CHAPTER 4

“Sensuous Geographies” in the “Age of Steel”: Educating Future Workers’ Bodies in Time and Space (1900–1940)

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The Institut Emile Metz seeks to protect the future workers from the current mechanization of labor, by connecting their intellectual, professional, and moral values with the evolution of modern labor.

Jean-Pierre Arend, director of the Institut Emile Metz, 1921

You will see on the screen the work of the blast furnace operator, the steelmaker, the smelter, the rolling-mill operator, of an entire work world conscious of its value. You will admire the grandeur and the complexity of the industrial organism, where the hand unites with the brain in a harmony that we strive to render as perfect as possible.

Nicolas Wagner, mining director of Arbed, 1923

Introduction: Intimacy in the “Age of Steel”

Walter Benjamin, in his Arcades Project (1927–1940), used the example of the Parisian passages couverts and their iron and glass construction to describe a new feel of urban space and a new mentality that had begun to emerge during the nineteenth century. In a “montage” on “Iron Construction,” he noted:

1 Jean-Pierre Arend, “L’Evolution de l’Institut Emile Metz et l’atelier d’apprentissage,” in Institut Emile Metz: Programme publié à la clôture de l’année scolaire 1920–1921 (Luxembourg: Imprimerie Th. Schroell, 1921), 50. Unless otherwise noted, all translations are the authors’ own.

2 From Nicolas Wagner’s opening speech at the first Luxembourg National Trade Fair in Esch-sur-Alzette in September 1923, cited in Ira Plein, “Machines, Masses, and Metaphors: The Visual Making of Industrial Work(ers) in Interwar Luxembourg” (in this volume).
It must be kept in mind that the magnificent urban views opened up by new constructions in iron ... for a long time were evident only to workers and engineers. ... For in those days who besides the engineer and the proletarian had climbed the steps that alone made it possible to recognize what was new and decisive about these structures: the feeling of space?³

Indeed, iron and steel not only influenced architecture but increasingly became important drivers of social, cultural, economic, and technological transformations that were explicitly built on the industrial worker, his strong mental attachment to the age of industrialization, and his embodied sensuous-spatial professional knowledge.⁴

In 1930, the German Werkbund, an association aiming to create new lifestyles through promoting aesthetic reform, published Eisen und Stahl (Iron and steel), a book that quickly became an icon of industrial photography.⁵ Featuring ninety-seven images by the photographer Albert Renger-Patzsch, the book included an introduction by Albert Vögler, at the time chairman of the Vereinigte Stahlwerke, a German industrial conglomerate of several coal, iron, and steel companies. In his text, Vögler stressed the tremendous cultural importance of steel and iron as materials that had come to shape intellectual life, everyday products, architecture, technology, and the economy.⁶ In fact, it was Vögler who coined the term “age of steel” (Zeitalter des Stahles) to describe the early twentieth century as a distinctly new material world shaped by engineers, architects, designers, artists, industrial workers, and employees, and characterized by evolving new markets and international developments in iron and steel technology enabling mass production, fostering competition between steel-producing countries, and leading to the creation of steel cartels and internationally active companies.⁷

According to Vögler, technological innovation in iron and steel production, together with the collaboration between science and industry after World War I,
facilitated new ways of using these materials. In his view, the material quality of iron and steel became more and more refined, leading to new dimensions of everyday life: It encouraged the construction of huge buildings and bridges; it supported technological innovation in transportation—be it trains, road vehicles, aircrafts, or ships; it influenced agriculture, the printing industry, electricity generation; it shaped the design and use of everyday objects; and it generally revolutionized all kinds of technologies. Iron and steel fostered the emergence of new textures, new fabrics, new surfaces, new landscapes, new ways of experiencing technology, new ways of thinking, new aesthetic forms, and new lifestyles, all of which affected, and were affected by, the human body and its senses.  

Within these newly emerging “sensuous landscapes,” nature, culture, and technology—or, the organic, intellectual, and mechanical worlds—may therefore be better analyzed as interconnected and entangled entities. In other words, the social, emotional, intellectual, and technological worlds are fundamentally intertwined while at the same time shaping and being shaped by bodily-sensory experiences and influencing how people act in the world.

Moving within these emerging industrial landscapes, it was primarily the steel workers who, by using all their senses, established intimate relations with the steelmaking process, the steel products, and the related technologies. This heightened the importance of vocational orientation and training in the “age of steel.” In fact, iron and steel production and processing required

8 See Richard Sennett, Flesh and Stone: The Body and the City in Western Civilization (New York: Norton, 1994); Tim Dant, Material Culture in the Social World (Buckingham: Open University Press, 1999).
9 See J. Douglas Porteous, “Smellscape,” Progress in Physical Geography 9, no. 3 (1985): 356–78; J. Douglas Porteous, Landscapes of the Mind: Worlds of Sense and Metaphor (Toronto: University of Toronto Press, 1990); Paul Rodaway, Sensuous Geographies: Body, Sense and Place (Abingdon: Routledge, 1994). “Sensuous landscapes” is our term, inspired by these works.
10 See Hartmut Böhme, “Kulturgeschichte der Technik,” in Orientierung Kulturwissenschaft, ed. Hartmut Böhme, Peter Matussek, and Lothar Müller (Hamburg: Rowohlt, 2000), 164–78; David Nye, Technology Matters: Questions to Live With (Cambridge, MA: MIT Press, 2006); Martina Heßler, Kulturgeschichte der Technik (Frankfurt: Campus, 2012).
11 See Karen Barad, Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning (Durham, NC: Duke University Press, 2007); Richard White, The Organic Machine: The Remaking of the Columbia River, 3rd ed. (New York: Harper Collins, 1997); Mark Paterson, The Senses of Touch: Haptics, Affects and Technologies, 2nd ed. (Chichester: John Wiley & Sons, 2012); Paul R. Carlile et al., eds., How Matter Matters: Objects, Artifacts, and Materiality in Organization Studies (Oxford: Oxford University Press, 2014), 3.
12 See Porteous, Landscapes of the Mind; Paterson, The Senses of Touch, 4, 6.
proper handling, a specific bodily-sensory approach to industrialization, and a large qualified workforce across the different branches of steel production. Therefore, vocational training had to connect bodies and minds to the industrial environment(s), equip future workers with multi-sensory “embodied experiences,” generate both professional knowledge and “body memory,” and thus create truly “knowing bodies.” In the context of the steel industry, apprentices acquired skills in sensing and perceiving steel plants, machines, tools, and raw materials, not least by touching them—be it in intimate, or naked, distant, or even “imagined” ways.

Drawing on Paul Rodaway’s *Sensuous Geographies*, this essay seeks to explore some features of a hidden and often forgotten “geography of the senses” and to gain insight into the role of the senses in the everyday experiences of apprentices in the steel industry. In other words, it examines how sensing—seeing and hearing but especially touching and feeling—was part of the learning and training activities at a progressive vocational school, how this may have affected the sensory and bodily experiences of the future workers (sensation), and how it may have contributed to their understanding, appreciation, and sense of orientation within the material world (sense making). In doing so, we consider separate yet entangled layers of sensation and “perception,” such as the sensorial, emotional, cognitive, and cultural dimensions of “reaching out to the world.” Consequently, we assume, with Rodaway, that “perceptual sensitivity is learnt and forms part of ... the socialization into a culture.”

Our essay focuses on one of the global players in the steel business, the Luxembourg-based Aciéries réunies de Burbach-Eich-Dudelange (*ARBED*), and its pioneering role in vocational orientation and training through the Institut Emile Metz, a vocational school founded in 1914. We will investigate how the school’s curriculum and psychometric techniques envisaged the human body

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13. Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 2nd ed. (Chichester: John Wiley & Sons, 2007), 40; Paterson, *The Senses of Touch*, 7, 16, 95.
14. Pallasmaa, *The Eyes of the Skin*, 45, 66.
15. Ibid., 53–54.
16. Rodaway, *Sensuous Geographies*.
17. See Yi-Fu Tuan, *Topophilia* (Englewood Cliffs, NJ: Prentice-Hall, 1974).
18. Rodaway, *Sensuous Geographies*, 22.
19. *ARBED*, the predecessor of ArcelorMittal, resulted from the merger of several steel producers in 1911: the Société Anonyme des Hauts Fourneaux et Forges de Dudelange, the Société Anonyme des Mines de Luxembourg et Forges de Sarrebruck, and the Société en commandite des Forges d’Eich, le Gallais, Metz et Cie. For further information on the vocational school, its psychophysiological laboratory, its main protagonists, and its relation to 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.
as a prototype seamlessly interacting with new technologies. We will further look at how the psychometric techniques developed in the Luxembourg laboratory were used strategically to educate and train skilled workers—or rather, a workers’ elite—by optimizing both their bodies and their use of tools through objectivized observation, measurement, and categorization. In other words, how did apprentices learn professional skills through handling objects, touching materials, and refining their senses and bodies while at the same time being subject(ed) to psychometric testing and training?

In addition, we want to explore how the Institut Emile Metz—by empowering future workers through science-oriented processes that envisaged the human body, its functions, and its senses as an essential element of the industrial-technological landscapes—contributed to the birth of the individual. Our main focus, however, is on the interconnectedness of human bodies, machines/tools, and resources/materials in the context of science-based vocational orientation and training and on the question of how body-sensory and material aspects intersected within the specific “technosphere” of the steel industry in Luxembourg. Psychometric techniques deliberately encouraged active and tacit sensory approaches to education by orchestrating human-material interactions within new structures of time and space in order to foster “the intelligence of the hands,” “haptic memory,” and “embodiment relations.”

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20 In the sphere of recreation, the school also focused on training the senses by means of Swedish gymnastics and scout activities. At first sight, these activities may seem to relate to “nature” as a counter-sphere to industrialization, but their prominent position in the wider curriculum of the Institut Emile Metz clearly indicates the involvement of modern “technologies of the body”; see Frederik Herman, Karin Priem, and Geert Thyssen, “Körper_Maschinen? Die Verschmelzung von Mensch und Technik in Pädagogik, Industrie und Wissenschaft," *Jahrbuch für Historische Bildungsforschung* 20 (2014): 47–75.

21 See Carlile et al., *How Matter Matters*, 2.

22 Don Ihde, “The Experience of Technology: Human-Machine Relations,” *Philosophy & Social Criticism* 2, no. 3 (1975): 276–79. The term “technosphere” is Ihde’s, see ibid., 279. On interconnectedness, see Matthew Jones, “Untangling Sociomateriality,” in Carlile et al., *How Matter Matters*, 197–226. The authors would like to thank Noah Sobe for pointing out that, within this context, workers’ bodies were seen not only in terms of muscular power but also in terms of fine-tuned sensorial, sensitive, and social bodies.

23 See Richard Sennett, *The Craftsman* (London: Allen Lane, 2008); Klaus Prange, “Erziehung als Handwerk,” in “Die Materialität der Erziehung: Kulturelle und soziale Aspekte pädagogischer Objekte,” ed. Karin Priem, Gudrun M. König, and Rita Casale, special issue, *Zeitschrift für Pädagogik* 58 (2012): 81–91.

24 Pallasmaa, *The Eyes of the Skin*, 60.

25 Ihde, “The Experience of Technology,” 277. See also Lucy A. Suchman, “Embodied Practices of Engineering Work,” *Mind, Culture and Activity* 7, no. 1 (2000): 4–18; Lucy A. Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions* (Cambridge: Cambridge University Press, 2007).
Through an in-depth analysis and deconstruction of human-material and socio-material interactions, we hope to shed light on the interrelationship between education and technology in modernity.\footnote{See Herman, Priem, and Thyssen, “Körper_Maschinen”; see also John Shotter, “Reflections on Sociomateriality and Dialogicality in Organization Studies: From ‘Inter-’ to ‘Intra-Thinking’... in Performing Practices,” in Carlile et al., How Matter Matters, 33.}

In what follows, we will, first, give a brief sketch of the educational program of the Institut Emile Metz. Second, we will elaborate more specifically on the testing and training of the senses. Third, we will have a closer look at one particular test, the filing test, and examine in greater detail the various sensory processes that were pioneered at the vocational school and its psychophysiological laboratory. Drawing on both textual and visual sources, this paper will conclude with a reflection on how photography—itself a product of optical-mechanical innovation, mechanization, and industrialization—played a major role in presenting and promoting these entanglements, designs, and lifestyles of a brave new world.\footnote{See Lewis Hine, Men at Work: Photographic Studies of Modern Men and Machines (New York: Dover, 1977); Barbara Wolbring, Krupp und die Öffentlichkeit im 19. Jahrhundert: Selbstdarstellung, öffentliche Wahrnehmung und gesellschaftliche Kommunikation (Munich: C. H. Beck, 2000); Herman, Priem, and Thyssen, “Körper_Maschinen”; Frederik Herman and Ira Plein, “Envisioning the Industrial Present: Pathways of Cultural Learning in Luxembourg (1880s–1920s),” Paedagogica Historica 53, no. 3 (2017): 268–84; Robert Hari- man, “Icon, Allegory, Catastrophe: Three Modes of Articulation within 21st Century Public Culture,” in On Display: Visual Politics, Material Culture, and Education, ed. Karin Priem and Kerstin te Heesen (Münster: Waxmann, 2016), 17–34.}

2 Hands and Brains: The Rational Organization of Vocational Training

On November 4, 1914, the Institut Emile Metz, located next to the ARBED steel plant in Dudelange, Luxembourg, opened its doors to thirty-two student apprentices. The institute was founded and financed by a foundation with close personal ties to ARBED stakeholders. Its purpose was to educate ARBED’s own workforce including the workers’ children—the future blacksmiths, locksmiths, lathe operators, planers, electricians, smelters, pattern makers, moulders, and core makers—in order to enhance the quality of production and to continually reproduce a workforce that would be motivated, ambitious, and well integrated into society. By being instructed theoretically and trained practically, by being measured and tested, the apprentices were introduced to a
specific “[multi-]sensuous geography,” which influenced how they experienced the industrial workplace and industrialized society, how they perceived spatial and material relationships, and how they experienced and perceived the material world surrounding them in the spheres of production and technology (tools, raw materials, workshops, products, etc.). During the three-year training course at the Institut Emile Metz, the focus was on the rational training and testing of the cognitive properties of the brain as well as of the perceptual system of the body (sense organs, muscles, locomotion). Four mornings a week (from 7:30 a.m. to 12:00 noon) were devoted to theoretical education and physical exercises, whereas two mornings (from 7:30 a.m. to 12:00 noon) and six afternoons a week (from 1:30 p.m. to 5:00 p.m.) were reserved for practical work. The Institut Emile Metz consisted of three “activity centers” (centres d'action): theory, practice, and psychotechnics. In 1922—eight years after its establishment—the vocational school was equipped with trade-specific workshops for apprentices and a psychophysiological laboratory. These facilities were designed to offset the disadvantages of vocational training in the factory workshops themselves, as it had taken place during the company’s initial years under the supervision of a foreman and experienced workers. The factories themselves were not appreciated as suitable training spaces, since on-the-job training was often disrupted by the unpredictability of factory life and hampered by the low commitment of older workers who were paid for performance and therefore were more interested in increasing their output than in instructing and coaching apprentices. The laboratory, in contrast, made it possible to study and analyze the apprentices’ professional skills and their various tasks and subtasks in order to determine and teach the most hygienic and profitable labor performance. After August 1, 1922, the Institut Emile Metz comprised three fully operational components: (1) the vocational school, which provided apprentices with professional knowledge and prepared them for their future roles in a modern society; (2) the workshops, which taught specific work ethics and values; and, finally, (3) the psychophysiological laboratory, where the technical and professional skills of the apprentices were screened, analyzed, and trained while “leading them [i.e., the apprentices] toward maximum individual happiness.”

28 The term is Rodaway’s, see his Sensuous Geographies, 5.
29 Arend, “L’Institut E. Metz et l’atelier d’apprentissage,” 50.
30 ARBÊD, Œuvres sociales (Luxembourg: Victor Bück, 1922), 46.
31 Ibid., 47.
32 Ibid., 42.
that these three *centres d’action*, individually and in concert, would not only help the future workers to smoothly adapt to their jobs but also help to solve the social question.33

Approximately fifteen hours a week were devoted to theoretical instruction and physical education.34 Theoretical instruction was designed to foster the individual development of the apprentices, allow them to orient themselves in modern society, and gain insight into the various production processes, including the most basic handling of tools and raw materials. The first three semesters were mainly devoted to general instruction (e.g., languages, history, mathematics, physics, freehand drawing), while from the fourth semester onward more specialized courses were taught (e.g., technical arithmetic, engineering, metallurgy, electricity, mechanics, iron foundry work, technical drawing). It is worth mentioning that drawing was a mainstay of the curriculum and that the apprentices were instructed in different disciplines of drawing. During the first two years of training, they had to take arithmetic, drawing, and freehand drawing lessons. Freehand drawing focused on exercises based on aesthetics, memory, imagination, and observation.35 Technical drawing was introduced in the third year and included training in the use of symbols, scales, and conventions of display. Additional emphasis was put on the development of spatial imagination, visualization, perception, and memory as well as on geometrical features and dimensions. In addition, visual thinking was trained by asking apprentices to cut geometric solids by a plane and draw longitudinal and cross-sections of these objects. Physical education (rational Swedish gymnastics and swimming) was essential, as a healthy condition was seen as conducive to a stable character and a well-balanced mind. Through this curriculum—which included aesthetic, moral, and social elements—the Institut Emile Metz aimed for the “total formation of the worker” (as opposed to the creation of “demi-savants”). It sought to produce model workers who, as

33 Ibid., 47.
34 For more detailed information about the institute’s three-year curriculum, see *Institut Emile Metz: Programme publié à la clôture de l’année 1917–1918* (Luxembourg: Imprimerie Universelle Linden & Hansen, 1918), 63–64; see also ARBED, *Œuvres sociales*, 49–52.
35 *Institut Emile Metz: Programme publié à la clôture de l’année 1917–1918*, 63–64. The curriculum in drawing, like in other subjects, seems to have undergone slight changes over time; see *L’Institut Emile Metz* (1914–1954) (Luxembourg: Imprimerie Bourg-Bourger, 1954), 143–44. For Gottfried Boehm, drawing in particular is “closely connected with all processes of grasping reality”; drawing can be said to touch the eye and the mind while being based on a specific sensory connection between the hand, a drawing tool, the mind, and the eye that cannot be replaced by any other form of (re-)presenting the material world; see Gottfried Boehm, *Wie Bilder Sinn erzeugen: Die Macht des Zeigens*, 2nd ed. (Berlin: Berlin University Press, 2007), 143–44.
an elite, would appreciate the value of their “ennobling” labor\textsuperscript{36} and would, as it were, fall in love with their machines and tools while developing “the intelligence of their hands”\textsuperscript{37} “haptic memory,”\textsuperscript{38} and “embodied relations.”\textsuperscript{39}

In the workshops—“where the eyes and hands are trained while being guided by the brain”\textsuperscript{40}—the apprentices were taught how to handle and use tools and measuring equipment, such as files, rulers, triangles, center punches, scraping knives, etching needles, hammers, bench-vides, saws, and drills. The apprentices’ correct body posture, appropriate use of physical strength, and keeping to a regular and natural rhythm were rigorously scrutinized and drilled with a view to obtaining the most economical performance without wasting human energy. The apprentices were also instructed to manufacture their own tool sets, which can be interpreted as a kind of transition ritual and a sign of taking ownership of their future work. During the first six months in the workshop, all apprentices, with the aid of a file, a ruler, and a triangle, built a rectangular prism: a square prism which, with the aid of a bigger toolkit, was then transformed into a hexagonal prism used to make bolts. Transforming a cylindrical piece into a square prism with the aid of a hammer and a graver was part of the curriculum of the second semester of the first year. At this point the apprentices made their own tools (e.g., turnkeys, bench-vides, caliper compasses) and got involved in the production processes. This continued during the third and fourth semesters. The apprentices also executed small (repair) jobs on demand. At the same time—and irrespective of their future trade—they were introduced to smithery (during a six- to eight-week training at the forge); soldering work (during a series of practical courses), workbench work, planning, and grinding (with simple machines). During their last year of training, a lot of time was spent on the factory floor. The apprentices’ performance on the job was meticulously recorded in personal journals and regularly checked by the head of the apprentice workshop. In addition to this general program, the school also offered a variety of trade-specific programs (e.g., for blacksmiths, locksmiths, lathe operators, planers, electricians, smelters, pattern makers, molders, and core makers).

Testing in the laboratory was seen as key to obtaining a precise and complete picture of the apprentices’ senses, muscular system, physical and mental

\textsuperscript{36} Arbéd, Œuvres sociales, 51.
\textsuperscript{37} See also Sennett, The Craftsman.
\textsuperscript{38} Pallasmaa, The Eyes of the Skin, 60.
\textsuperscript{39} See also Ihde, “The Experience of Technology.”
\textsuperscript{40} Jean Renard, “Une visite à l’Institut Emile Metz,” Bulletin international—Bureau international des fédérations nationales du personnel de l’enseignement secondaire public 5 (1922): 84.
abilities (aptitudes/facultés) in order to help them choose the occupation that suited them best.\textsuperscript{41} Central to this approach was a strong belief in adaptability and trainability (la faculté de l’adaptation au travail/Übungsfähigkeit), which included measuring whether and to what extent an individual, with a specific hereditary disposition, could adapt to the specialized requirements of the industrial sphere of production and acquire specific skills. In 1922, the annual report of the Institut Emile Metz explicitly mentioned that workers should be guided by their muscular sensations, their visual acuity, and the tactile sensibility “in their fingertips.”\textsuperscript{42} In the next section, we will now turn to an exploration of the entangled ways in which the apprentices’ senses were thus tested and trained.

3 Progressive Testing of the Senses: Fabricating Sensuous Geographies

It is necessary to distinguish three types of tests that during the 1920s were applied to measure and train the senses.\textsuperscript{43} The first series of tests focused on individual senses, more specifically on the acuity, reaction speed, and fatigue of seeing, touching, and hearing (aptitudes psycho-physiologiques). A second series took a multi-sensory approach to test the perceptual system of the body and train the coordination of different senses. The last category dealt with job-specific skills (aptitudes professionnelles). The testing and training of the different sense organs in the laboratory and workshops thus followed a progressive structure and aimed at a meticulously designed and interconnected map of entangled sensations and perceptions.

3.1 Seeing, Hearing, and Touching

The testing and training of the senses (aptitudes psycho-physiologiques) focused on seeing, touching, and hearing. The testing of seeing as a distinctive

\textsuperscript{41} See Nicolas Braunshausen, “Psychologische Personalbogen als Hilfsmittel der Pädagogik und der Berufsberatung,” in Institut Émile Metz: Programme publié à la clôture de l’année scolaire 1917–1918, 21; Aloyse Robert, “La psychologie appliquée au service de la formation professionnelle et du travail,” in Institut Émile Metz—Lycée Technique Privé Émile Metz (1914–1954) (Luxembourg: Imprimerie Bourg-Bourger, 1954), 45–83; ARBED, Œuvres sociales, 27.

\textsuperscript{42} Institut Émile Metz: Programme publié à la clôture de l’année scolaire 1921–1922 (Luxembourg: Imprimerie Th. Schroell, 1922).

\textsuperscript{43} Some of the tests used in the laboratory were developed at the Institut Émile Metz itself, and their findings were extensively reported at several international conferences (e.g., in Paris in 1927, Utrecht in 1928, and Barcelona in 1929); see Herman, “Forging Harmony in the Social Organism.”
sense (*examen de la vue*) was based on an arrangement of different devices. Here, the apprentice had to look at a photographic aperture while putting one finger on a tapping key (*tambour manipulateur*) and tap the button as soon as he saw the light coming through the aperture. The observer’s role was to rotate the cylindrical recorder (*cylindre enregistreur*) with one hand while opening the aperture with the other hand, which subsequently projected a cone of light and simultaneously transmitted a signal to the recorder. The recorded track of the test comprised two different marks: one indicated the opening signal (that is, the moment when the test person could see the light) and the other marked the reaction time (that is, the moment when the test person tapped the tapping key). The time between the two marks was registered in hundredths of a second and represented the (simple) visual reaction time. The graph also indicated the tapping pressure (soft or hard) applied by the test person; this presumably provided information on the candidate’s motor skills, with the reaction time thought to reveal a hesitant or decisive character. The next test measured the conscious reaction time. Here, the projected light was either red or blue, and the apprentice had to either tap a red key with one finger of his right hand or a blue key with a finger of his left hand. The test thus measured not a simple reflex but the ability to discriminate between colored lights, to remember the color-coded keys, and to correctly select the corresponding key. In sum, these seeing tests were designed to gain insight into the specific mental and psycho-motoric abilities of the test person.

The hearing test (*examen de l’audition*) and assessment of touch were also done with the aid of a psychograph and followed a similar procedure. Hearing, too, was tested through the use of fingertips. In a simple test, the apprentices were asked to tap a key as soon as they heard a sound. A second hearing test focused on the sounds of rotating machines operating at different speeds. The test examined the ability to recognize—by means of sound—the variations of a running machine by using a rotating cylinder whose speed could be adjusted by the person administering the test. The manipulated changes in speed were noticeable within a fifth of a second and marked on the cylinder; the test persons responded by tapping on a Marey’s tambour, and their responses were recorded through corresponding marks. In one of the touch

44 See Aloyse Robert, “La méthode psycho-physiologique du travail et l’orientation professionnelle,” in *Institut Emile Metz: Programme publié à la clôture de l’année scolaire 1919–1920* (Luxembourg: Imprimerie Joseph Befort, 1920), 53–71.

45 Ibid., 64.

46 Aloyse Robert, “L’orientation professionnelle pratiquée à l’Institut E. Metz de Dommeldange (Luxembourg)—Rapport présenté par M. Robert à la 3me section—Conférence internationale de psychotechnique de Barcelone (Septembre 1921),” in *Institut Emile Metz: Programme publié à la clôture de l’année 1921–1922*, 80–81.
exams (*examen du toucher*), the test person had to put the index finger of one hand on a drum while placing the index finger of the other hand on another drum. As soon as he felt that the observer was touching one of the drums, he had to respond by tapping on the same drum with one of his fingers.  

A second test focused on materials. The 1922 annual report of the institute explicitly mentioned touch-exams that tested the blindfolded apprentices’ capacity to sense the different textures and surfaces of materials like steel with their “naked” hands and to capture and classify the surfaces’ different degrees of roughness. Another test involved arranging several sets of small wooden geometric solids in sets of the same shape and size simply by touching them.

### 3.2 The Hand and the Eye

The systematic testing and training of the hand and the eye aimed at the perceptual system of the body and the coordination of the senses. The sensory training provided for the apprentices of the Institut Emile Metz was designed to enhance their haptic memory and help them perceive embodied relations. One of the tests consisted of bending iron wires with bare hands into a given shape. The test made apprentices experience the quality and flexibility of iron. The activity was repeated five times to check the apprentices’ ability to anticipate the material quality and acquire manual dexterity. Another test focused on perforating paper strips by punching holes in a grid structure as quickly and accurately as possible, a test that was repeated ten times. This test has been photographed—presumably, as can be inferred from the deliberate staging and configuration of the equipment, to demonstrate its design and functioning at conferences: The photograph (see fig. 4.1) shows the test person moving the paper strip with one hand and punching the holes as accurately as possible. In the center of the image we see the cylindrical recorder, registering the time to perform the test (length of the graph), the punching rhythm, and the power used to push down the punch. Another image (see fig. 4.2) displays the recording devices as well as the test results of two trials, with the lower graph showing a steady and powerful performance.

Another test was designed to evaluate the coordination of the hands. The test person was asked to move along a given track as quickly and accurately as

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47 Robert, “La méthode psycho-physiologique du travail,” 64.
48 Robert, “L’orientation professionnelle pratiquée à l’Institut E. Metz,” 80.
49 Ibid.
50 Aloyse Robert, “Recherches sur l’entrainement et l’éducabilité au point de vue professionnel,” *Revue de la science du travail: Psychotechnique et organisation* 1, no. 2 (1929): 233–54.
51 Aloyse Robert, *Berufliche Ausbildung auf psychotechnischer Grundlage* (Luxembourg: Gustave Soupert, n.d.), 15.
possible by steering a mobile platform with the aid of a two-hand coordinator (*appareil neuromusculaire*, or *Zweihandprüfer*). This procedure was repeated forty-eight times. One of these devices as well as the given track can be seen on the right side of figure 4.3. Another coordination test was a reaction exercise at the turning lathe, where apprentices had to screw a bolt in or out of a screw thread that was either in rest or in motion. This exercise had to be performed
eighty times with a steady hand without slipping off the screwhead. Finally, some tests involved typing or copying a text with two index fingers, with rising levels of difficulty, or assembling dispersed pieces of building blocks. All exercises were recorded as graphs, and their repeated execution was designed to find the best possible rhythm of movement and coordination of senses. While some of these tests and exercises had little to do with the tasks the apprentices would have to perform in their future jobs, there were also job-specific tests and exercises.

3.3 Occupational Skills: Hammering and Filing

The third series of testing and training was dedicated to work- or job-related skills (aptitudes professionnelles). The training of “perceptual sensitivity” in connection with work-related skills was a central component of the curriculum of the Institut Emile Metz. Besides filing and hammering, activities like forming, drilling, carving, folding, and bending were seen as essential and were performed with different tools and raw materials.

The hammering test focused on the kinesthetic sense. The kinesthetic sense (muscles and joints) was tested by hammer blows that the test person was to exert with equal force on a mobile object (Moede device, see fig. 4.4), registering differences in the rhythm and force of the blows. The test person first beat the hammer several times while checking the movement of a needle. Then he had to continue to strike, if possible using the same force, without looking at the needle. Figure 4.5 shows the test results for twelve apprentices, displaying two series of strikes for each apprentice (from right to left). The horizontal line makes it possible to compare the amplitude of the recorded hammer blows.  

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52 Robert, “La psychologie appliquée au service de la formation professionnelle et du travail,” 72.
The filing test was one of the most refined testing and training methods at the Institut Émile Metz (see fig. 4.6). It addressed different forms of touch by also training the coordination of other senses and rehearsing a sophisticated rhythm. During the filing test,

the body needed to be upright, flexible and positioned at an exact distance from the vise, 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.53

Materials were touched in different ways, while their materiality, in turn, led to different experiences of touch: The apprentice’s right hand had to grip the wooden handle to fixate the file. In fact, the touch of steel was experienced through the flesh of the hand and through the extension of the body via the

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53 Herman, Priem, and Thyssen, “Körper_Maschinen?,” 58–59. For more background information, see Arbed, Œuvres sociales, 54; V. Neyens, “La psychologie appliquée au service d’une école et de la formation professionnelle,” in Institut Émile Metz—Lycée Technique Privé Émile Metz (1914–1989) (Luxembourg: Imprimerie Saint-Paul, 1989), 97–109; Aloyse Robert, “Coup d’oeil rétrospectif sur 40 années d’activité de l’Institut Émile Metz,” in L’Institut Émile Metz (1914–1954) (Luxembourg: Imprimerie Bourg-Bourger, 1954), 21–42; Robert, “La psychologie appliquée au service de la formation professionnelle et du travail,” 50; Anson Rabinbach, The Human Motor: Energy, Fatigue and the Origins of Modernity (Berkeley: University of California Press, 1992), 186.
wooden handle and the file itself, offering different sensory experiences by means of different materials: (1) by touching steel with the skin, (2) by extending the body and touching the surface of steel through the wooden handle of the file, and (3) by touching steel with a file. The material world and the sensuous cosmos of modernity were thus experienced in simultaneous yet diverse ways and optimized by further training.
Figures 4.7–4.9 show how the experimental settings of the psychophysiological laboratory were translated into educational practice. A progressive and systematic approach to the testing and training of the senses fostered the creation of new “[multi-]sensuous geographies” with the aid of an elite of workers. In sum, “intimate sensing”—that is, active and tacit human-material interactions along with emotional and intellectual engagement—played a key role in examining, selecting, and training the apprentices of the Institut Emile Metz for their future work. The precise and efficient handling of tools and materials as well as the training curriculum were designed to help create social, emotional, sensory, and mental dispositions, which in turn were to have positive effects on the workplace in particular and industrial societies in general.

4 The Touch of Steel and the Rhythm of Modernity

In this section, we will take a closer look at the filing test and illustrate in greater detail the various sensory processes that occurred during the testing and training procedures. We thus want to gain more insight into the feelings provoked by human-material entanglements, and into how “touch” was experienced and observed in this context. In other words, we will investigate how apprentices were encouraged to develop bodily-sensory engagement with the technosphere in order to “learn new ways of relating themselves to the material world.” Touch has often been labeled as “the mother of the senses,” and includes a wide variety of “tactile senses,” such as “pressure, pain, temperature, and muscle movements.” In addition, touch—like other sensory perceptions—is said to help us “perceive objects we manipulate” and interact with. Touch is also said to help us build intimate physical and bodily relationships with the material world and to develop sensible knowledge.

See J. Douglas Porteous, “Intimate Sensing,” *Area* 18, no. 3 (1986): 250; David Howes, “Architecture of the Senses,” in *Sense of the City: An Alternate Approach to Urbanism*, ed. M. Zardini (Montreal: Canadian Centre for Architecture; Baden, Switzerland: Lars Müller Publishers, 2005), 322–32.

55 Shotter, “Reflections on Sociomateriality,” 32.

56 See Herman, Priem, and Thyssen, “Körper_Maschinen”; Priem and Herman, “Hautnah.”

57 See Tiffany Field, *Touch* (Cambridge, MA: MIT Press, 2001), 83; Bruno Latour, *Eine neue Soziologie für eine neue Gesellschaft: Einführung in die Akteur-Netzwerk-Theorie* (Frankfurt: Suhrkamp, 2010).

58 Silvia Gherardi and Manuela Perrotta, “Doing by Inventing the Way of Doing: Formative-ness as the Linkage of Meaning and Matter,” in Carlile et al., *How Matter Matters*, 238ff.
The filing experiment in the laboratory of the Institut Emile Metz was based not only on sophisticated eye-hand coordination, but also on precise body movements. Drawing on Richard Sennett’s work, we suggest that it is the rhythmic movement of the hand that creates positive emotions, activates the body, motivates the mind, and connects the human body with technology and the material world.59 This connection is the result of a neuronal network in the body that integrates touch with other human senses (such as vision) in a mode of anticipation or “prehension.”60 Filing, as it was experienced by the apprentices of the Institut Emile Metz, could generate a rewarding effect through minutely differentiating between different levels of speed, strength, grip, touch, and tapping.61 In addition, the sensorial effects of the material itself could create pleasure and satisfaction.62 Indeed, the filing experiment not only hinted at optimizing the worker’s body but also at the perfect match, or combination, of mind, memory, and emotions within the future worker's body. Both the training of the senses and related emotions were to be connected to the mind and thus experienced as part of a learning process that focused on the perfection and conscious optimization of touch. By connecting senses, emotions, and the mind in optimized ways, future workers were trained to become agents of societal transformation and promoters of a specific work ethos.63 With Foucault, one could even argue that the experimental equipment of the psychophysiological laboratory was a “medium” that could transform “logos” into “ethos.”64 Apprentices experienced this intellectual and ethical transformation process as an innovative, progress-oriented, and complex sensorial training that not only included measurable, active but also rather intuitive, reactive components.65

Don Ihde, in his article on “The Experience of Technology: Human-Machine Relations,” posits that touch can also be analyzed as “a distant sense.”66 Indeed, the filing experiment stimulated various distant as well as “naked” experiences with steel and iron.67 On the one hand, steel and iron were experienced

59 Sennett, The Craftsman, 201–39.
60 Ibid.
61 Ibid., 235; see also Gherardi and Perrotta, “Doing by Inventing the Way of Doing,” 238; Constance Classen, The Book of Touch (Oxford: Berg, 2005), 401–2; Dorinne Kondo, “Polishing Your Heart: Artisans and Machines in Japan,” in Classen, The Book of Touch, 409–11.
62 See Sennett, The Craftsman, 235; Paterson, The Senses of Touch, 30–32.
63 See Paterson, The Senses of Touch.
64 Michel Foucault, L’Herméneutique du sujet: Cours au Collège de France, 1981–82 (Paris: Editions de l’Ecole des Hautes Etudes, Editions Gallimard, Editions du Seuil, 2001), 312.
65 See Paterson, The Senses of Touch, 30–32; Rodaway, Sensuous Geographies.
66 Ihde, “The Senses of Touch,” 271.
67 Ibid.
distantly through the wooden handle of the file. On the other hand, steel and iron were observed or felt “nakedly” by touching these materials with the bare hand. The focus of action—that is, the proper treatment of steel and iron—therefore was experienced in different ways. Both the file and the hand were different yet equally important means to experience the rough or smooth qualities of various surfaces. By using the file, an extension of the body, the touch of steel was experienced in a mediated way. Here, steel was experienced sensually through the tool and thus connected to the human body and the materials through an “embodiment relation.”

In an experimental, psychophysiological setting, this relation not only enriched and amplified the sensory, emotional, and intellectual experience of touching steel and iron but also intensified the apprentices’ attachment to the logos and ethos of the age of steel as they continued to utilize traditional tools, such as files.

At a time when science found its way into vocational orientation and training, new forms of observing touch emerged. During the filing experiment, the apprentices’ movements were electronically recorded on paper. The touch of steel became a visible pattern. In the case of the filing test, a dynamographic file as well as the recording tools acted as interconnected technologies to observe touch by electronic-visual means. In other words, touch became visible through technologies of recording and display (e.g., the movement of the needle during the hammering test), which could be described as touching from a distance or, more concretely, as touching with the mind. We have, in sum, discussed different forms of touch: naked touch, which refers to touching via the skin; distant or mediated touch, which involves a tool or other technologies; a third form of touch refers to the mind (reasoning and imagination); and a fourth and final kind refers to emotional touch (being touched). We would, therefore, like to argue that an exploration of sensuous geographies should also involve looking at their entanglement with geographies of knowledge and emotions.

5 Conclusion: Intimacy and Belonging

The establishment of the psychophysiological laboratory at the Institut Emile Metz marked a milestone in vocational orientation and training at a time when the collaboration between science and the metallurgical industry brought about tremendous changes in architecture, technology, the economy, and intellectual life. The emergence of new textures, new fabrics, new surfaces,
and new landscapes triggered new lifestyles, new ways of thinking, new aesthetic experiences, and new “sensuous geographies” that were also extensively covered and commented on by the media (see fig. 4.10). The training of skilled industrial workers was a key component of these transformation processes. In Luxembourg, the Institut Emile Metz became a showcase for new pathways

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**Figure 4.10** Cover image of *Revue Technique Luxembourgeoise* 29, no. 6 (November 1937).
to vocational orientation and training. At the institute’s psychophysiological laboratory, experimenting, testing, measuring, and training forged an alliance with educational reform, with all these activities forming the human body, its functions, and its senses into a prototype that was designed to perfectly interact with the new technologies and materials.

Psychometric techniques, we have argued, encouraged active and tacit approaches to education and aimed at connecting sensory training with emotional well-being and mental attachment to the “technosphere” of industry. The interactions between humans, materials, and technologies were experienced in various ways, be it “naked” or distant, thus creating “embodied relations” within the “technosphere” of modernity and influencing the “navigation of feeling.”69 We therefore want to suggest that in the sphere of industrial production—even more than in traditional craftsmanship—sensory learning processes encoded moral values and feelings of ownership rather than alienation. From a critical perspective, one could argue that these material-sensory processes also testify to emotional subordination or dependency.70 In any case, it may be appropriate to refine Marxist alienation theories by including body-sensory dimensions when analyzing the effects of industrial production and the training of an elitist work force.71

One medium that may be helpful in this endeavor is photography. Many photographs taken in the context of the Institut Emile Metz show workers touching the machines and gigantic products of the steel industry with their naked hands in a gesture of intimacy, pride, and professional agency (see figs. 4.11 and 4.12).72 Consequently, photography, very much like the visual display of testing and training results, can be described as another technology of touch that has the effect of being present at a distance.73 The sense of intimacy and belonging to the technosphere is grounded in embodied relations and sensory-spatial experiences, which in turn were fostered by the visualization, reproduction, and circulation of photographic images. As agents of the “age of steel” and tools of industrial promotion campaigns, photographs were meant

69 William M. Reddy, *The Navigation of Feeling: A Framework for the History of Emotions* (Cambridge: Cambridge University Press, 2001).
70 Gherardi and Perotta, “Doing by Inventing the Way of Doing.”
71 See, e.g., Bjornar Olsen, “Reclaiming Things: An Archaeology of Matter,” in Carlile et al., *How Matter Matters*, 175; Philipp Blom, “Forces Unbound: Art, Bodies, and Machines after 1914,” in *Nothing but the Clouds Unchanged: Artists in World War I*, ed. Gordon Hughes and Philipp Blom (Los Angeles: Getty Publications, 2014), 4–14; Gordon Hughes, “In Dead Men Breath: The Afterlife of World War I,” in Hughes and Blom, *Nothing but the Clouds Unchanged*, 15, 21.
72 Paterson, *The Senses of Touch*.
73 Ibid., 127.
**Figure 4.11**  Worker sitting on a part of a hydraulic turbine.  
© INSTITUT EMILE METZ. CNA COLLECTION.

**Figure 4.12**  Workers touching machines. Digital positives from glass plate negatives.  
© INSTITUT EMILE METZ. CNA COLLECTION.
to forestall negative thoughts and feelings about mass production and inhumane working conditions.

In addition, the smooth surfaces, impressive sizes and shapes of the steel machinery and products displayed in the photographs refer to a hidden knowledge that was presumably accessible to the workers only. Indeed, touch in its many different forms brought the workers and the products of the steel industry into close proximity and possibly evoked emotions that were based on embodied relations and tactile-spatial experiences. Touch, as displayed in the photographs, may indeed encompass “the affective, the emotional, ... or more metaphorical meanings of touch”74 that could be seen as “archaic” or even “private.”75 As we have shown in this essay, the experience of the flesh—the hand or the body—played a major role in the “age of steel” and its educational reform efforts. It is commonly thought that touch lost some of its value and importance with the emergence of the machine age, when compared with traditional craftsmanship. This paper, however, posits the creation of intimacy between humans and technology. Even if the workers’ touch was frequently labeled as automatic, it cannot be described as unfeeling.76

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74 Ibid., 3.
75 Pallasmaa, The Eyes of the Skin, 16. See also Schweizerisches Nationalmuseum, ed., Arbeit/Le Travail: Fotografien aus der Schweiz 1860–2015/Photographies provenant de Suisse 1860–2015 (Zurich: Limmat Verlag, 2015); Paterson, The Senses of Touch, 31–33.
76 See Constance Classen, The Deepest Sense: A Cultural History of Touch (Urbana: University of Illinois Press, 2012), 180.
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