Circulations: A Virtual Laboratory and its Elements•

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Abstract

This paper presents and discusses the website < http://vlp.mpiwg-berlin.mpg.de/index_html>. Under the title "The Virtual Laboratory: Essays and Resources on the Experimentalization of Life" it gives access to a massive collection of texts and images concerning the experimental life sciences of the 19th and early 20th century. The main focus is on physiology and psychology. Plant breeding is an additional theme. As of now, the Virtual Laboratory gives access to some 12,000 digital items, i.e. historical text books, journal articles, manuscripts, trade catalogs, photos, films, audio files, etc. At the same time, the Virtual Laboratory is a platform for historians of science to publish and discuss their research on the experimentalization of life. Topics range from the history of precision time measurements in the physiological lab to the historical epistemology of hearing and the role of the Axolotl as an experimental animal in zoology. By way of a guided tour through the Virtual Laboratory, the paper describes the kind of epistemic space that was created. It argues that open access to historical sources as well as tight connections between historical research papers and their raw data, e.g. manuscript sources, profoundly change what used to be called the Archive. Today's historians of science have started to work within a space that is widely distributed and extremely flexible with respect to its internal connections. It is a space that turns the Archive into an authentic laboratory for the science historian.

Keywords

History of experimentation; Life Sciences; Internet; Archive; Open access

Circulações: Um laboratorio virtual e seus elementos

Resumo

Este artigo apresenta e discute o website <http://vlp.mpiwg-berlin.mpg.de/index_html>. Sob o título "O Laboratório Virtual: Ensaios e Recursos sobre a Experimentalização da Vida", dá acesso a uma coleção maciça de textos e imagens acerca das ciências experimentais da vida nos séculos XIX e XX. O foco principal é fisiologia e psicologia. Reprodução vegetal é um tema adicional. No presente, o Laboratório Virtual dá acesso a aproximadamente 12.000 itens digitais, como livros de texto, artigos em periódicos, manuscritos, catálogos profissionais, fotografias, filmes, arquivos de áudio, etc. Ao mesmo tempo, o Laboratório Virtual é uma plataforma para que os historiadores da ciência publiquem e discutam suas pesquisas sobre a experimentalização da vida. Os tópicos incluem desde a história das medições precisas do tempo no laboratório fisiológico à epistemologia histórica da audição e o papel do axolotl como animal de experimentação em zoologia. Através de um tour pelo Laboratório Virtual, este artigo descreve o tipo de espaço epistêmico que assim foi criado. Sustenta que o acesso aberto a fontes históricas assim como as conexões íntimas entre os artigos sobre pesquisa histórica e sua matéria prima, como por exemplo, fontes manuscritas,

• This article is a revised and updated version of a paper published under the same title in *Making Things Public: Atmospheres of Democracy*, ed. Bruno Latour and Peter Weibel (Cambridge [MA]: The MIT Press, 2005, 320-325

mudam profundamente o que tradicionalmente era chamado de Arquivo. Os historiadores atuais da ciência têm começado a trabalhar num espaço amplamente distribuído e extremamente flexível em relação com suas conexões internas. É um espaço que transforma o Arquivo num autêntico laboratório para o historiador da ciência.

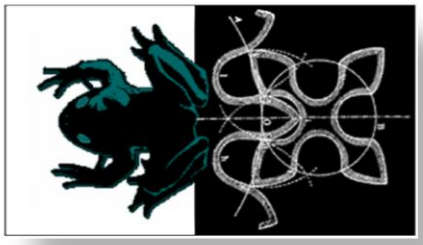
Palavras-chave

História da experimentação; Ciências da vida; Internet; Arquivo; Acesso aberto

http://vlp.mpiwg-berlin.mpg.de

At the entrance to this web site, one seems to have the choice. On the one side, one recognizes the scheme of a machine element from the nineteenth century, on the other, the colored drawing of a frog. On the right, a mechanical quote (a scheme taken from a handbook of machine scientist Franz Reuleaux); on the left an organic original (a frog drawing made expressly for this web site). Here is the entrance to the archive, the collection of historical documents; there the access to new images and texts. In reality, there is only one entrance. It is situated in the middle, beneath the divide between machine and organism, quotation and original, past and present.

Figure 1: Entrance Icon of the Virtual Laboratory



The peculiarity of this entrance consists in that it can be selected but not traversed. You can use it, but this not will open a space you can enter physically. All visitors remain standing on the threshold of the laboratory. They may be inside it, but at the same time they stand in front of it. Everything is within easy reach (biographies, instruments, laboratory notes, architectural plans, articles, books and more) but not close enough to touch. Even the moves you can make and the various connections you can draw (between texts and scholars, model organisms and instruments, concepts and experiments) remain flat, immaterial. They appear under glass, lit up from behind. What you can see is colored but remains silent, and moves only exceptionally, for a few moments. The visitor standing inside this laboratory (and at the same time in front of it) looks into a virtual space, a virtual laboratory. This laboratory is not structured like a three-dimensional space. It has no ground plan, no walls. Rather, it is a dynamic network of elements that can be linked with one another in almost arbitrary combinations. It is a space that dissects the syntheses that characterize the real space of our everyday experience. It surprises us with the play of its parts and their configuration.

Actuality of the laboratory

During the nineteenth century, actual laboratories became sites of productive connections between multiple "actants". In growing numbers, scientists, technicians and students gathered behind locked (or at least closed) doors in order to handle instruments, model organisms and substances and to use sheets of paper, note books and other inscription surfaces in order to produce nothing more than scientific facts. The widespread emergence of such research sites was connected to the formation of a specific building type. Since the 1880s, architecture textbooks gave precise indications concerning the disposition and equipment of laboratory rooms – from the work places to the lecture hall, from the library to the storage facilities. At the same time, the laboratory began to stand for the successful establishment of a certain kind of scientific activity. "Natural" phenomena and processes were visualized, observed and manipulated by means of specific tools, instruments, and apparatuses, while the production and use of these means required specific handicraft skills as well as extended conceptual knowledge. The mode of "thinking with one's hands" became connected with the technical embodiment of theories in instruments to form a new realm of material creativity. (If Martin Heidegger had known the laboratory from within, he would not have worried so much about the essence of technology. It would have become obvious for him that it was nowhere else but here that the very *Geschick* – in the double sense of dexterity and destiny – of disclosure took place that, in the name of the arts and crafts, he sought to count up so wordily against the permanent standing in reserve of a technological "enframing.") Both thinking hands and acting heads, in crosswise challenge, contributed to establishing the laboratory as a "space of knowledge" that was to be understood as radically modern. It was the prototype of an open-ended space. Perhaps one should say that it was a space on the edges to the unknown, a space for exploration, for probing experimental associations, but at the same time for investigating exploration in itself. From now on, "science" always also meant "technology", at least in the sense of *bricolage*. And being a scientist almost always would imply working together with other scientists and technicians in a collective. However, recent sociology of science has shown that the laboratory is also an arena of practices that may suspend the very oppositions so often understood as characteristic of modernity: nature/culture, mind/matter, human/non-human. In particular, today's biomedical laboratories question, suspend or re-distribute such presumed oppositions.

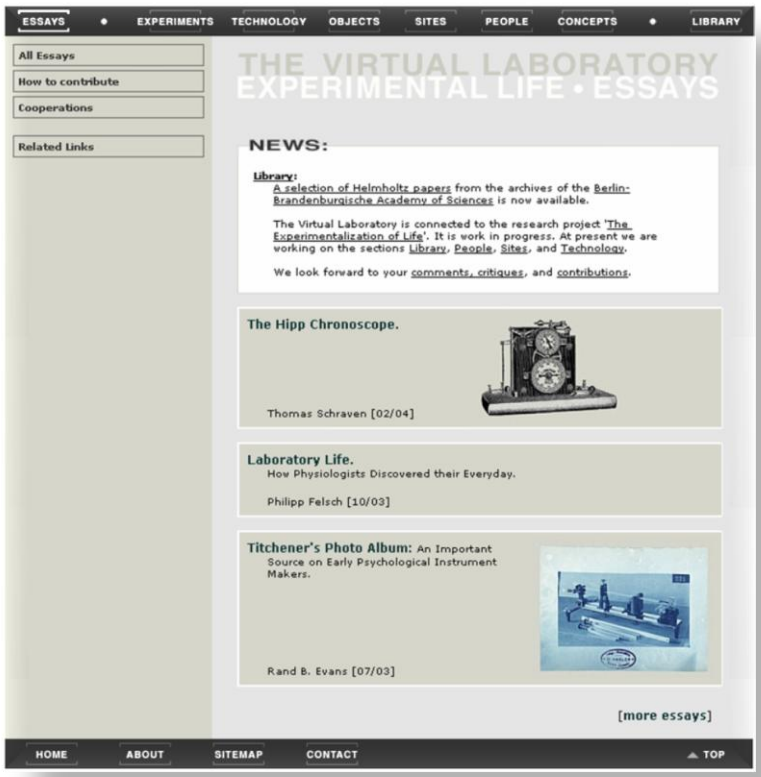
This tendency of the laboratory is reinforced by transposing it into virtual space. The materiality of the lab, its technology and architecture as well as the peculiar thickness of the social interactions it organizes – all this is extended into and validated by a symbolic world consisting of 1s and 0s, "ons" and "offs." By the same process, it is transformed and called into question. What we are dealing with here is not just some on-line archive, a digital library or teaching program using distributed information and communication technologies. Nor are we speaking about a site for performing or collecting "virtual experiments," as economists and other scientists conduct them.[1] Rather, the Virtual Laboratory is a tool that allows us to disclose the history of experimental science in a novel way – a way that is experimental in itself and hence appropriate to the laboratory. To pick up an expression coined by Eduard Dijksterhuis, one could call it an "epistemological laboratory," something like a meta-laboratory.[2] It creates a site of flexibility, of extending and condensing events.

[1] On virtual experiments, see, e.g., Mary S. Morgan, "Experiments without Material Intervention: Model Experiments, Virtual Experiments, and Virtually Experiments", in *The Philosophy of Scientific Experimentation*, ed. Hans Radder (Pittsburgh [PA]: University of Pittsburgh Press, 2003), 216-35.
[2] Eduard Dijksterhuis, "The Origins of Classical Mechanics: From Aristotle to Newton", in *Critical Problems in the History of Science*, ed. Marshall Clagett (Madison: University of Wisconsin Press, 1969),163-90.

The network of laboratory elements

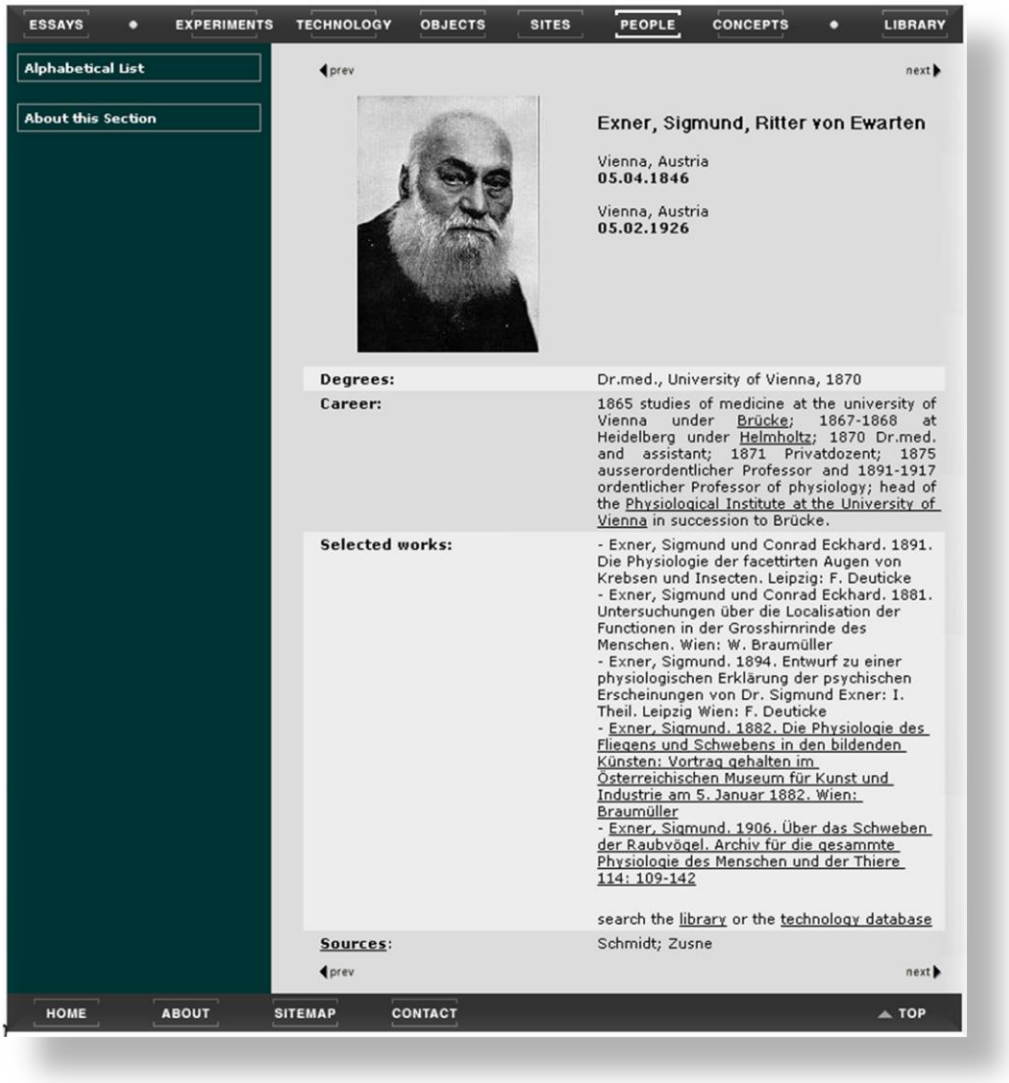
Standing on the threshold, the visitor of the lab has a real choice. Again, it is not a question of physical movements in space, but rather of displacing and multiplying points of view. At the upper edge the names of the initial oppositions reappear: to the right, the archive, the digital library; to the left, the recently published texts and images, the essays. But these names no longer refer to oppositions or stand for an either-or that you could dive through. They now mark concrete extreme points of a continuum, "marginal totalities"; between them a series of different points of view are inserted. From these points, the viewer can get to single scientists, research sites, instruments, model organisms, concepts, and experiments. What thus appears is the (often meandering) path from the concrete work of one scientist in a particular laboratory to the publication of his results in a journal. Simultaneously, we see the (often equally meandering) path from research past to historically oriented science studies.

Figure 2: Standing on the threshold: the essay section of the Virtual Laboratory



A textbook of nineteenth-century physiology as it is kept in the library section may serve as a first point of view. This textbook was written by a scientist (second point of view) who, at the time of writing, was working in a specific research institution (third point of view). In this institution, he handled specific instruments (fourth point of view), worked with particular model organisms (fifth point of view) and made use of specific concepts (sixth point of view). In the textbook, he reported on his experiments (seventh point of view), while not making transparent the concrete procedures leading to the fabrication of scientific knowledge. What is of interest in the textbook is the result, not the way that one reaches it. The same holds true for journal articles. They are designed to represent a scientific fact, not its development. In the borderline case of a perfect fact, the "perfact," this emergence is effaced.

Figure 3: The second point of view: from the text book to the scientist who wrote it



This effacement is exactly what is at stake in the Virtual Laboratory. As a digital environment, it serves to investigate the "gradual composition" of scientific facts in experimentation (eighth point of view? total view?). How does an experimenter get from a temporally and spatially circumscribed set-up to facts that, as scientific, cannot be circumvented in the horizon of the present, even if they reveal themselves as preliminary in the long run? How are they read and deposited, the manifold traces that scientists produce at or with their heterogeneous assemblages in the laboratory? How are they removed from these assemblages and mobilized from their deposits, in order to be transferred eventually to the big, wide and comparatively clean world of printed texts? The Virtual Laboratory thus leads to a kind of historically grounded perspectivism, able to make transparent the chain of transformations that Bruno Latour has described inimitably in his photo-philosophical montage about Boa Vista – nice view, clear sight![3]

[3] See Bruno Latour, "The 'Pédofil' of Boa Vista: A Photo-philosophical Montage", *Common Knowledge* 4 (1995): 144-87.

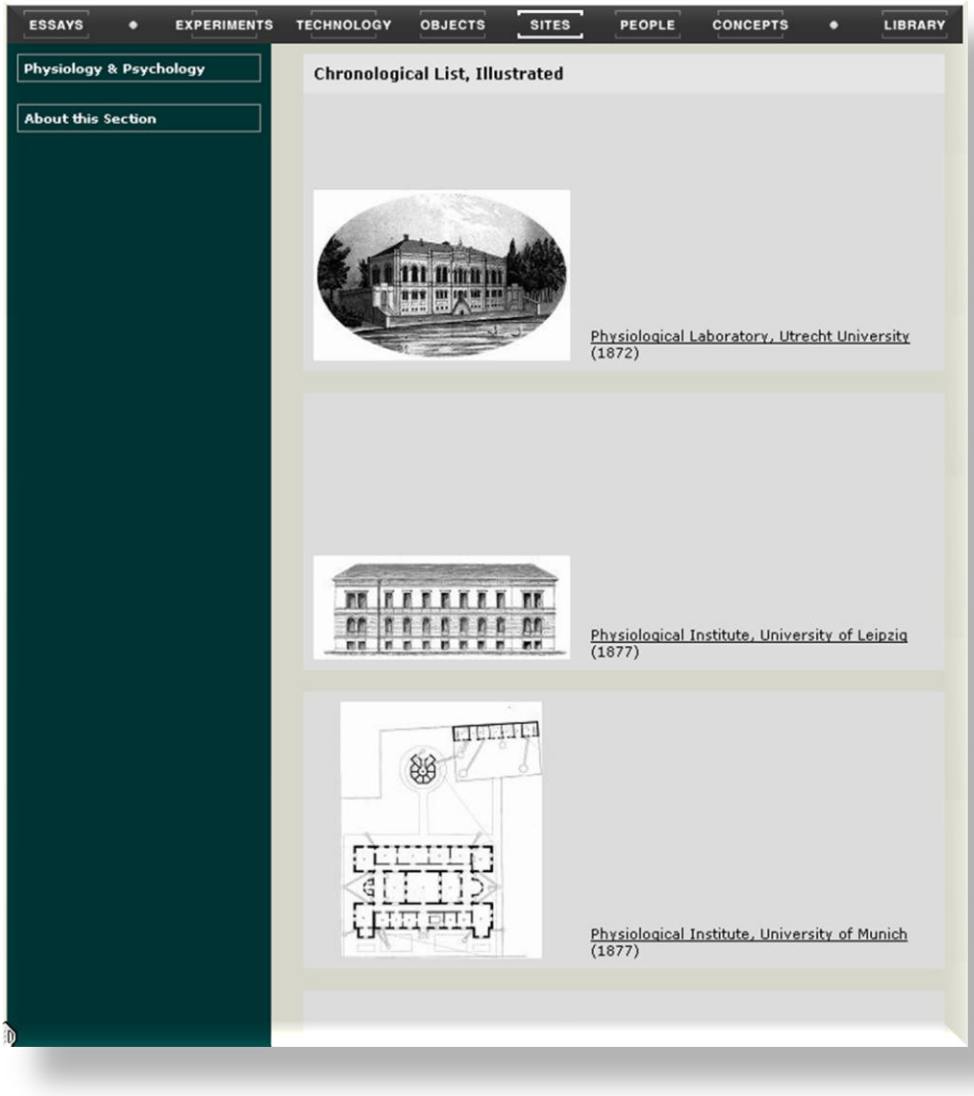
The Virtual Laboratory is an experimental plant, where the processes of knowledge production are explored. It creates a system of coordinates and a net of references, in other words, a space that allows one to represent the production of knowledge in the entire multiplicity of its resources. It is a machine to represent the cunning of science and its detours. In a similar context, Michel Serres has suggested the following image: In order to represent the movement of knowledge, it makes sense to assume that the ball leads the game. The teams are grouped around the ball, not the other way around. At the same time, the ball records the relations that emerge within the fluctuating collective around it. In this sense, the Virtual Laboratory is a square (*Geviert*) where one can begin to forget about disciplines: "There are only corpuses of texts, situations, sites, objects. By the way, less and less texts, less and less objects… Let's forget a little bit that there are various sciences, literatures, arts, etc. Let's try to see that the process of science consists in the way it displaces itself. Science is less a content than a mode of circulation."[4]

Maps of knowledge

The horizontal movement from texts to persons and sites, from instruments to model organisms and experiments, is one of the two perspectives that the Virtual Laboratory offers on the continuum between past and present. The other perspective follows a vertical axis. The spaces and people of science, their instruments and model organisms, and in particular their experiments, never stand alone. Together with other spaces, people, instruments, they always compose series. They form "sequences" or "linked solutions," as one may put it following art historian George Kubler.[5] Let's say the author of the textbook in question was the physiologist Sigmund Exner. Exner stands in line with other physiologists before him – e.g., Johannes Müller, Claude Bernard – and behind him – Keith Lucas, William Bayliss, etc. The same holds true for the instrument that Exner developed to measure reaction times in human beings in the 1870s, the so-called "neuramobimeter". This instrument stands in a row with Hipp's chronoscope, Donders' noematachograph and d'Arsonval's chronometer, which other scientists used, in various contexts, for similar purposes. The same goes for the physiological laboratory in Vienna, where Exner was active while working on his textbook. The Vienna laboratory stands in line with similar research sites that were created, before and after, in Leipzig, Munich, Budapest, and so forth. Kubler developed his idea of the sequence as a chain of problem solutions with respect to architectural forms. However, it can be applied to experiments, instruments and spaces of knowledge, thus creating an intermediate domain stretching out between biographical accounts and the history of disciplines. Here, the Virtual Laboratory unfolds its potential.

[4] Michel Serres, *Eclaircissements: Entretiens avec Bruno Latour* (Paris: François Bourin, 1992), 160; 154.
[5] George Kubler, *The Shape of Time* (New Haven [CT]: Yale University Press, 1962), 33-9.

Figure 4: A sequence of laboratories



Another vocabulary presents itself to describe the basic structure of the Virtual Laboratory. Taking up a pair of categories known from linguistics, one might say that this laboratory opens *syntagmatic* and *paradigmatic* perspectives. The axis of the syntagm (in linguistics, this would be, e.g., a sentence) is made up of the connections existing between a text in the archive, its author, the instruments and model organism he used, and the experiments he conducted. In contrast, the axis of paradigm consists of the respective lists of other texts, authors, instruments, organisms, experiments, and research sites. Certainly, the comparison is lame, highlighting differences more than identities. Historical laboratory work, as it is documented, explored and represented by the Virtual Laboratory, is by no means restricted to linguistics. Representing the results of experimental research already involves not only writing, but also numbers and images. In addition, the laboratory elements as they are connected in virtual space are also technological and architectural, logical as well as biological. And finally, we should not to forget that the place of the laboratory designates a space where *work* is done, even if the things being produced are epistemic things, not things of everyday life. Still, the above comparison transmits an impression of the horizontal and vertical structure, the grid, so to speak, that the Virtual Laboratory unfolds. On one axis, we have the "combination" of historical actants *in praesentia* involved in the process of experimental research. The other axis deals with the "exclusion" of actants, i.e. with actants *in absentia* (or should we say: *in*

latentia?) that were excluded at a specific point in this process or eliminated by choice, but remain, in principle, always ready to be mobilized.

This laboratory structure has no foreseeable closure. Only the number of entries on the syntagmatic axis displays a relative stability: experiments, technology, objects, sites, people, concepts. But this stability might always be called into question when other areas of historical research become integrated. How would this axis look like if its starting point was, e.g., not the history of physiology, but the history of heredity? How would it have to be enlarged in order to take into account a historical research on heredity? Furthermore, the entries on the paradigmatic axis seem to be almost unlimited. The alphabetical and the chronological list prove to be quite productive algorithms (even if – or perhaps because - they are not very sophisticated). Taken together, the entries on both axes lead to a topography, something like a landscape for the production of knowledge.

A new form of encyclopedia?

As a collective effort to map scientific knowledge in its making, the Virtual Laboratory remains work in progress. Every day, a small group of humanities scholars with different backgrounds (history of science, art history, literary study and others) moves, together with a group of students, within and in front of this laboratory in order to investigate historically the "experimentalization of life". The team receives support from experts in information technology who do their best to mediate between the technological necessities of the laboratory and the requirements of scientific work. A growing number of visitors (about 10,000 per day) uses this emerging structure through the Internet – for referencing, searching and downloading documents, to inform themselves about the progressing work of the research group, to discuss with the scientists and technicians involved, and, eventually, to publish results of their own research. On a daily basis, 1 to 2 gigabyte of data are transferred.

The progressive nature of this work explains why not all of the lists that were opened in the Virtual Laboratory are filled in simultaneously. The syntagmatic and paradigmatic axes of the different actants develop stepwise, by groping, so to speak. As a whole, the Virtual Laboratory is oriented not toward completeness, but exemplarity, exemplary groups of connection. ("Show me the number of your possible connections, and I will show you the way into the lab.") It condenses around a more or less contingent starting point. From there, it grows by means of apposition. It experiences extensions and spreads out in amoeboid movements. The peculiar knowledge space thus emerging defines itself not as a *particular* laboratory. Rather, we acquire the elements of a history concerning all possible laboratories in a specific domain or discipline. Here, the Virtual Laboratory unfolds its peculiar position between the concrete and the abstract. The Virtual Laboratory stands halfway between case study and encyclopedia. It grows, as one can say with Serres, "along the threads of a moving, flexible, distorted and decentralized grid".[6] It establishes not a *declarative* order of knowledge, but a *procedural* one. It offers not ready-made narrations, but opportunities for searches, for navigation and exploration.

[6] Michel Serres, "Préface", in *Le Trésor: Dictionnaire des Sciences*, ed. Michel Serres & Nayla Farouki (Paris: Flammarion, 1997), VII-XXXIX, on XVIII.

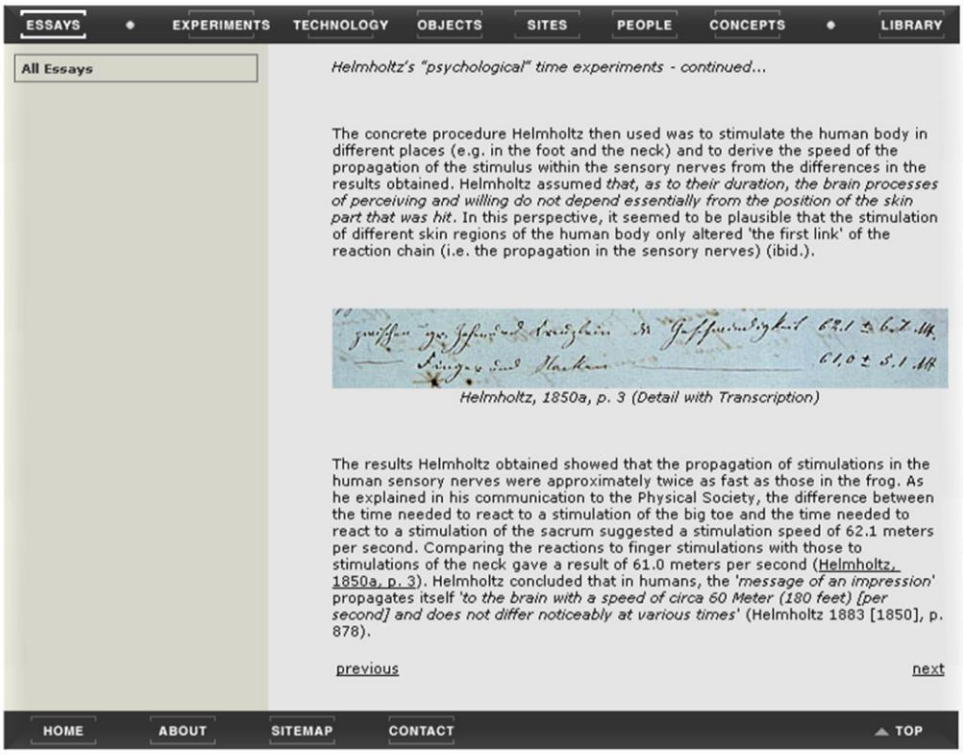
One has often observed that, during the last twenty or thirty years, the increasing spread of powerful computers has led to an apparent unification of laboratory activities. Whether in biology, chemistry or physics, scientists sit today in front of screens and keyboards. Even the visible differences between the natural sciences and the humanities have started to vanish in the course of this development. Historians and classicists are no longer forced to conduct their research in archives or rare book collections. Like their colleagues on the hard side of science, they are able to perform a large part of their activities, research, reading, transcription, and so forth in front of computer screens. If they use the Internet, they even rely on an infrastructure that, several years ago, served exclusively for laboratory scientists to communicate with one another. Thus, the question arises whether or not this unification of procedures and apparatuses announces a new kind of universality in science. If so, this universality would be connected, in its very emergence, with the reality of the virtual, structured by the use of screens behind of which the surfaces of the virtual extend themselves.

A permanent conference

It would be misleading, however, to conceive of the Virtual Laboratory as the result of simply transferring technologies and procedures from the natural sciences to the sphere of the humanities. There are common features such as the orientation by means of shared research problems, the work in a collective and the division of labor this entails, the subscription to standards of data gathering and processing, the character of a conference in permanency. All this characterizes the existence of science in the laboratory. Despite this fact one can imagine that the function the Virtual Laboratory fulfills could also be achieved by means of conventional, non-experimental tools, tools that clearly distinguish themselves from the gestures and techniques common to laboratory research in the natural sciences. Thus, one sees the horizontally and vertically connected lists taken out of the virtual and translated into illustrated and cross-referenced cards in filing boxes. The historical documents could be kept as reproductions in folders on a shelf in a separate room. The series of publications based on this collection could be placed on other shelves. Entering such an archive would be a different, physical, factual act. Search procedures would be much more tedious and time consuming. But in principle, according to this account, there would be hardly any difference with the Virtual Laboratory.

This is exactly what is not at stake. Decisive is not the principle, but the concrete form of our cultural life reality. Despite some attempts to connect libraries, archives and museums and to link them with research institutions, there are no real or actual sites where one could practice a history of science centered equally on texts, images and objects. Institutionalizing philology, archaeology, and history as largely autonomous disciplines has led to lines of separation, and traversing these lines requires the construction of bridges according to principles that still need to be invented. Hence the meaning and the necessity of a virtual gathering of such sites that is open to the public.

Figure 5: Inserting a manuscript source into an essay: the combination of publication and raw data



Even more decisive is the fact that science by and large is still dominated by the practice of separating publications from raw data. Of course, there are good reasons for this practice. The reader of a book or an article on historical matters does not want to be bothered with source material; he wants to see results. On the other hand, there are increasingly good reasons for publishing results along with the data that they rely on, be it for the sake of putting the data at the disposal of the respective research community that wants to further process and analyze them, or for the sake of creating more transparency and opportunities for public control. Today, the genome sciences are perhaps the best example of the extent to which a change in the practices of knowledge production requires new formats for data storage and preservation. Additions to the data pool concerning a pattern of cellular activity are in themselves perhaps as important to further research as are the conclusions a particular scientist draws from his or her experiments. The creation of comprehensive databases and their accessibility through the Internet are making this possible. Another aspect comes into play here. Publication on the Internet opens possibilities of presentation that rarely or never can be realized in the world of book printing today: multiple, dynamically processed cross references, a huge proportion of color images, the integration of animations, movies, sound-tracks. Even more important, much of the data created by scientists are in and by themselves primary products of electronic processing and not only the result of secondary digitalization. For them, the Internet is already the place of their existence. Every other kind of technology has to be seen as a basically unnecessary detour.

In other words, one has the choice within this virtual space. It is as public as it remains open. Standing on the threshold, one may follow this path or another. Its sequences are constantly extended. It creates spots that open surprising perspectives. Neither specific connections (you don't have to go from the author to the text) nor specific actants (scholars, instruments, experiments, concepts, or texts) are ontologically privileged. As a laboratory, it provokes experiments in the

history of science. All things in the arsenal of the Virtual Laboratory are of the stuff to become subjects of narration.

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