

Keeping Track On Alpine Metrology

Philipp Felsch

1. Metrology

"Facts and machines are like trains [...]: they can go everywhere as long as the track along which they travel is not interrupted", states Bruno Latour on scientific artefacts, which move outside of laboratories [LATOURE 1999, 250]. Against the notion of a necessary diffusion of science into the outside world he reconstructs the multiple acts of conquest and persuasion required to keep scientific laboratories' products alive even outside of their construction sites. What he considers necessary is *"metrology"*: construction and use of networks, which open spaces for science by expanding lab features into non-scientific environments - like tracks, that secure trains their constructor's standard. [ibid., 251]

2. Mountains

"The laboratories [...] have become insufficient [...]: thus, in the study of organised bodies we will soon come to an end if we do not manage to observe nature in its own domain", writes the Paris physiologist Etienne-Jules Marey in 1883, articulating a critique of physiology's contemporary lab standard, which is namely shared by those colleagues studying organic locomotion and energetics. [MAREY 1883, 226, transl. P.F.]. Upon a physiological research operating with animals, vivisection and closed laboratory spaces - *"sad, poor, and unhealthy places"* [ibid., 227] - Marey reacts by setting up his Station Physiologique in the outskirts of Paris, which allows to study bodily locomotion on humans in the open air. The Turin physiologist Angelo Mosso leaves the city entirely. In order to examine the energetic economy of the human organism - the hidden relations between psycho-physical life functions and energy consumption - in its own domain he transfers his physiological research just into that nature which contemporary perception knows as the other of experimental science (Wissenschaft): into the landscape (Landschaft) Alps. Considering aesthetics the physiological mountain expeditions of Mosso and his first successors Nathan Zuntz and Emil Bürgi proceed successfully:

"With a slight aesthetic shiver one thought of the laboratory buildings' grey walls while mounting through well tilled meadows, and enjoying the magnificent view over the lake, the village, and the Faulhorn rising vis-à-vis." [ZUNTZ 1906, 130, transl. P.F.]



But thus far from the lab we must - with Latour - expect metrologic problems. How are the Alps transformed into a site of physiological experimentation?

3. Track



"The visitors were flocking to the summit in crowds and on their way up they were delighted in the strange figures which, decorated with a shiny headdress rotating in the wind, carrying on the back a mysterious instrument, were marching off the railway track in casual tourist clothing." [ZUNTZ 1906, 133, transl. P.F.]

What Zuntz describes here from a tourist angle is a key experiment of his physiological Alp research: the *"mounting trial"*. [see BÜRGI 1900] It combines a physical effort - climbing in thin mountain air - with two separate measuring devices (not to talk of the helmetlike Anemometer or wind measuring apparatus): the respiration apparatus on the back collects the expired air, allows to analyse its amount and components, and thus makes it possible to determine the physiological energy consumption or metabolism. The second measuring device owes itself to the *"extraordinary kindness, with which the Rothornbahn's management and its chief engineer supported our work"* [ZUNTZ 1906, 107, transl. P.F.] - i.e. the mountain railway track:



"The establishment of the other quantities necessary to determine the performance [...] was made rather easy for us in Brienz. The railway track we used has an extraordinary marking. In its whole extension it is marked with details on length of way, degree of gradient, height above sea-level. The gradient is throughout steady and amounts to 25 %. [...] The space between two sleepers is always 90 cm." [ZUNTZ 1906, 168, transl. P.F., picture 3)

In the alpine landscape and its *"unsteady, accidental, and unstructured"* topology mountain railway tracks are indispensable to guarantee measurable performances in mounting experiments - even *"footpaths could not be used due to their inconstant gradient conditions"*. [SIMMEL 1997, 297; BÜRGI 1900, 519] The alpine physiological experiment is in fact based on an uninterrupted rail network: from Berlin to Bern and Brienz to transport the scientists and their delicate instruments safely into the mountains; from Brienz to the Rothorn's summit to send up the experimentees - the *strange figures* on foot and a complementary control group by train. *"A final examination of mountain sickness will not be possible until the railway onto the Jungfrau will be opened in some years"*, writes Mosso on the limits a related research topic faces for lack of tracks. [MOSSO 1899, 225]

4. Machine

Franz Reuleaux' 1875 *Kinematics of Machinery* dates back the emergence of the machine age in transportation to the introduction of the railway or "*the uniting of the carriage and the road into a machine. The rail forms a part of this machine.*" [REULEAUX 1963, 235] For Reuleaux all machines share a common principle. They unite elements to pairs und thus create "*constrained*" motions: whereas the "*kosmical system*" consists of a multitude of overlapping motions, "*in the machine [...] the moving bodies are prevented, by bodies in contact with them, from making any other than the required motions*". [Reuleaux 1963, 33, 41, 46] Therefore the "*problem of steam locomotion on common roads [...] [is] self-contradictory. It is desired to make something which shall be a machine, but in which at the same time the special characteristics of the machine, - the pairing of elements, - may be disregarded.*" [Reuleaux 1963, 235]



When Emil Bürgi contacts the chief engineer of the Rothornbahn after unsatisfactory mounting trials to transfer his experiments to the rails he thus makes a categorical step: as a beneficiary of the track the physiological experiment becomes a machine - and begins only now, with the pairing of respiration apparatus, organism, and track to produce valid results. It seems that the physiology of locomotion can generate its products only inside a mechanical regime - even where it leaves the laboratory and the city to catch up with the landscape's cosmic order. What the Swiss engineer Strub states of the new alpine tourism - "*that mass exodus which pours from the cities into the landscape every year*" - is valid for alpine physiology as well: "*The mountain railway technique smooths the way for this trend of the times.*" [STRUB 1900, 2, transl. P.F.] Although physiology has not reached the Alps by but as a railway.

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