeidheidsstudie, Psychotechniek en Biometrie in België (1900–1945) [Energy in the scale: Fatigue studies, psychotechnics and biometrics in Belgium (1900–1945)]', *Belgisch Tijdschrift voor Nieuwste Geschiedenis/Revue Belge d'Histoire Contemporaine* 32, no. 1–2 (2002): 23–71.

[27] Cf. Rabinbach, *The Human Motor.*

[28] See, e.g., Rudolf Bode, *Ausdrucksgymnastik* [Expression gymnastics] (Munich: Oskar Beck,1922).

[29] Müller-Wille and Rheinberger, *A Cultural History*, 1–3.

to transform the understanding of bodies and the relationship between bodies, minds and machines. The Great War – this world-shattering machinery, crushing people of all classes and maiming their bodies in an unprecedently gruesome fashion with the aid of new technology and weapons – partly redrew the map we have described so far.[30] It resulted in new, highly visible and near-seamless fusions of bodies and apparatuses through prostheses, which went hand in hand with a fixation on recovering disintegrated limbs and – based on a belief in mechanical progress – rehabilitating discredited technology. Other developments facilitated the transformation of imaginaries around the human and the mechanical, and with them the way that mechanisation (and automatisation) was (were) perceived.[31] In the leisure sphere, for instance, individuals found themselves both fascinated and overwhelmed by inventions such as the steam, hydraulic and electrical elevators popularised at the 1853 New York World Exhibition or the motion picture, which emerged around 1890. In the area of labour, industrialisation led to increasing rationalisation and mechanisation – processes which clearly affected people. Working conditions were in turn seen as both threatening individual autonomy and facilitating economic efficiency.[32] Similarly, the individual at the site of production was deemed at risk of disintegration, depersonalisation and demoralisation.[33] Such processes were moreover perceived as potentially harmful not only to the physical body but also for the 'social organism', where a "lack of vital cells" could lead to "social disease" of a "contagious" nature.[34] These very terms echoed the new vocabulary connected to the marvellous discoveries in chemistry and epidemiology. The diagnosis was a degree of "social intoxication", which was linked at the same time to insufficient remuneration, labour accidents,[35] and the rise of social unrest and socialism or communism. Newly emerging forms of organisation and all kinds of potentially disrupting

[30] Cf. Gordon Hughes and Philipp Blom, *Nothing but the Clouds Unchanged: Artists in World War I* (Los Angeles, California: The Getty Research Institute, 2014); Roxanne Panchasi, 'Reconstructions: Prosthetics and the Rehabilitation of the Male Body in World War I France', *Differences: A Journal of Feminist Cultural Studies* 7 (1995): 119–121. Of course, the first World War did not constitute a complete rupture with the past. See Jean-Michel Rabaté, *1913: The Cradle of Modernism* (Malden, Oxford, Victoria: Blackwell, 2007).

[31] Indeed, ambivalence increasingly characterised this perception and promoted counter-metaphors to the human motor like that of the self-determined, creative human being; see Meyer-Drawe, 'Maschine [Machine]', 731. See, also, Constance Classen, *The Deepest Sense: A Cultural History of Touch* (Urbana, Chicago, Springfied: University of Illinois Press, 2012), 180.

[32] Cf. Aloyse Robert, 'Coup d'oeil rétrospectif sur 40 années d'activité de l'Institut Emile Metz [Retrospective look at 40 years of activity at the Institute Emile Metz]', in *L'Institut Emile Metz 1914–1954*, ed. Institut Emile Metz (Luxembourg: Imprimerie Bourg-Bourger, 1954), 80–1; Robert Schuler, 'Quarante ans après [Forty Years On]', in *L'Institut Emile Metz 1914–1954*, ed. Institut Emile Metz (Luxembourg: Imprimerie Bourg-Bourger, 1954), 19–20.

[33] ARBED, *Oeuvres sociales,* 41.

[34] Ibid. See also Robert, 'La méthode psycho-physiologique du travail', 60.

[35] Amar, *Titres et travaux scientifiques*, 9–11.

events[36] both facilitated and complicated society's conception as a 'social machine'.[37]
In the midst of this frenetic movement, not least in view of the "cult of economic harmony" pursued at the time,[38] it was necessary to command the social machine, the individual body-motor and the (newly discovered) micro-organisms that could threaten this body-motor's "internal machinery"[39] to guarantee the optimal functioning of society. One way to command the human machine on all of these levels was to calculate. Indeed, in the field of 'social physics', for instance, as promoted by Adolphe Quetelet and his writings on the 'average man' (*L'Homme Moyen*), individuals and populations over time became ever more intimately tied to models and devices of computation – for instance, population censuses, national statistics, and anthropometric/psychometric measurement systems – transforming them both into aggregates and individual units situated at a given distance ('deviance') from the average.[40] The associations made between computing and human/social functioning over time were to impact the social and human sciences to great extent, and with them also educational research.

The human motor inside and outside the *Institut Emile Metz*

[36] Migration, as one such event, not only became conceived as something threatening while also repairing a society's internal machinery, but also became medicalised and seen as both an 'injection' of newly qualified workers and an 'infection' of the social fabric; likewise, urbanisation was understood as the development and tumour-like growth of cities. See Alan M. Kraut, *Silent Travellers: Germs, Genes and the 'Immigrant Menace'* (New York: Basic Books, 1994). In contrast, increased bureaucratisation supported more purely mechanical views of society as it was taken to be a precondition of well-oiled policy-making and seen as a seemingly neutral, objective and democratic generation of data and categories on demography, health, prostitution, violence, etc. See Jacob P. Mayer, *Max Weber in German Politics* (London: Faber And Faber, 1944), 125–131. Similarly, the functioning of the economy was seen as either a smooth or dysfunctional machine-like process associated both to the opening up of international markets, transfer of ideas, etc. and a deregulation of trade and an explosion of economic traffic. See Jürgen Osterhammel, *Die Verwandlung der Welt: Eine Geschichte des 19. Jahrhunderts* [The transformation of the world: A history of the nineteen hundreds] (Munich: C.H. Beck, 2009). With this traffic would come competition, economic instability and insecurity, reliance on circulation-, money- and goods-dependent markets that differed from those in a predominantly agricultural society dependent on the environment.
[37] Amar, *La prothèse et le travail des mutilés*, 3.
[38] ARBED, *Oeuvres sociales*, 41.
[39] Ferdinand Papillon (1874), cited in Tomes, *The Gospel of Germs*, 42.
[40] Among the many computation models or devices converting aspects of human activity into data similar to those used at the *Institut Emile Metz* were those developed by Dudley Allen Sargent at Harvard University; see Thomas de la Peña, *The Body Electric*, 64–72.

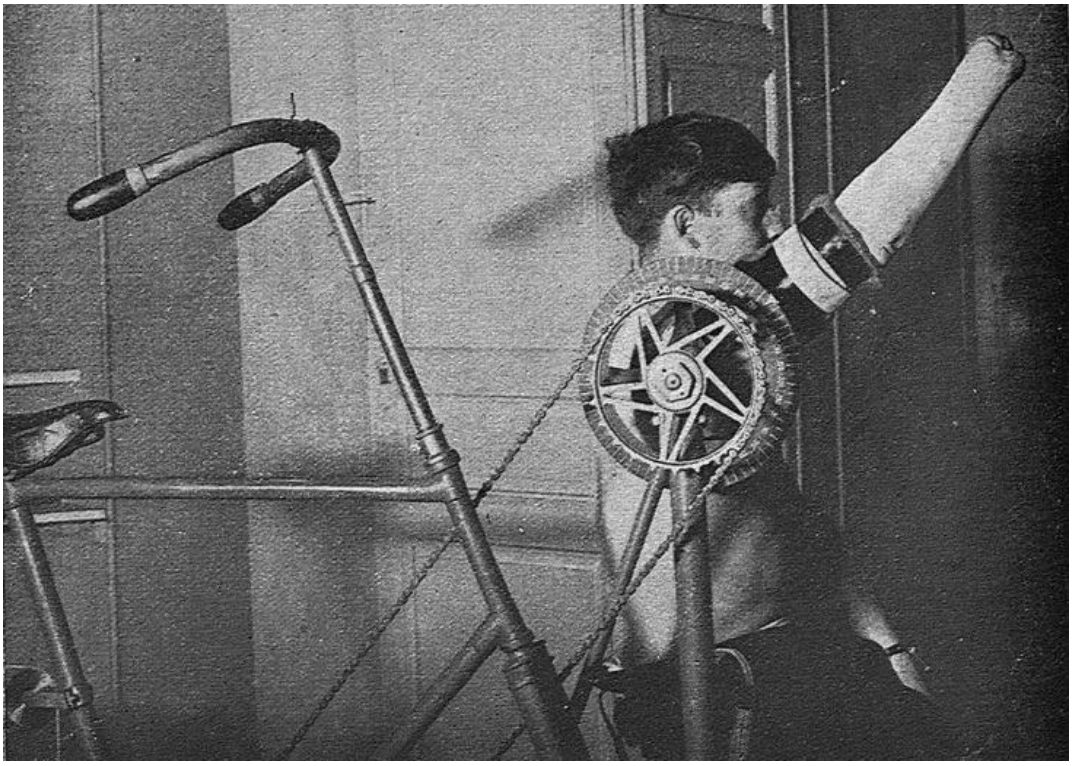

Figure 1. The ergometric bicycle as a training apparatus for maimed soldiers.[41]

In the next sections of the paper we draw on photographs and texts related to the *Institut Emile Metz* to investigate how the human motor powerfully yet sometimes almost imperceptibly pervaded common practice in material, visual and metaphorical ways. The photographs selected are from three different countries (France, Luxembourg and Belgium), which reveals, on the one hand, the strong connections Luxembourg had with neighbouring countries whilst still a young nation-state, and on the other hand the international frame of reference that characterised the scope of action of industrialists behind the *Institut Emile Metz*.[42] In addition, it shows the extent to which the body-machine, as a nexus of projections, cut across imagined boundaries. Be that as it may, through their sheer sensory 'presence',[43] the images included here present and interrogate different ways and degrees in which bodies and machines connected and fused together; sometimes apparatuses and bodies thereby emerged as more or less visible extensions of each other, other times the mechanical, while not physically present, appears to have been embodied and to have manifested itself as a hidden power. Our analysis of the photographs, in addition,

[41] Émile Galtier-Boissière, *Larousse Médical Illustré de Guerre* (Paris: Librairie Larousse, 1917), 8.

[42] Herman, 'Forging Harmony'. See also Frederik Herman and Ira Plein, 'Envisioning the Industrial Present: Pathways of Cultural Learning in Luxembourg (1880s-1920s)', *Paedagogica Historica - International Journal of the History of Education* 53, no. 3 (2017) (in press).

[43] Karin Priem, 'Visual, Literary and Numerical Perspectives on Education: Materiality, Presence and Interpretation', in *Educational Research: Material Culture and Its Representation*, ed. Paul Smeyers and Marc Depaepe (Dordrecht: Springer, 2013), 53–69.

relates to the socio-cultural context surrounding the image, and finally moves to a symbolic-interpretive level which is "inevitably speculative and allows for alternative readings".[44] However, the innovativeness of our approach consists in complementing this art historical analysis with a material-cultural analysis, which explores photographs as social objects whose interactive impact changes according to context, thus initiating different usages while adding new threads to the webs of meaning surrounding them.

Our first photograph (fig. 1) was taken at the Paris *Laboratoire de prothèse militaire et du travail professionnel* (Laboratory for Military Prosthesis and Occupational Labour) founded by Jules Amar. We have chosen this image, because it displays the very apparatus he later introduced at the *Institut Emile Metz* as part of psychophysical methods. What may strike the viewer at first sight is the curious apparatus visible in the foreground, casting a shadow on the man behind it. We know it to be an ergometric bicycle devised by Amar himself and used initially to measure and compare indigenous Africans and prisoners in the context of establishing (supposedly racially neutral) theories on energy and fatigue, and later to test and train soldiers with a view to their restoration and reintegration into the post-war labour force.[45]

The way the human figure and the apparatus in the picture are functionally connected visually (re)presents a kind of fusion or hybridisation of body and machine. The metal wheel connected to a brace of softer material – what seems to be a Bakelite shell with leather lining – and the upright arm suggest both movement and entrapment. The gear wheel can stand as a metaphor both for the human joint and for the nexus between body and machine. Not only was the apparatus thereby rigidly imposed upon the body; as much as Amar's technical abilities permitted, it was also fitted and adapted to the shape and sensory experiences of the body in order to yield maximum effect. In other words, machinery was designed with reference to bodily features and functions and, in turn, impacted upon the body, including its muscles and sensory organs. Material body-machine adjustments and their depiction moreover offered models for people to understand themselves as dependent on, and similar to, machines.

The image at the same time may be said to symbolise an ambivalence towards machinery as something that could help humans to transport, facilitate and make functional certain things, while impinging on, and restricting the freedom of, body and mind. On the one hand, the extension of the body through the machine and vice versa echoed fears of mankind being overwhelmed by machinery and its power, speed and noise.[46] On the other hand, body-machine

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[44] Max Kozloff, foreword to *How to Read a Photograph: Understanding, Interpreting and Enjoying the Great Photographers*, by Ian Jeffrey (London: Thames & Hudson, 2008), 7.

[45] See for more context Pieter Verstraete and Frederik Herman, 'A Plea for Commonality: Disability History, Discourses of Rehabilitation, and the Individual', *Asclepio - Revista de Historia de la Medicina y de la Ciencia* 67 (2016) (in press).

[46] Several contemporary films, such as *Ballet Mécanique* (Directed by Fernand Léger and Dudley Murphy. France: Synchro-Ciné, 1924.), *Metropolis* (Directed by Fritz Lang. Germany: UFA, 1927.) and *Man With a Movie Camera* (Directed by Dziga Vertov. Soviet Union: VUFKU, 1929.), capture the fascination exerted by machinery and the rapid development of technology as well as the fear of an incontrollable invasion of autonomous machines. See, also, Philipp Blom, *The Vertigo Years: Change and Culture in*

fusions made evident infinite possibilities.[47] As an agent, the image enabled such understandings of the interrelation of bodies and machines and added new layers of meaning around the physical and the mechanical in the field of education and beyond.

Figure 2. Filing test in the institute's psychophysiological laboratory.
© Institut Emile Metz / [Inventory number HISACS000713V01] (CNA Collection).

At the time when photographs like the one discussed above reflected, and reflected upon, new connections particularly between 'defect' male bodies and machinery[48], the triumph of experimental research increasingly turned all human bodies qua motors into measurable entities. Increasingly intimate interrelationships of bodies, machines and measurements also manifested themselves in the *Institut Emile Metz* as seemingly objective technologies. They did so as an extension and anchoring of initial attempts at professional selection in 1917, based on personal information forms introduced by Nicolas Braunshausen.[49] The latter managed to recruit Amar,

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the West, 1900-1914 (London: Phoenix, 2000), 249-276.

[47] Käte Meyer-Drawe in this context hinted at the power of machinery competing with that of God, as the creator of mankind. Cf. Käte Meyer-Drawe, *Menschen im Spiegel ihrer Maschinen* [Humans reflected in their machines] (Munich: Fink Verlag, 1996), 37. See also Blom, *Alleen de wolken* [Fracture], 228.

[48] Exploring potential differences in terms of, e.g., gender, class, age and ethnicity in the human-motor relationship must be the subject of another essay. For reflections on this issue, specifically in the American context, see Thomas de la Peña, *The Body Electric*, 10–3.

[49] The results of this testing and selection were published in the *Programme de l'Institut Emile Metz* (1918) and in *Zeitschrift für angewandte Psychologie*. Nicolas Braunshausen, 'Psychologische

who provided the equipment for a 'psychophysiological laboratory' that was installed in the Dommeldange institute in 1919 and fully implemented a year later for the purpose of testing, orientation and training. A second photograph (fig. 2), in which apparatuses play an equally prominent role, shows a staged section of this laboratory. Everything from the geometrical arrangements of objects and people to the angle and position from which the photographer captured the scene may have been designed to guide the viewer's gaze: firstly, towards the measurement device known to be a dynamograph and the expert absorbed by it; secondly, towards the pupil-apprentice shown on the right side of the picture and to the activity he is engaged in. There is a strong sense of movement about this part of the image, enhanced by the blurred head of the young man, his firm and energetic posture, his manipulation of an object – a dynamographic 'Imbert-Amar' file –, all of which connect to then-circulating theories on the transformation of energy, fatigue, overstraining and concentration of attention.[50] The photograph indeed closely corresponds to Amar's detailed instructions on the apprentice's posture and physical activity and on the causal-linear chain that had to be established between the adolescent male body, the recording tool and the work environment. These instructions in turn resulted from a series of 62 trial experiments reported by Amar in 1919.[51] The body needed to be upright, flexible and positioned at an exact distance from the vice, the latter placed at the level of the navel. The feet had to be positioned at a specific angle, and the heels at a precise distance. The left arm was supposed to be completely extended and exert slightly greater pressure on the tool than the right arm. The file's movements were to take the form of an effortless gliding back and forth, the rhythm of which was expected to correspond to a predetermined count per minutes.[52] Allegedly in line with a filer's natural cadence,[53] such refined choreography required sensitive

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Personalbogen als Hilfsmittel der Pädagogik und der Berufsberatung [Psychological information forms as a tool for education and vocational guidance]', in *Institut Emile Metz Dommeldange. Programme publié à la clôture de l'année scolaire 1917–1918/Programm herausgegeben am Schlusse des Schuljahres 1917–1918* [Programme published at the close of the school year 1917–1918], ed. Institut Emile Metz (Luxembourg: Imprimerie Centrale Gustave Soupert, 1918), 19–51; Nicolas Braunshausen, 'Psychologische Personalbogen als Hilfsmittel für Pädagogik und Berufsberatung [Psychological information forms as a tool for education and vocational guidance]', *Zeitschrift für angewandte Psychologie und psychologische Sammelforschung* 15 (1919): 1–13.

[50] Cf. ARBED, *Oeuvres sociales*, 54, 62–3.

[51] Amar, *Titres et travaux scientifiques*, 36–7.

[52] See for more context ARBED, *Oeuvres sociales*, 54; Victor Neyens, 'La psychologie appliquée au service d'une école et la formation professionnelle [Applied psychology in the service of a school and of professional training]', in *Institut Emile Metz. 1914–1989. Lycée technique privé Emile Metz* [Institut Emile Metz. 1914–1989. Emile Metz private technical college], ed. Institut Emile Metz (Dommeldange: LTPEM, 1989): 97–109; Robert, 'Coup d'oeil rétrospectif', 43–84; Aloyse Robert, *La psychologie appliquée au service de la formation professionnelle et du travail* [Applied psychology in the service of vocational training and labour] (Dommeldange: Institut Emile Metz, 1955), 50; Rabinbach, *The Human Motor*, 186.

[53] ARBED, *Oeuvres sociales*, 54.

touch and flow of movement and thus passed as the art of filing.[54] This choreography was embedded in a more complex chain of connections between human bodies and machines. In this chain a dynamographic file could become a lens to inspect, an instrument to train or correct, and statistics could in turn become the brain of an expert[55] by means of which pupils' performances were assessed, and compared with a norm with which they were expected to comply. Machines and bodies thus fused, both completing and perfecting each other in a human-mechanical constellation. The body, by being attached to devices which in the context of the then-reigning experimental system were supposed to be able to measure its output, and by performing in a mechanical choreography, implied and further reinforced human motor metaphors.

Figure 3. Gym of the *Institut Emile Metz* (1939).
© Institut Emile Metz / [Inventory number HISACS002200V01] (CNA Collection).

Gymnastic equipment was another kind of machinery, which in such modern visions of complementarity and perfectibility became connected to human body-motors with seeming naturalness, despite the equipment's artificiality. The metaphor of the human motor indeed inspired inventors of gymnastic apparatuses, while this equipment in turn reinforced and transformed the human motor metaphor.[56] In close union with such equipment, bodies figured as

[54] Amar, *Titres et travaux scientifiques*, 36.
[55] Dupuit, cited in Theodore M. Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton: Princeton University Press, 1995), 33.
[56] Cf. Gleyse, et al., 'Physical Education', 13.

part of scenarios in which balance seems to be key. In our next photograph (fig. 3), everything from the arrangement of the room to the positioning of the equipment and the alignment of the pupils may be said to represent the energy balance pursued at the institute. The central figure can be seen to embody this ideal as a model executor of a balance exercise in a geometrical-symmetrical composition along horizontal, vertical and diagonal lines connecting devices and bodies as mutual extensions of each other. This gives the photograph a distinct feel of both mobility and immobility. Along an implied trajectory, pupils-apprentices were indeed tied to some extent to machinery as in an assembly line, with gymnastic equipment figuring in choreographies of rest and activity. The tight orchestration displayed here does not differ much from the one upheld in the psychophysical laboratory and classrooms, or in the workshops connected to the school. In fact, the whole gymnastic configuration shown here can be said to have been as 'rationalised' as any workshop or laboratory configuration while creating a stage for a balanced body tonicity.[57]

While delicately mobilising the senses to obtain balance and steer energy flow through nodes connecting bodies and devices, such gymnastic choreographies were to produce both "regeneration," compensating for the "assaults of modern life",[58] and a 'straightening up',[59] strengthening both 'constitution'[60] and 'morality'.[61] 'Vigour of character' and 'balance of mind';[62] that is, 'moral hardening' as much as 'physical hardening'[63] indeed provided the rationale behind gymnastics, to which the *Institut Emile Metz* attached extraordinary importance. The image's grid structure also suggests balance and aesthetic harmony as signs of progress

[57] Timo Luks, 'Kanalisierte Dynamik, angeordnete Körper: Bewegungsmetaphern, Gesellschaftsordnung und der Industriebetrieb (1920–1960) [Channelled dynamics, arranged bodies: Movement metaphors, social order and industrial enterprise (1920–1960)]' in *Kontrollierte Arbeit – Disziplinierte Körper? Zur Sozial- und Kulturgeschichte der Industriearbeit im 19. und 20. Jahrhundert* [Controlled labour – disciplined bodies? On the social and cultural history of industrial labour in the nineteenth and twentieth century], eds. Lars Bluma and Karsten Uhl (Bielefeld: Transcript-Verlag, 2012), 251–81; Karsten Uhl and Lars Bluma, 'Arbeit – Körper – Rationalisierung: Neue Perspektiven auf den historischen Wandel industrieller Arbeitsplätze [Labour – bodies – rationalisation: New perspectives on the historical changes of industrial workplaces]', in Uhl and Bluma, *Kontrollierte Arbeit* [Controlled labour], 9–31.

[58] Joan Tumblety, *Remaking the Male Body: Masculinity and the Uses of Physical Culture in Interwar and Vichy France* (Oxford: Oxford University Press, 2012), 6–8.

[59] Cf. Michel Foucault, *Surveiller et punir: Naissance de la prison* [Discipline and punish: The birth of the prison] (Paris: Gallimard, 1975).

[60] Institut Emile Metz, *Programme 1916–1917*, 88.

[61] E.g., Martine Nies-Berchem, 'IEM – LTPEM, 1914–1989'. in *Institut Emile Metz. 1914–1989. Lycée technique privé Emile Metz* [Institut Emile Metz. 1914–1989. Emile Metz private technical college], ed. Institut Emile Metz (Dommeldange: LTPEM, 1989), 53; Jean-Pierre Thommes, 'Die soziale Bedeutung der physischen Erziehung [The social meaning of physical education]', in *L'Institut Emile Metz 1914–1954*, ed. Institut Emile Metz (Luxembourg: Imprimerie Bourg-Bourger, 1954), 129.

[62] ARBED, *Oeuvres sociales*, 50.

[63] Thommes, 'Die soziale Bedeutung der physischen Erziehung', 128.

while at the symbolic level enforcing traditional beliefs of redemption, as is epitomised by the enlightened central figure. As a member of the gymnastic club associated with the institute – which is suggested by his white uniform –, he represents the promise of an elite member of the workforce, "convinced of the social importance of physical education"[64] in view of such social diseases as alcoholism and tuberculosis. In this optimistic view, the angle-like protagonist also embodies the successful adjustment of the human engine, representing the plasticity and malleability of the living organism, whose movements are increasingly deemed in need of channelling through inert material. This material could purposely be used to remediate 'physical deformations',[65] among other things, with the aid of 'exercise machines'[66] developed most famously by physicians and orthopaedists Jonas Gustav Vilhelm Zander[67] and Daniel Gottlieb Moritz Schreber.[68] Yet, as in the case of school desks, it also facilitated and limited movement in ways less purposely conceived of, thus allowing for a whole new repertoire of action including not only modish physical exercises but also, for instance, minor acts of vandalism on the part of pupils.

[64] Ibid., 125.

[65] Cf. Aloyse Robert, *Berufliche Ausbildung auf psychotechnischer Grundlage* [Job training on the basis of psychotechnics] (Luxembourg: Soupert, 1936), 41.

[66] Megan Garber, 'Going to the Gym Today? Thank this 19th-Century Orthopedist', January 2, 2013, http://www.theatlantic.com/technology/archive/2013/01/going-to-the-gym-today-thank-this-19th-century-orthopedist/266768/ (accessed August 13, 2014).

[67] Jonas Gustav Vilhelm Zander, *Die Apparate für mechanisch-heilgymnastische Behandlung und deren Anwendung* [Equipment for mechanical preventative gymnastic treatment and their application] (Stockholm: Göransons mek. verkstad, 1894).

[68] Daniel Gottlob Moritz Schreber, *Kallipädie oder Erziehung zur Schönheit* [Callipedia, or education for beauty] (Leipzig: Fleisher,1858).

Figure 4. Activities around the institute's bathing and swimming installations.[69]

Like the institute's gymnastics equipment, its bathing and swimming installations – as they were commonly called at the time – were also apparatuses that advanced and reflected newly imagined interrelations between bodies and machinery. As a self-promotional brochure issued by ARBED in 1922 stated, in these installations, too, "every day the systems of [Georges] Hébert and [Pehr Henrik] Link [sic] [were] practiced". In other words, here too supposedly 'natural' and 'mechanical'[70] systems of choreography were applied to human body-motors. Cleanliness, pureness, revitalisation and preservation as key elements of the new cult of hygiene and medical prescriptions[71] further justified scrutinising these human motors. The water central to the photograph (fig. 4) necessitated and helped naturalise the exposure of their more intimate body parts. At the same time, the various ways in which this water was treated required much of the machinery interacting with human body-motors to remain hidden from view. That said, evoking associations with happiness, natural rhythm and relaxation, the scene in which the spectator takes part from behind the participants' shoulders obfuscates just how much the habit of disrobing and bathing in public[72] needed to be interiorised in order for the body to interact in an almost

[69] Thommes, 'Die soziale Bedeutung der physischen Erziehung', 126.

[70] Gleyse, et al., 'Physical Education', 9, 18–9.

[71] See Institut Emile Metz, *Stenographischer Bericht der Versammlung vom Dienstag den 17. Juni 1913* (Dommeldingen: Buchdruckerei Albert Nicolay, 1913), 5.

[72] E.g., Julia Twigg, 'The Spatial Ordering of Care: Public and Private in Bathing Support at Home', *Sociology of Health & Illness* 21, no. 4 (1999): 381; Julia Twigg, *Bathing: The Body and Community*

unnoticed and seemingly harmonious way with novel technical equipment. As in other areas of the institute, these technologies made possible a whole range of activities – in this case related to water as an element that offered physical resistance, conducted flows of energy and purified the organism. In this sense, much like in the laboratory, workshop and gym, these activities helped maintain the organisms' homeostasis and at the same time strengthen their physical condition. Water, carrying hygienic-religious connotations[73] and serving as oil for the human engine, helped the latter to synaptically merge with devices in a single flowing, subtly steering and facilitating movement. In the photograph, the positioning of the bodies directs the viewer's gaze towards two adolescents in the background. The scenario in which they are involved is ambiguous and, on a visual level, combines contradictory elements: they may have partaken in a seemingly chaotic event of play, relaxation and effort, or submitted to a hygienic regimen, whether preparing for showering and/or performing gymnastics, known to have been monitored by a special supervisor.[74] In either case, it seems to have been intended to showcase and legitimise the displayed sanitary devices and practices as symbols of progress.[75] The extent of ornamentation displayed in the image focusing on the altar of this temple of hygiene, also gives nobility and religiosity to the activities performed. At the same time the merging of bodies with sophisticated infrastructure stresses the philanthropic ideas behind it, which to some extent were inspired by fears of germs invisibly carried by, and potentially infecting, both the physical engine and the social body.[76] Indeed, psychometrics, gymnastics and hygiene alike concentrated on movement, energy and balance, thereby blurring the boundaries between physicality and morality, nature and technology, matter and mind, humans and machines.[77] Fusing such interconnected, developing disciplines in a rather exceptional manner, the *Institut Emile Metz* endeavoured to harmonise often-dichotomised aspects of the modern human and social condition in ambivalent visions of experiment and progress.

Care (London, New York: Routledge, 2000).

[73] Twigg, *Bathing*, 23.

[74] ARBED, *Oeuvres sociales*, 50–1.

[75] Such associations are easily drawn also from numerous propaganda films of the time, which circulated internationally. For an example from a French industrial context, see *Rythmes et Lumières*. Directed by Edouard Rombeau and Jean Piat, France: Mélodium, 1939–1945 [file I Patrim A 28, Service du Patrimoine, Médiathèque de Roubaix].

[76] Cf. Tomes, *The Gospel of Germs*; Alfons Labisch, 'Sozialhygiene [Social hygiene]', 262.

[77] Cf. Manzin, 'Die Maschine Mensch [The human machine]'; Rabinbach, *The Human Motor*.

Figure 5. Worker standing in a crusher's gear wheel.
© Institut Emile Metz / [Inventory number HISACS000849V01] (CNA Collection).

> The human engine produces effort. The worker is the owner and employer of his own living machine. (…) [T]his machine comes into contact with the great industrial machine of his employers, either through union with it or by opposition to it.[78]

The attempt to harmonise ambivalences could also have inspired the next (undated) image (fig. 5) we have selected for analysis. More explicitly than the previous image, it is indicative of the 'human/machine ratio' which was a common concern for many contemporaries.[79] Like figures 2, 3 and 6, it belongs to a larger set of glass plate negatives related to the *Institut Emile Metz*.[80] The picture shows a worker standing in what we, from inventories found with the glass plate

[78] Philippe Tissié (1919), cited in Gleyse, et al., 'Physical Education', 16.

[79] Ian Jeffrey, *How to Read a Photograph: Understanding, Interpreting and Enjoying the Great Photographers* (London: Thames & Hudson, 2008), 96.

[80] The CNA holding comprises 2,248 restored and archived glass plate negatives (see HISACS Institut Emile Metz, Centre National de L'Audiovisuel, Dudelange, Luxembourg), which are also available in digitised form and which were mostly created in the context of the *Institut Emile Metz* and the nearby factory. The glass plates show portraits (sometimes, like in this particular case, of workers together with products); the wide range of products manufactured by the steel industry, from decorative household items to components of large equipment; the students' leisure activities; classrooms; labs; workshops, etc. A great many negatives were reproduced in ARBED brochures and the institute's annual reports. No information is yet available on the photographer(s). A number of glass plate negatives seem to have been destroyed before they were given to the archives and thus came to constitute a particular 'collection'.

negatives,[81] know to be a crusher's gear wheel (supposedly weighing 5,500 kilograms and measuring 3.327 meters in diameter) to which is attached a smaller cogwheel.[82] The worker's posture – a slight *contrapposto* – is relaxed and gives an appearance of confidence and pride. The whole worker/gear-wheel constellation is central to the image, with a factory workplace – the worker's 'natural' habitat – serving as the background. The human figure gives scale to the industrial product, and its smaller size highlights both the smallness of the human gear wheel within the larger machinery of production and the greatness of industry as a man-driven enterprise of progress. At the same time the worker demonstrates belonging, ownership and sensory connectedness to a product of the industry by touching the wheel with his hands and adapting his body in relaxed balance to its circular form.[83] The connectedness evoked, as by analogy, can be said to have strengthened the notion of workers themselves being industrial products which, 'perfected' by all sorts of material and social care provisions provided by the industry, were bound up with each other in a chain of production.[84] Finally, the human figure

[81] See HISACS Institut Emile Metz, 'Livret inventaire II [Inventory book n° 2]', 5; 'Livret inventaire III [Inventory book n° 3]', 16, 30, Centre National de L'Audiovisuel (Dudelange, Luxembourg).

[82] It could be said that there is an iconic quality to the image in that it reiterates visual patterns found in industrial photography more generally. See Jeffrey, *How to Read a Photograph*, 96–7.

[83] Touching again an end product like this may have aroused various emotions in the worker here but may have enacted in particular a 'visceral relationship' of pleasure and satisfaction. Cf. Silvia Gherardi and Manuela Perrotta, 'Doing by Inventing the Way of Doing: Formativeness as the Linkage of Meaning and Matter', in *How Matter Matters: Objects, Artifacts, and Materiality in Organizations Studies*, eds. Paul R. Carlile, Davide Nicoloni, Ann Langley and Haridimos Tsoukas (Oxford: Oxford University Press, 2014), 227-259: 238-239. For further reading see Karin Priem and Frederik Herman, 'Hautnah. Materialität der Moderne und sensomotorische Ansätze der Berufsbildung im "Zeitalter des Stahles" [Immediate Touch. Materiality of Modernity and Body-Sensory Approaches in Vocational Education in the "Age of Steel"],' in *Die Sache(n) der Bildung* [The Object(s) of Education], eds. Rita Casale, Christiane Thompson and Norbert Ricken (Paderborn, Munich: Ferdinand Schöningh and Wilhelm Fink 2016) (in press).

[84] As part of such a commercial chain, the products, social care provisions and people involved in such 'social works' (*œuvres sociales*) fitted into an astute marketing strategy which from 1920 onwards was taken to heart by COLUMETA, a sales department jointly established by ARBED and its later subsidiary company *Terres Rouges*. See Antoinette Lorang, *L'image sociale de l'ARBED à travers les collections du Fonds du Logement* [The social image of ARBED through the collections of the Fonds du Logement] (Luxembourg: Fonds pour le développement du logement, 2009); and ArcelorMittal, ed., *La sidérurgie luxembourgeoise: Un siècle d'histoire et d'innovation / Steelmaking in Luxembourg: A Century of History and Innovation* (Luxembourg: ArcelorMittal, 2011). The image closely resembles certain frames of a 1921–1922 advertising film originally named "Columeta" after the company who had commissioned it and later renamed '*Vu Feier an Eisen*' [On Fire and Iron]. See: Charles Barthel, '"Columeta" ("Vu Feier an Eisen"): L'aventure du premier film publicitaire de l'Arbed ["Columeta" ("On fire and iron"): The adventure of first advertising film of Arbed]', *Hémecht* 50, no. 2, (1998): 177–206. Photographs like the one shown here largely functioned in the same way as similar frames of the film: serving as a bridge between predominantly industrial and predominantly social-educational images, they suggested both a relationship between machinery and people that was presumed to be harmonious and a machinery of care that was implied to be necessary. Geert Thyssen and Klaus Dittrich, 'Water and Dust: Recovering

inside the gear wheel, like the pointer of a clock, can be said to symbolise subjection to the rhythm of the machine imposed by the industry's quest for maximum productivity.[85]

Figure 6. Pupils in a geometrical formation on the beach in Belgium.

The ambiguous visions of experiment and progress that accompanied the harmonising of man and machine obviously not only changed over time at the *Institut Emile Metz* but were also continuously affected by the outside world. The next photograph, taken during an excursion of pupils of the institute to the Belgian coast (fig. 6), gives insight into how these visions travelled and changed both concretely and abstractly. As part of the same collection including three of the previous images analysed (figs. 2, 3 and 5), it was purposely selected for its capacity to evoke the extent to which the body-machine successfully proliferated to the point of becoming naturalised. Cropped so as to give the impression of an infinite configuration and of an ideal ('normal') pattern of distribution, the photograph shows an aesthetically balanced formation, seemingly part

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Washed-Out Pasts of Industry in Luxembourg', in *Education across Europe: a Visual Conversation* [e-book published on the occasion of the 20th anniversary of the European Educational Research Association (EERA)], ed. Catherine Burke et al. (s.l.: Network 17 – Histories of Education, EERA, 2014), 263–6.

[85] Karin Priem and Frederik Herman, 'Putting Male and Female Bodies in Their Place: Arenas and Theatres of Educational Reform', in *Education across Europe: a Visual Conversation* [e-book published on the occasion of the 20th anniversary of the European Educational Research Association (EERA)], ed. Catherine Burke et al. (s.l.: Network 17 – Histories of Education, EERA, 2014), 243–6.

of 'Swedish' gymnastics. Its display of collectivity and perfect equilibrium is enhanced by matching postures and at the same time countered by distinct individual elements (physical characteristics and clothing) assembled in a near-flawlessly (per)formed ensemble. The natural surroundings of beach and sea soften the acrobatic-mechanical construction and its constituent elements. Here the flexibility, endurance and power of a collective physical body, as one big human motor, again serves as a metaphor for the social body as a constructible and shapeable machine. The pupils in the structure resemble the dents of a smoothly functioning gear wheel, conflating human figures into industrial products and perfectly harmonised elements of technique. Every cell of the collective body seems to function optimally and perform maximally in a mutually trusting relationship, in the presumed interest of social and economic progress and individual advancement. At the same time, the photograph hints at the fragility of this construction and the sensitive equilibrium needed to maintain it. This construction worked only if all limbs or cogs of the social engine fulfilled their roles in mutual cooperation, each taking its proper place assigned on the basis of physical and mental abilities.

As part of a whole series of similar images, or digital reproductions of the glass plate holdings, the photograph linked human bodies to industrial products and production. Like the images of the psychophysical laboratory and the gym, it most likely circulated via all kinds of exhibitions, conferences, journals, books and newspapers connected to ARBED and/or prominent figures of the institute.[86] Such circulations helped further popularise human-motor concepts and over time helped internalise the body-machine junction and make it common practice in all sectors of society, even in the most abstract forms.[87] The photograph just analysed testifies to this abstraction by evoking the body-motor in the complete absence of machinery, while representing its controllability and measurability in a symmetrical bell-curve-like figure – the aesthetic "model of a godly universe".[88] The pupils displayed in the figure indeed constitute the living

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[86] Cf. Herman, 'Forging Harmony'. See also Lorang, *L'image sociale de l'ARBED* [The social image of ARBED], 18–20; Braunshausen, 'Psychologische Personalbogen als Hilfsmittel', 19–51; Braunshausen, 'Psychologische Personalbogen als Hilfsmittel', 1–13; Robert, 'Autour d'une conférence', 61–76.

[87] On the nature and mechanisms of science popularisation in particular, see, e.g., Roger Cooter, *The Cultural Meaning of Popular Science: Phrenology and the Organization of Consent in Nineteenth-Century Britain*. Cambridge Studies in the History of Medicine Series (Cambridge: Cambridge University Press, 1984); Roger Cooter and Stephen Pumfrey, 'Separate Spheres and Public Places: Reflection on the History of Science Popularization and Science in Popular Culture', *Science History Publications* 32 (1994): 237–67.

[88] Lynn Fendler, 'Bell Curve', in *Encyclopedia of Educational Theory and Philosophy*, ed. Dennis C. Phillips (Thousand Oaks - CA, London, New Delhi, Singapore: SAGE Publications), 83. See also Edward Tufte, *Visual Explanations: Images and Quantities, Evidence and Narrative* (Cheshire - CT: Graphics Press, 1997); Edward Tufte, *Beautiful Evidence* (Cheshire - CT: Graphics Press, 2006). The English term "bell-curve" refers to the bell shape of the normal curve, which fittingly characterizes the silhouette of the depicted gymnastic exercise. On this, Fendler comments: 'Quetelet believed that mathematical regularity was a sign of moral perfection. Extrapolating that a universe created by God would not be chaotic or asymmetrical, Quetelet supposed that empirical phenomena (including tides, births, and crimes) *must* be

statistical tables 'social physicians' like Adolphe Quetelet had helped popularise. As elements of these tables, the pupils may be said to have been distributed around a "fictitious being" thought to be "analogous to the centre of gravity in bodies", that is: "the mean about which," in Quetelet's opinion, "oscillate[d] the social elements" and upon which "social mechanics" ("*mecanique sociale*") had to be based.[89]

Discussion

In this paper we have endeavoured to uncover epistemic traces which, over time, have come to build a web of meaning around the human and the mechanical as a unity of two parts. The body-machine and human motor thus took shape and proliferated in metaphorical, material and visual forms while capturing and mobilising new ways of knowing and acting. Changing 'experimental systems' were at the heart of this; in connection to slowly developed, dynamic mental maps or dispositions around the physical-mechanical they came to impact educational praxis and research. In the process things – including technologies such as the clock, the engine and the calculator – became metaphors, which in turn impacted upon concrete, material practice and research in the form of mental maps or dispositions. Such maps allowed for the body machine or human motor to present itself as a nexus of all kinds of would-be sciences, such as labour science, as well as by then more established social sciences like anthropology, sociology, economics and education. Across these (pseudo-)scientific disciplines the body-machine or human motor proved malleable enough to encompass a variety of levels including society (the social machine or factory), the individual and her/his body (the human machine or motor – later also computer –), and the invisible parts of the body susceptible to micro-organisms (the internal machinery).[90] The metaphors and images also proved successful in that they gave a sense of comprehensibility, measurability ('computability') and controllability to all these levels, justified the gathering of 'data' on the human machine in the above-mentioned sciences, and helped provide a basis for statistics – as social 'physics' or 'mechanics' – to demonstrate its usefulness in all areas of life, including education. In this field, as in others, they legitimised the registration, assessment and adjustment (training, orientation, etc.) of bodies as human motors. This becomes clear, to various extents, from all images analysed in this paper: from those explicitly dealing with rehabilitation and testing, to those more implicitly evoking the 'straightening up' and 'oiling' of body-motors, to those hinting at the modelling of a collective after mechanical principles internalised as 'natural'[91] laws of organisation.

From the paper emerges a high correspondence of technologies, metaphors, images and ways of making sense of society and human interrelations. The fact that textual and visual imaginaries of

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distributed in a bell curve, and it was the task of social scientists to create the statistical mechanisms that would make divine regularity apparent.' See Fendler, 'Bell Curve', 83.

[89] Adolphe Quetelet, cited in Frank H. Hankins, *Adolphe Quetelet as Statistician* (New York: Columbia University, 1908), 63.

[90] See also Blom, *Alleen de wolken* [Fracture], 232.

[91] Hankins, *Adolphe Quetelet as Statistician*, 77.

the body-machine in various forms have managed to mobilise new forms of knowing and acting around people, material apparatuses, and so on can be explained from different angles. Firstly, as our paper has shown, 'bodies' and 'machines' over time have increasingly come to 'affect' and 'effect' one another; notions of their interdependence and similarity have thereby branched off and spread, or, in other words, become layered or 'articulated'.[92] Secondly, it required concrete connections between bodies and machines (for instance, in the form of extensions) for 'mental maps' or 'dispositions' to manifest themselves as implicit knowledge around the human motor.[93] Thirdly, and most importantly, metaphors and visual images have created powerful analogies between such newly connected bodies and machines and in so doing interconnected them to such extent that they have become one and can only be disentangled with difficulty. Indeed, language and other forms of expression transform reality. Sometimes imaginaries of the human motor or machine have thus *become* invisible or naturalised; at other times, however, they may also purposely have been *made* invisible, that is, seemingly de-mechanised. For instance, in the context of statistics underlying current 'evidence-based' educational research, it almost requires *mechané* – a warlike trick in the classical Greek sense –[94] to expose the mechanical in seemingly natural ways of engaging with data. Likewise, in the context of activities commonly associated with reform pedagogy, such as gymnastics and swimming, images of the natural contained the mechanical.

Indeed, it now demands an effort to see hidden manifestations of the body-machine in education and question common perspectives and categories. In the light of this, material-anthropological analyses, whether or not drawing on the work of Bruno Latour,[95] may indeed be warranted. In any case, people and human bodies have changed and become what they are precisely through the various and constantly shifting connections that are established between them and all kinds of machinery. Histories that focus on bodily aspects[96] of education should therefore also account for the mechanical and technical as an intrinsic part of the sensory-physical.

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[92] Bruno Latour, 'How to Talk about the Body? The Normative Dimension of Science Studies', *Body & Society* 10, no. 2–3 (2004): 205–7, 209.

[93] Müller-Wille and Rheinberger, *A Cultural History*.

[94] Meyer-Drawe, 'Maschine [Machine]', 726–7.

[95] Bruno Latour, *Eine neue Soziologie für eine neue Gesellschaft: Einführung in die Akteur-Netzwerk-Theorie* [Reassembling the social: An introduction to actor-network-theory] (Frankfurt am Main: Suhrkamp, 2007).

[96] See, e.g., Catherine Burke, ed., 'The Body of the Schoolchild in the History of Education', special issue, *History of Education* 36, no. 2 (2007): 165–282.

Acknowledgements
We would like to thank all whose comments and support have helped us improve earlier versions of this article. We are obliged to the staff at the *Centre National de l'Audiovisuel* (CNA) for providing us with access to its valuable glass plate negative holdings. We are also grateful to the *Archives Nationales de Luxembourg* for competently supporting our research in a variety of ways. Research for this essay was supported by project grants from the *Fonds National de la Recherche Luxembourg* (FNR). We would also like to thank Manuela Thurner for her editorial revisions. Last but not least, we thank the editors of the periodical of the German History of Education Society, *Jahrbuch für Historische Bildungsforschung*, to allow for the publication of a revised version of our contribution "*Körper_Maschinen? Die Verschmelzung von Mensch und Technik in Pädagogik, Industrie und Wissenschaft*".

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