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Experimenting with History

Simon Dumas Primbault, Ion Gabriel Mihailescu

For the past three years we have been teaching a course titled *Experimental History of Science* as part of the Social and Human Sciences program at EPFL. Following the teaching method of "learning by doing," the course is aimed at master students in engineering, physics, architecture, chemistry, mathematics, life sciences, or computer science, who have almost no background in history or history of science and technology. The first semester introduces the essential questions and insights in our field through lectures and "laboratory work"—deciphering hand-written texts, visiting the cantonal archive, examining and handling historical instruments from the UNIL-EPFL collection (Fig. 1),[1] reenacting alchemical experiments.[2] In the second semester, students work in groups on a project concerning the reenactment of past knowledge creation (experiments, observations, drawings, etc.).

While the course is inspired by the experimental approach to the history of science pioneered by Otto Sibum and Peter Heering,[3] both practical constraints and pedagogical concerns have made us steer in a different direction, charted by Hasok Chang who proposed *physical replication* as an alternative to *historical replication*.[4] If the latter tries to get "as close to the original as possible" (both in terms of materials and

1. https://www.epfl.ch/campus/art-culture/museum-exhibitions/fr/collection-dinstruments-scientifiques/.
2. Pamela H. Smith's *Making and Knowing Project* (https://www.makingandknowing.org/) has been an important source of inspiration for the whole course.
3. For a review of the literature on the experimental approach in the history of science see Fors *et al.*, 2016.
4. Chang, 2011.

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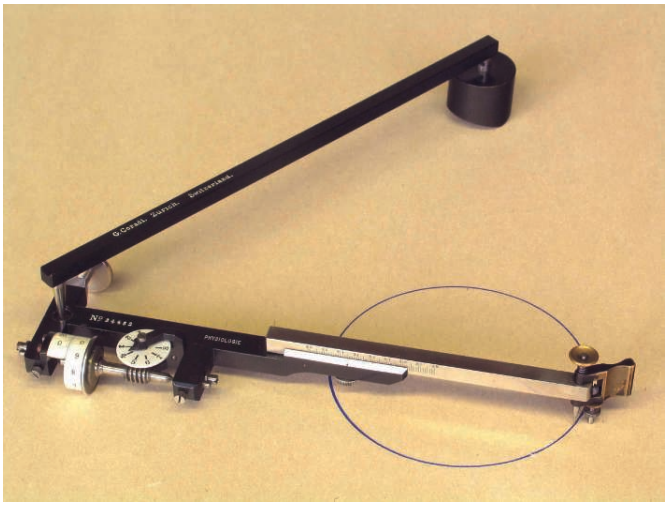

Fig. 1. – During the "laboratory work" students got to examine and use historical instruments from the UNIL-EPFL collection, such as this Coradi planimeter

© Photograph Jean-François Loude.

Fig. 2. – An attempt of assembling a battery of Leyden jars following Benjamin Franklin's instructions

© Photograph Alec Massimo Flowers.

historical understanding), the former deals with phenomena of interest and "complementary experiments" using any convenient instruments or procedures. By aiming to reconstruct certain aspects of experimenting (objects, practices, techniques, etc.) rather than whole historical experiments, we believe we were able to strike a balance between these two forms of replication. Though our students had to choose a historical case, they were free to experiment and tinker with their setup as needed. The students' ability to address historical issues thus emerged as they had first to assess and justify which aspects they could not reproduce, and then gauge and criticize in detail what historical insight they could draw from what they had replicated. In the end, their projects were evaluated not based on how close they came to the original, but rather on what insights they obtained in the process. This approach is not only practical (as it is not restricted by the use of historical materials), but also meaningful and highly engaging.

Sociabilities

Organizing group work in times of pandemic was cumbersome for most of the students. This gave one group the idea to enquire about Benjamin Franklin's art of writing letters and conveying experimental protocols for his peers to reproduce his results across the Atlantic. After half of the group had reenacted some of Franklin's electricity experiments with Leyden jars — then struggling with the materiality of their plastic replicas and identifying the need to share materials for the experiment to be reproducible (Fig. 2) — they drafted a letter that they sent, together with some pieces they deemed essential, to the other half of the group abroad. Thereby, they reflected on the literary technologies and on the circulation of materials necessary for a given receiver in a specific context to be able to reproduce what they had achieved experimentally — themselves acting on their interpretation of Franklin's correspondence. Other groups addressed issues regarding scientific sociabilities by reenacting public demonstrations — e.g., projecting Lissajous curves on the wall with tuning forks, or gently electrifying people holding hands with a Volta battery — followed by questionnaires to qualify their audience's perception.

Instruments, bodies, materialities

Having to engage physically with more or less instrumentalized experimental setups in the laboratory as well as on the field, students are often confronted with the materiality of both the objects they manipulate and their own bodies as experimenters. One project aimed at reproducing some instruments designed and used by the eighteenth-century savant Horace Bénédict de Saussure to quantify natural phenomena pertaining to the physics of the atmosphere. When following Saussure's protocol to make a cyanometer and a diaphanometer — paper instruments designed to measure, respectively, the blueness of the sky and the transparency of the air (Fig. 3) —the students were able to grasp how much the two were entwined, the former being calibrated on the latter, and, more importantly, how their making relied not on supposed objective quantities, such as a concentration of pigment, but on the eyesight of the observer and their ability to discern different shades of colors. Later, on top of the mountain, this perspective on the senses thickened as they realized they had to rest, catch their breath, and clean their glasses in order for their bodies to act as instruments, themselves entwined with their paper counterparts. As a telling counterexample, projects focusing solely on the 3D reconstruction of past mechanisms with CAD software often fail at formulating and addressing genuinely historical issues and tend to hover above their object in a theoretical and disembodied manner.

Places and spaces

Some students had to venture into the open field for their projects. One group tried to follow the methods of Eratosthenes and Al-Biruni for determining the size of Earth. But the straightforward geometry and the seemingly universal diagrams were not easily translatable on the ground. The moment they were confronted with the practical question of how to find a viewpoint within Switzerland from where the horizon would be visible, they immediately became aware that the success of these methods might have depended more on access to particular locations (and knowledge about them), rather than just geometry. After choosing a mountain to carry on their measurements, they realized they still had to approximate the skyline in the far distance, to calibrate their hand-made

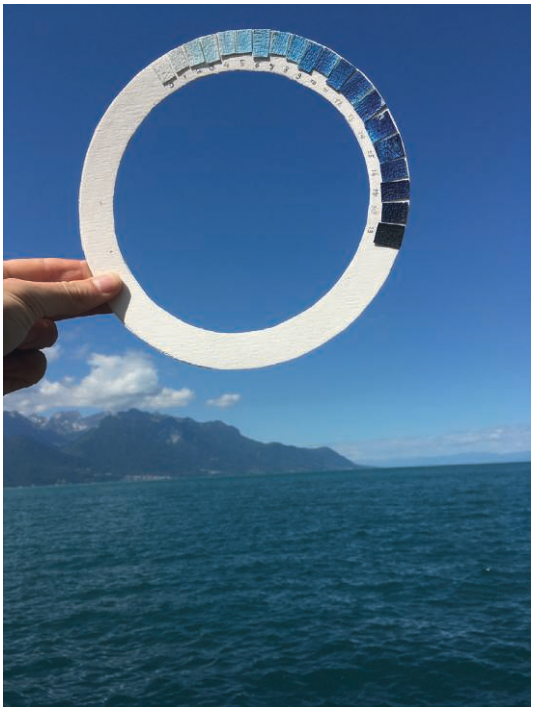

Fig. 3. – A hand-made cyanometer to measure the blueness of the sky on a scale depending on the observer's eyesight
© Photograph Cornelius Van Den Heuvel.

instruments — however basic they were — and to perform a series of measurements in different setups in order to statistically eliminate some very situated variables such as bodily fatigue, wind, or the atmosphere opaqueness. Rather than the placeless computation of trigonometric formulas as they thought, their project turned out to highlight with force what it takes to turn a specific milieu — the mountain — into a place where you can make measurements.

Open-ended experimentation

Though at the beginning of the course we clearly emphasize that the goal should be open-ended experimentation rather than the replication of a known result, students — especially at an engineering school — are laser focused on getting the "right" results. However, this rarely happens because

they are not working in a lab under someone's supervision, using purpose-built instruments and experimental setups, and following fine-tuned instructions. Often, the failure to get satisfactory results forced students to produce much more meaningful reflections.

One group followed the DIY instructions of the S'Cool LAB at CERN for how to build a cloud chamber. Despite having all the listed materials, and instruction videos, they seemed to fail to produce the expected cloud formations. To understand what went wrong, they interviewed the team at S'Cool LAB and attended one of their workshops. To their surprise, they found out that their cloud chamber was successful in forming clouds, only that they had failed to recognize them as such because they did not look like regular clouds and did not elicit any emotion. While the S'Cool LAB cloud chamber was intended to work such that "you just turn off the light, switch the torchlight on, and suddenly you can see the building blocks of the universe", by first failing in their replication, students were forced to reflect on how this effect was achieved.[5]

Failure was also what led a group working on the acoustic Doppler effect to dig deeper into the historicity of their object. Although they found it "frustrating" to not obtain the "correct" — *i.e.* contemporary — formula, they were thereby forced to contact the Austrian Academy of Science in order to obtain copies of Ernst Mach's experimental reports on the subject. Originally enquiring about why there had been a long-lasting controversy about the Doppler effect while it is clearly audible, these mishaps led them from one experiment to the following with a renewed sensibility regarding the conditions of experimentally producing and measuring a supposed natural phenomena.

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The blending of historical and physical replications makes the course particularly attractive to students. On the one hand, they are fascinated to interact with historical objects and are puzzled to imagine themselves as part of very different worldviews. On the other hand, they enjoy the freedom of not having to mindlessly follow a protocol, or merely produce a known result. It is mostly during such moments, when they encounter

5. As reported in the students' interview with a S'Cool LAB spokesperson.

small failures or are confronted by choices, that they are forced to start reflecting on the social and material aspects of their own practices. As they tackle these challenges through tinkering and trial-and-error, they often wonder how their attempts would fare against those of their historical actors.

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