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The Virtual Laboratory for Physiology

A Project in Digitalising the History of Experimentalisation
of Nineteenth-Century Life Sciences

FOREWORD

The Virtual Laboratory for Physiology is an ambitious digitalisation project dedicated to the history of the experimental life sciences in the nineteenth century. The project is located in Department III of the Max Planck Institute for the History of Science (Hans-Jörg Rheinberger, director). Participating in it are historians of science and computer scientists in close cooperation. The thematic emphasis is on the laboratory work performed by physiologists such as Claude Bernard (1813-1878) and Emil Du Bois-Reymond (1818-1896) and psychologists like Wilhelm Wundt (1832-1920). The objective is to establish a virtual research site for historical work on those forms of knowledge prefiguring what today's public knows as "bio-technology" and "molecular biology".

The VLP is to be made accessible to other scientists and to the interested public over the Internet in the near future. The intention of the VLP project is to use advanced computer technology to erect an interactive platform for history of science research. Because this platform functions both as an archive for materials and as a research tool, it will challenge scholars to develop new forms of historical work.

The following text and the enclosed CD-ROM serve to introduce the ideas upon which the VLP is based, to explain the arrangement of the digitalised resource materials and to document the decision-making process about its technical foundation. The VLP's potential is illustrated by examples of selected materials on the CD-ROM. The current VLP thus is a *prototype*, nothing more and nothing less. Nevertheless, we believe that publishing the VLP in this preliminary form makes sense, also because it contributes to the ongoing discussion about the rapidly growing potential of the World Wide Web in research and teaching.

Berlin, May 8, 2000

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INTRODUCTION

Since the Internet was opened for world-wide use at the beginning of the 1990s, scholars working in the historical sciences, the history of science and in science and technology studies increasingly have employed this media technology. One of the most obvious potential uses, and by now also one of the most common, is to set up web sites. Like the *Max Planck Institute for the History of Science* (MPIHS) in Berlin, the *Dibner Institute for the History of Science and Technology* in Cambridge, MA, also has created a web site which presents staff members, lists research topics and provides useful information (addresses, telephone numbers, Email addresses, etc.).¹ Similarly, many departments for the history of science have established such sites to provide information about faculty, topics of instruction and conferences.² Such sites increasingly allow access to materials of instruction in the form of digitalised secondary literature and primary sources.³

Non-university institutions, too, have long since begun to grant historians and other interested readers access to relevant information over the WWW. Increasingly, library catalogues, databases and even the holdings of museums can be used “online”. A few of the most prominent examples are the catalogues of the *Bibliothèque Nationale* in Paris, the *Library of Congress* in Washington and the *Südwestdeutsche Bibliotheksverbund*. Among the databases historians access via the Internet are *America: History and Life* as well as *Historical Abstracts* and *Eureka*.

Holdings of particular interest for historians of science are available from such institutions as the *Museo della Specola* in Bologna and the *Istituto e Museo di Storia della Scienza* in Florence. These museums have published their catalogues in the Internet. Other science museums employ more advanced technologies: the *Science Centre* in Ontario offers a virtual tour through its holdings, the *Deutsche Museum* in Munich displays virtual experiments, and an Internet version of Foucault’s pendulum is exhibited by the *Musée des Arts et Métiers* in Paris.

One of the most active institutions within this growing field is perhaps the *National Library of Medicine* (NLM) in Bethesda, MD. The *NLM* provides access to the nearly 60,000 images of the prints and photograph collection held by its History of Medicine Division. The collection includes portraits, pictures of institutions, caricatures, genre scenes, and graphic art in a variety of media, illustrating the social and historical aspects of medicine. The *NLM* site also makes available to the public archival material on and by prominent scientists, for instance, the biolo-

1 The URLs for these web sites and those mentioned below are listed in their entirety at the end of the introduction. Explanations for the abbreviations used are located on page 43.

2 For example, see the *Department for Science and Technology Studies* at Cornell University or the *Program in History and Philosophy of Science* at Stanford University.

3 For example, cf. the site established by the *Program in the History of Science* at the University of Minnesota.

gist Joshua Lederberg. The collections contain published and unpublished materials, including books, journal volumes, pamphlets, diaries, letters, manuscripts, photographs, audio tapes and other audio-visual materials.

Internet technology also is implemented for the historical sciences in the form of topical projects which serve to provide general information, instruction and sometimes also research on their respective topics. The *Galileo Project* is a hypertext source of information on the life and work of Galileo Galilei (1564-1642) and the science of his time. The project provides hypertext information about Galileo and his contemporary era to readers of all ages and levels of expertise; however, a special focus is placed on primary and secondary education.

The *Valley of the Shadow* project follows two communities, one Northern and one Southern, through the experience of the American Civil War. The project is a hypermedia archive of thousands of sources for the period before, during, and after the Civil War in Augusta County, VA, and Franklin County, PA. The sources include newspapers, letters, diaries, photographs, maps, church records, population census data, agricultural census data, and military records. Students can explore every dimension of the conflict and write their own stories, reconstructing the life stories of women, African Americans, farmers, politicians, soldiers and families. The project is designed for secondary schools, community colleges, libraries, and universities. Of similar scope and ambition, the *American Memory* project offers online access to a huge collection of sources related to the modern period of American history.

Probably the most significant project of this kind is the *Perseus* project, a continually growing digital library for the study of antiquity. The library's materials include ancient texts and translations, philological tools, maps, extensively illustrated art catalogues, and secondary essays on topics like vase painting. A collaborative team from a number of academic institutions has worked together to collect materials for *Perseus*. More than seventy museums have contributed pictures of their art objects.

A further step toward employing the Internet specifically for the purposes of history of science work was taken with the site *Galileo's Notes on Motion*, a joint project of the *Biblioteca Nazionale Centrale* (Florence), the *Istituto e Museo di Storia della Scienza* (Florence) and the MPIHS (Department I: Jürgen Renn, director). The site features an electronic representation of Galileo's famous manuscript on motion and mechanics which documents his work on mechanical problems over a period of more than forty years. The manuscript contains numerous short texts in Latin and Italian, some of them sketches of proofs, but others constituting extended drafts intended for publication, calculations, tables of calculated numbers, diagrams, and even some documents pertaining to experiments performed by Galileo. The scholarly work on the

manuscript (transcriptions, translations, internal cross-references, references to the literature, classification of folio pages, etc.) is included as part of the electronic representation. For the purpose of individual research, the reader is provided with extensive navigation possibilities to handle the over 300 manuscript pages. Links to other sources, publications, and academic work allow the reader to obtain a quick overview of the state of research on the pages of the manuscript.

In a similar vein, the *Mouse Site* at Stanford University explores new forms of scientific collaboration in the field of science and technology studies. The site is a resource for exploring the history of human-computer interaction, beginning with the pioneering work of Douglas Engelbart and his colleagues at the Stanford Research Institute in the 1960s. The general aim of this site is to broaden the understanding of the development of ideas connected with the computer mouse, hypertext, windowing, and networked collaborative workspaces. More specifically, the project attempts to reach individuals who worked directly or indirectly with pioneers in the field at the Stanford Research Institute. The site aspires to add online archival materials and to multiply the points of view by tapping the community memory of the participants in these events, who are encouraged to provide new insights by contributing their own stories to the archive and commenting upon and augmenting other participants' perspectives. The result constitutes a new kind of "oral history" via the WWW.

The Virtual Laboratory for Physiology (VLP) presented here is located on a level similar to that of the last two projects discussed. Just as they do, the VLP starts from the assumption that the Internet is more than a technical device which allows the representation of historical resources on the computer screen. The intention pursued with the VLP project is not only to present the holdings of libraries, archives and museums, but also to publish current results of the research on and with these holdings, respectively. A specially adapted work environment is designed with sophisticated navigation support and search options to facilitate "online" work with historical materials. Moreover, the project aims to facilitate significantly the often-elusive international co-operation, especially where complex research subjects are concerned, by simplifying access to source materials.

Max Planck Institute for the History of Science (MPIHS)
[<http://www.mpiwg-berlin.mpg.de>]

Dibner Institute for the History of Science and Technology
[<http://dibinst.mit.edu>]

Department for Science and Technology Studies, Cornell University
[<http://www.sts.cornell.edu/CU-STS.html>]

Program in History and Philosophy of Science, Stanford University
[<http://www.stanford.edu/dept/HPS/>]

Program in the History of Science Department, University of Minnesota
[<http://www1.umn.edu/scitech/>]

Bibliothèque Nationale
[<http://www.bnf.fr>]

Library of Congress
[<http://lcweb.loc.gov>]

Südwestdeutscher Bibliotheksverbund
[<http://www.bsz-bw.de/>]

America: History and Life; Historical Abstracts
[<http://abc-clio.com>]

Eureka
[<http://eureka.thames.rlg.org>]

Museo della Specola
[<http://boas3.bo.astro.it/dip/Museum/MuseumHome.html>]

Istituto e Museo di Storia della Scienza
[<http://galileo.imss.firenze.it/index.html>]

Ontario Science Centre
[<http://www.osc.on.ca/>]

Deutsches Museum
[<http://www.deutsches-museum.de/>]

Musée des Arts et Métiers
[<http://www.cnam.fr/museum/foucault/index.html>]

National Library of Medicine (NLM)
[<http://www.nlm.nih.gov/>]

NLM: Profiles in Science (Joshua Lederberg Papers etc.)
[<http://www.profiles.nlm.nih.gov>]

The Galileo Project
[<http://es.rice.edu/ES/humsoc/Galileo/>] or via [<http://www.rice.edu>]

Valley of the Shadows
[<http://jefferson.village.virginia.edu/vshadow2/>]

American Memory
[<http://lcweb2.loc.gov/ammem/ammemhome.html>]

Perseus
[<http://www.perseus.tufts.edu/>]

Galileo's Notes on Motion
[http://www.mpiwg-berlin.mpg.de/Galileo_Prototype/MAIN.HTM]

Mouse Site
[<http://sloan.stanford.edu/mousesite/MouseSitePg1.html>]

THE VIRTUAL LABORATORY FOR PHYSIOLOGY

The VLP is a virtual research site for investigating the material culture of the experimental life sciences of the nineteenth century. It constitutes a forum in which scholars and other contributors can publicise and discuss their ongoing research on the “Experimentalisation of Life” and thus extend the contents of the VLP through a process of collaborative writing.

The VLP is conceived of as a place where new ways of doing history of science are actively explored in a collective effort. It takes seriously the potentials of web technology: proposing a multi-media method of historical research which integrates photos and even animated drawings into the body of narrations.

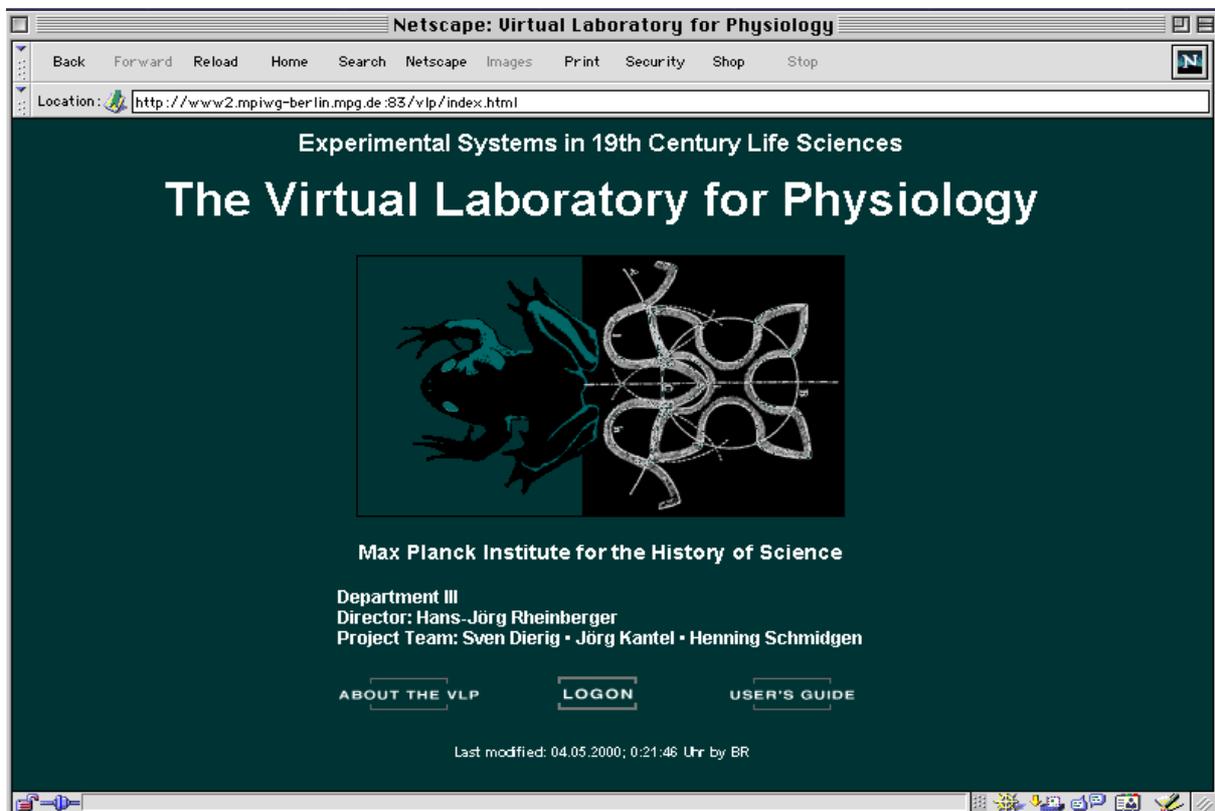


Fig. 1: The HOME Page of the Virtual Laboratory for Physiology

In its digital library the VLP presents scans of complete journals, handbooks and monographs dealing with experimental physiology and/or psychology. The library also grants access to a rich collection of images illustrating the experiments, instruments and the sites of knowledge production of this period.

The Sections of the VLP

The holdings of the VLP are organised according to the following sections: Experimental set-ups (EXPERIMENTS), instruments and urban technology (TECHNOLOGY), research objects (OBJECTS), buildings and locations (SITES), cultural effects (EXPOSITION), biographical notes (PEOPLE), and theoretical frameworks (CONCEPTS).

EXPERIMENTS: Experimental set-ups used in a laboratory for the production of knowledge are ensembles of practices, skills and technologies, including methods, concepts, and theoretical conjectures. Fields of research and ultimately disciplines aggregate around such ensembles.⁴ The EXPERIMENTS section presents visual representations of experimental arrangements relevant to the life sciences of the nineteenth century.⁵ In order to illuminate the contexts in which an experiment was performed, the section is sub-divided into thematic categories like ‘Heart & Circulation’, ‘Brain & Nervous Systems’ and ‘Experience & Behaviour’. The EXPERIMENTS section proceeds from the assumption that experiments are historically variable practices that have undergone significant shifts in structure and content. In accordance with this assumption, the aim of the EXPERIMENTS section is to collect images of similar forms of experiments and to present them in series over time.

TECHNOLOGY: This section primarily presents visual representations of instruments and general technical equipment used in physiological and psychological research in the nineteenth century.⁶ The TECHNOLOGY section is structured according to thematic headings like ‘Inscription of Movement’, ‘Electricity & Magnetism’ and ‘Time & Velocity’. It also provides information dealing with the interrelationships between the use of instruments and changes in technology beyond the walls of the laboratory,⁷ addressing the issue that instruments for experimentation are always used in settings dominated by local circumstances. The headings concerning this issue are devoted to urban technology (water, gas, electricity), systems of transport (e.g., urban railways, electrical street cars) and systems of communication (e.g., telegraphy, telephone).

4 For an exemplary study on the history of experimental systems in the life sciences, see Rheinberger (1997). For additional case studies see Rheinberger & Hagner (1993). See also Rheinberger (1994), and Rheinberger & Hagner (1997).

5 For references on the history of nineteenth-century physiology, e.g. on the rise of institutions, on education and teaching and their relations to public health and medicine or on the antivivisection movement see Coleman & Holmes (1988), Cunningham & Williams (1992), Sarasin & Tanner (1998).

6 Important studies on the instrumentation of nineteenth-century physiology are devoted to the “graphical method” (see, e.g., Brain, 1996). For an overview see Chadarevian (1993). Some of the devices used for graphical recording, such as the Helmholtz myograph, have been studied extensively (see Olesko & Holmes, 1993; Brain & Wise 1994).

7 E.g., electric street cars disturbed laboratory research in late nineteenth-century electrophysics and electrophysiology, see Cahan (1989), Dierig (1998).

OBJECTS: A decisive aspect of scientific innovation in the life sciences consists in choosing, shaping, reshaping, and sometimes in abandoning certain objects of study. In the nineteenth century, physiologists and psychologists carried out experiments on objects such as frogs, rabbits, dogs, and eventually human beings. These objects take various forms according to the different contexts in which they acquire their epistemological value. The *OBJECTS* section deals with the history of these objects, presupposing that ‘model organisms’ were as important a resource for experimentation as instruments (cf. Bonnie, 1993; Kohler, 1994). Experimental practices crystallised around prepared organisms. Nineteenth-century electrophysiology, for instance, is unthinkable without the frog as a model and emblem of bioelectricity.⁸ A closer analysis of such model organisms and their scientific ‘careers’ shows that the uses of certain organisms are bounded by a complex set of conditions.⁹ These include technical specifications such as utility, disposability, suitability for laboratory work, ease of manipulation; ethical and financial considerations; forms of everyday life; and theoretical presuppositions. Sources relating to this “objectal” dimension of research activities are located in the *OBJECTS* section.

SITES: This section focuses on sites of knowledge production (cf. Galison & Thompson, 1999; Ophir, Shapin & Schaffer, 1991). Research activities in the life sciences of the nineteenth century were carried out primarily in institutes and laboratories, but also in field stations, museums and hospitals. The interior of these sites was, however, closely related to the realms of the exterior. On the one hand, physiological knowledge crossed the laboratory walls and diffused into other sites; on the other hand, practices connected to sites outside the laboratories moved into the laboratory and became important both to the organisation of work and teaching and to the construction of theoretical models.¹⁰ Hence, the *SITES* section also presents sites that served the purposes of research in a secondary way, such as lecture rooms, gymnasiums, factories, theatres, and railway stations. All sites presented in this section are explained by means of building plans, charts and pictures. To demonstrate the relation of sites to their urban environment, the section also provides the reader with historical city maps.

EXPOSITION: A well known example of how nineteenth-century laboratory practices in the life sciences stimulated the fine arts is the work of the French physiologist Étienne-Jules Marey, whose chronophotography became a key source of aesthetic modernism at the dawn of the twentieth century (cf. Brain, 1996; Braun, 1994). Marcel Duchamp and Giacomo Balla are two examples of painters who adapted the rhythmical shapes of chronophotographs and trans-

8 On frogs in the history of electrophysiology, see Holmes (1993) and Rothschild (1973); see also Schmidgen (1999) on the role of the decapitated frog in physiological psychology.

9 On the role of the urban water and gas supply for Emil Du Bois-Reymond’s research on the electric fish, see Dierig (in press).

10 On the impact of Helmholtz’s research on acoustics on the Steinway piano factory, see Hiebert & Hiebert (1994); on the factory as a model for a physiological research institution, see Todes (1997).

formed them into a pictorial convention for the dynamic sensation of time. Such “de-contextualisations” of the experimental knowledge acquired by the life sciences are treated in the VLP section called EXPOSITION. It serves as a sort of internal VLP interface between history of science research and cultural studies. EXPOSITION offers the reader artistic representations ranging from paintings, novels and sculptures, to photographs, music scores, and choreographic works. A further goal of this section is to present materials which demonstrate how physiological knowledge and practices were taught to students or presented to a broader public (cf. Daum, 1998). The EXPOSITION section serves this field of interest by offering materials on lectures, demonstration experiments, exhibits and popular journals.

PEOPLE: This section provides the reader with short biographies of individuals involved in the experimental discourses and practices of nineteenth-century life sciences: scientists, instrument-makers and publishers, but also novelists, engineers, painters and philosophers. The PEOPLE section provides short overviews on the life and work of such persons, based on entries in current encyclopaedias. Data include dates of birth and death, information about the time and location of positions held at institutions and the progress of the individual’s career, inside or outside academia.

CONCEPTS: Experimental set-ups used in a physiological or psychological laboratory to produce knowledge are connected to concepts and theoretical frameworks. Like experiments, concepts like ‘reflex’, ‘inhibition’ or ‘circulation’ have histories of their own (cf. Canguilhem, 1977; Clarke & Jacyna, 1987; Smith, 1992). The theoretical framework of an experiment has its own constants and variables, long-term appropriations and transformations which cannot be reduced to the history of instrumentation. The CONCEPTS section grants the reader access to central concepts of the life sciences in the nineteenth century. CONCEPTS documents the way these notions were used in the dictionaries and encyclopaedias of the period in question, presents citations of passages where these concepts were defined and offers links to existing theories, philosophical and scientific, and to contemporary literary texts.

The Digital Library of the VLP

Like every current research laboratory, the VLP is equipped with its own library. The LIBRARY of the VLP is the central storage location for all holdings presented in the sections. Pictures and text passages displayed in sections like EXPERIMENTS and TECHNOLOGY can be viewed here in the entirety of their published form.

The collection currently emphasises sources of particular relevance to the study of the material culture of the experimental life sciences. These sources can be divided into two main groups: periodical literature and laboratory manuals. Periodical literature emerged around the first half of the nineteenth century with the establishment of laboratory research in experimental physiology following the examples of chemistry and physics (cf. Bonah, 1995). The essays and reports published in the journals constitute invaluable source material for the analysis of physiological fields of work and their research practices. To date there is neither a database for such analysis in which scholars can search and find articles systematically, nor a satisfactory infrastructure for the procurement of publications from these journals, many of which are available only rarely or incompletely in libraries. The digital LIBRARY of the VLP will fill this gap.

The second group of sources consists of laboratory manuals. These are particularly valuable sources for reconstructing the material culture of experimenting in the life sciences. The detailed instructions provided in such manuals allow inferences about the way in which instruments and organisms were structured into experiments.

At least as interesting are the documents of the small industries which settled in the vicinity of laboratories and institutes to produce instruments and laboratory equipment. Initially a task for artisans in mechanical workshops, an industrial-style trade in instrument construction developed in the final third of the nineteenth century. Evidence of the instrument construction trade includes catalogues and price lists for instruments, which, however, rarely have been preserved. These sources are to be integrated into the digital LIBRARY to the greatest possible extent.

Moreover, in the near future it is planned to include unpublished sources in the LIBRARY as well, such as laboratory journals, correspondence and lecture notes (see below, “Outlook”).

Navigating in the VLP

The enclosed CD-ROM contains a prototype of the VLP (state: 5/2000). The purpose of this prototype is to elucidate the structure and function of the VLP using *examples*. The CD-ROM was produced in ISO 9660 format and can be used with all common operating systems. The *Netscape* and *Internet Explorer* browsers (versions ≥ 4.0) are supported. To start the VLP, insert the CD-ROM in the drive of the computer and open it. Enter the VLP HOME page by opening the “index.html” file with the browser.

HOME PAGE: The HOME page of the VLP is designed to arouse the curiosity and interest of the reader (see above, Figure 1). Together with the PANEL (see below, Figure 2), the HOME page is designed as a sort of “entrance tunnel” (cf. Siegel, 1996). It provides basic and general information about the VLP project: click the button “About the VLP” for an explanation of the general goals of the project, a description of the history of the project and the names of the VLP staff members. The “User’s guide” provides information about how to navigate and explore the VLP. It also sketches the historiographical background of the VLP sections. “Logon” is the entry point to the interior of the VLP.

Upon entering the VLP, the reader is provided with a navigation system specifically adapted to the historical materials dealt with by the VLP. On the first page, the PANEL (more on this below), two navigation bars appear. These navigation bars will be found on every page of the VLP. The upper navigation bar grants access to the individual sections where the holdings of the VLP are presented: EXPERIMENTS, TECHNOLOGY, OBJECTS, SITES, EXPOSITION, PEOPLE, LIBRARY, CONCEPTS. All pages accessible from this bar have the same structure: headers and footers always contain the navigation bars. At the left edge is a ‘vario area’ adapted to the respective topics or contents of each section. The lower navigation bar allows the reader to jump back to the HOME page or the PANEL from any location in the VLP.

The internal navigation system constantly informs the reader where he is currently located within the VLP. One of the most frequently asked questions by WWW users: “Where am I?” (cf. Fleming, 1998) is always easy to answer with a glance at the navigation bars and the vario area. The second most frequently asked question of WWW users: “Where can I go?” (ibid.) is also made redundant by the permanently visible navigation bars.¹¹

¹¹ The entry points of the ‘vario area’ are achieved with *JavaScript* (cf. Flanagan, 1997; Koch, 1999). Moreover, the layout of the VLP was realised using *Cascading Style Sheets* (CSS) (cf. Lie, 1999). This is also the reason why a browser of the “fourth generation” (*Netscape 4* or higher, *Internet Explorer 4* or higher) is required to view the VLP as it was designed. However, the navigation elements were designed so that visiting the VLP is also possible with older browsers. Even a visit with the text-based *Lynx* browser was tested successfully.

PANEL: The “Logon” button on the HOME page leads first to the PANEL (see Figure 2). This page offers examples for the research work in progress in the VLP. In the present prototype version, the abstract of an article soon to be published about the objects of experiments in electrophysiology and a report about an interdisciplinary workshop on the history of the experimental life sciences are presented. These are accompanied by a short multi-media article: A click on the uppermost image-link in the PANEL takes the reader to a portrayal of the pedagogical regime of physiology in late nineteenth-century Berlin. Integrated in this article are not only photographs and graphics, which can be enlarged by mouse click, but also animated pictures demonstrating physiological experiments.

The reader can return to the HOME page by simply clicking the corresponding icon in the navigation bar at the lower edge of the PANEL. By clicking the corresponding buttons in the upper navigation bar the reader can jump to the individual sections of the VLP: EXPERIMENTS, TECHNOLOGY, OBJECTS, SITES, EXPOSITION, PEOPLE, LIBRARY, CONCEPTS, etc.

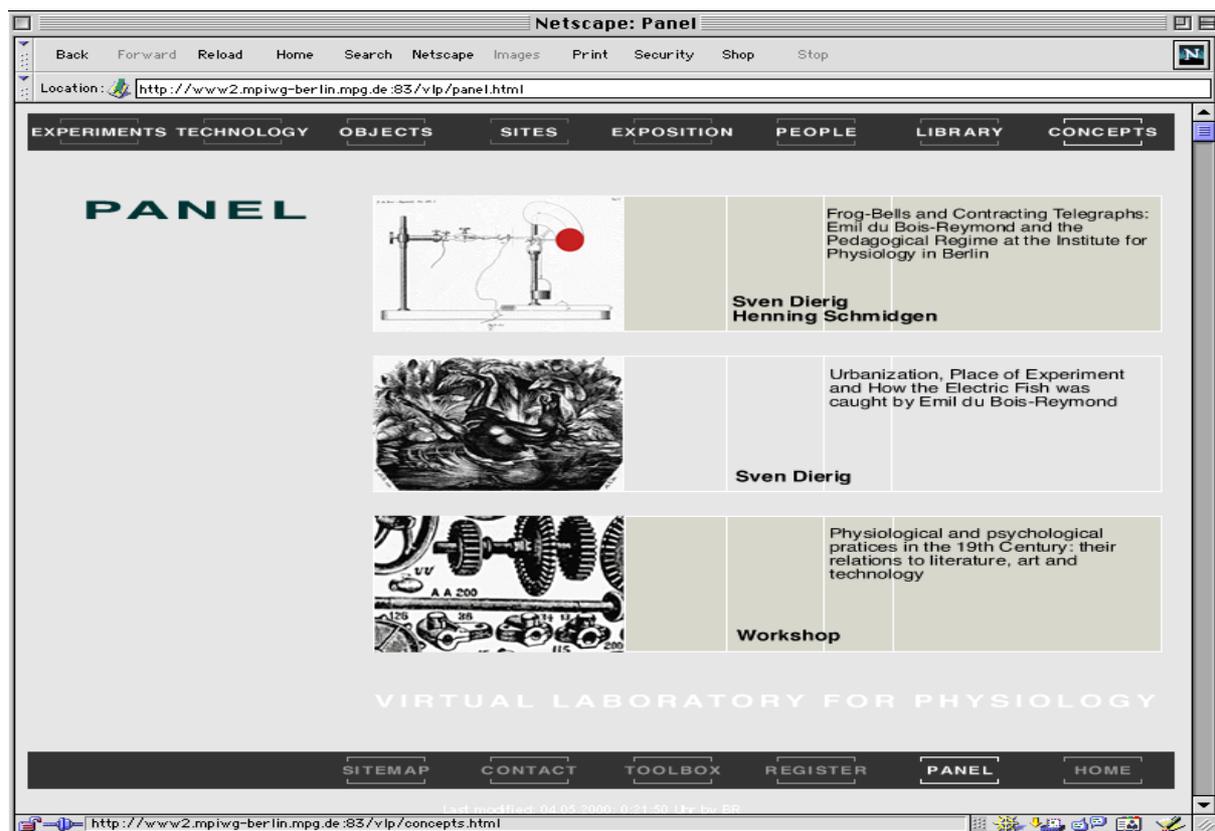


Fig. 2: The PANEL page of the VLP, with special navigation bars at the upper and lower edges

VARIO & STAGE AREA: Clicking any of the terms in the upper navigation bar opens the entry page of the corresponding section (see Figure 3). Each entry page is divided into two areas: the large ‘stage area’ on the right of the page and the smaller ‘vario area’ to the left.

The vario area follows an outline structure. Topic lists corresponding to the reader’s current position drop down to facilitate orientation. These simple means provide a “fish-eye” view, focusing the material accessible to the reader at any time in terms of his or her current position in the VLP: in sharp focus, or in detail, in the immediate vicinity; blurry, or less detailed, toward the edges (cf. Gloor, 1990; 1997).

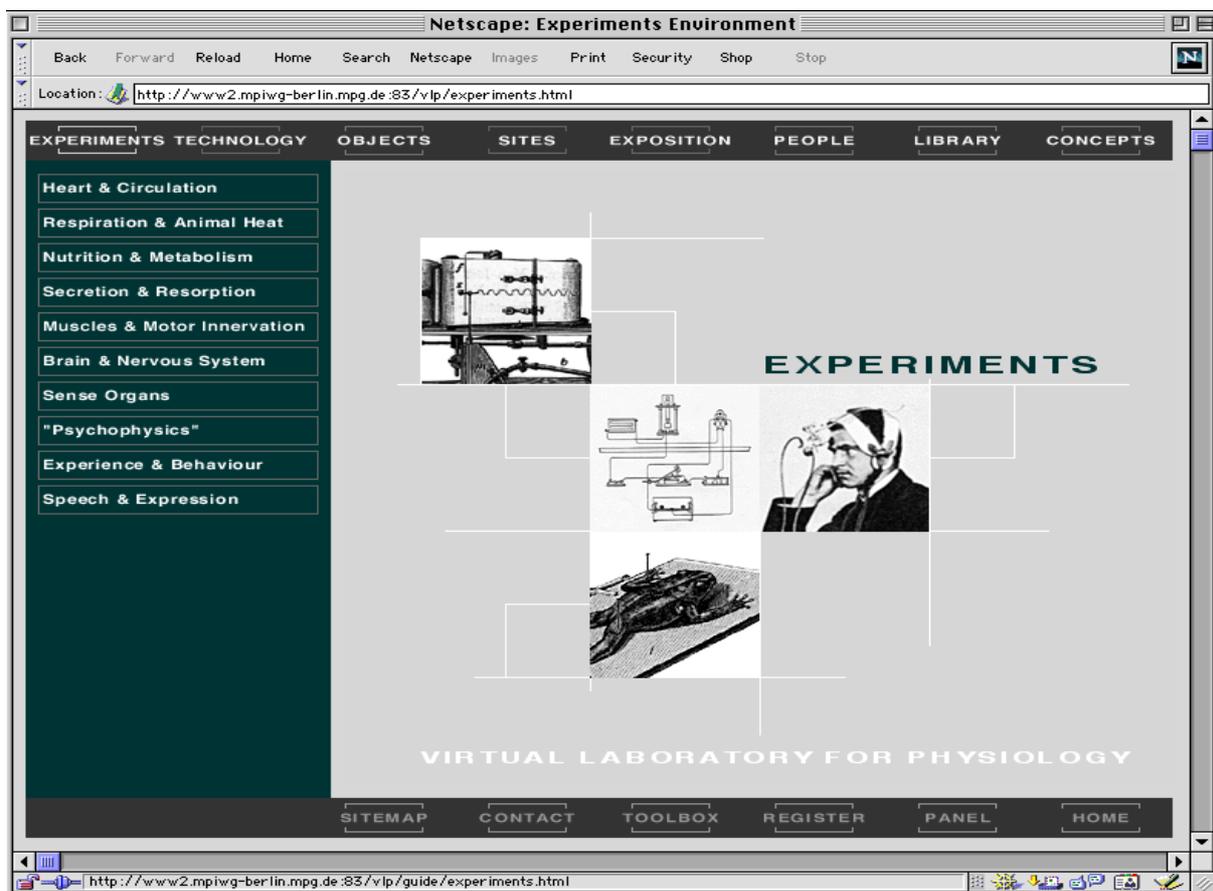


Fig. 3: Entry page to the EXPERIMENTS section, at right the stage area; left, the vario area with individual topics

The stage area on the right side of the page presents illustrations associated with the contents of the section. It also provides access to written information about the section’s contents. Clicking any element in the stage area opens a text box with corresponding explanations.

After selecting any of the topics listed in the vario area, the stage area displays the corresponding holdings of the VLP prototype, e.g. a list of experiments or instruments. When the reader clicks any of the items listed, detailed information about that item is displayed.

INFORMATION SHEETS: Clicking any of the items listed in the stage area presents the reader with an information sheet offering a detailed record of the item. The information sheet includes a pictorial representation of the selected item. For those readers who would like a closer view, the picture can be enlarged with a simple click of the mouse. The information sheet also provides the bibliographical references and other informations connected to the other VLP sections (see below, “Internal Cross References”).

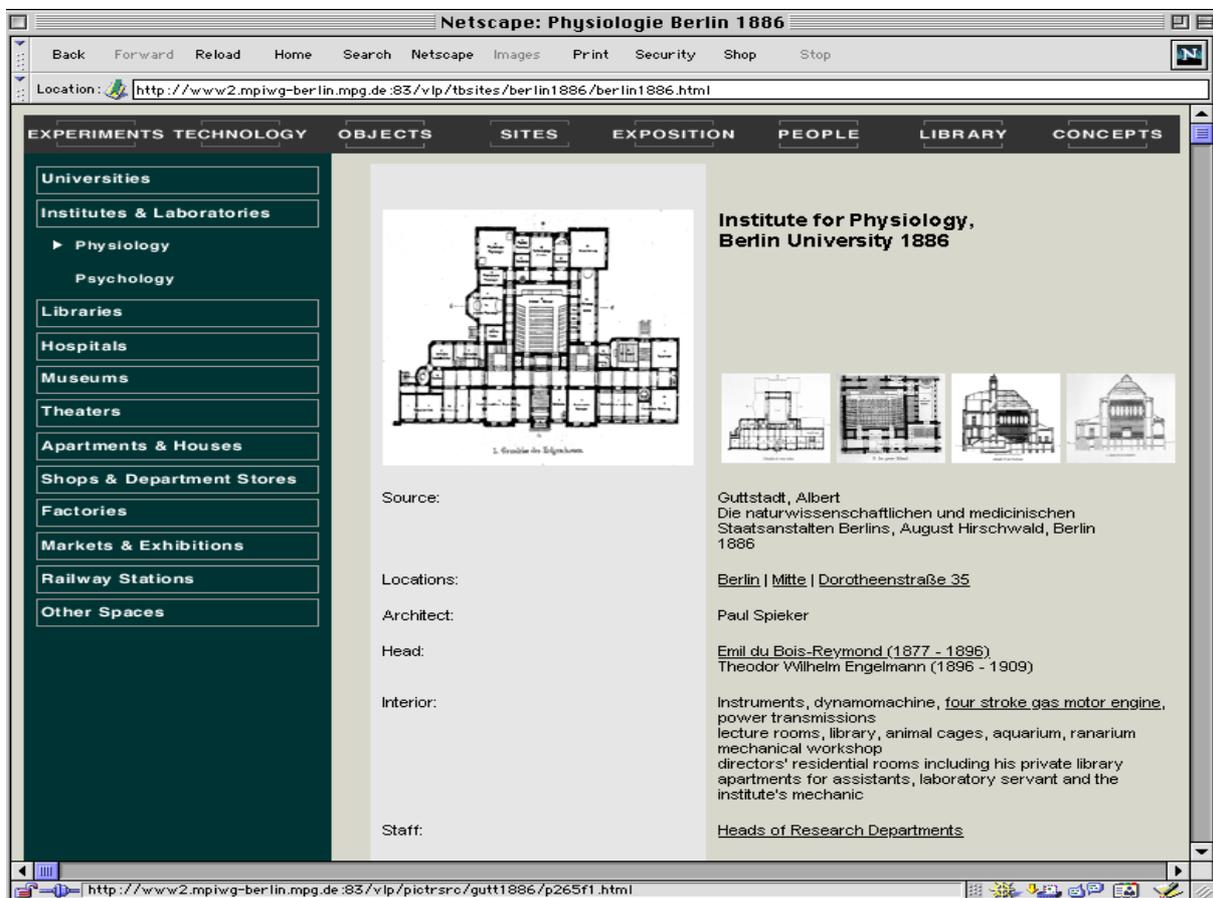


Fig. 4: Information sheet on a selected item with cross references to other sections of the VLP

The information sheets are organised in a similar manner in each section. In EXPERIMENTS, for instance, the sheet comprises the image of the chosen experiment, its source and a short de-

scription of the experiment. In addition, the reader is provided with information concerning the instruments or experimental objects depicted in the image, or about the conditions described in the corresponding source text. When the reader chooses an information sheet in the TECHNOLOGY section, a short description of the device and its experimental uses is opened, along with the name of the instrument maker (to the extent this is documented). When the reader selects an information sheet on a research institution within the SITES section, additional information is provided such as the location of the institute (city map), the directors of the institute during the period of interest, the architect responsible for building the institute or the organisation of the institute's research departments. Moreover, a short commentary on each information sheet draws attention to the significance of the experiment, instrument or institute and to further questions to explore.

INTERNAL CROSS-REFERENCES: The VLP sections are cross-linked on the level of the information sheets. Each information sheet has a set of *obligate links*. Obligate linking supports the content management within the VLP sections. It standardises the procedures of content registration and thus helps to smooth arbitrary differences specific to the individual authors contributing to the VLP. In the EXPERIMENTS section, for instance, instruments as well as experimental objects portrayed in the pictures (or described in the corresponding source text) are registered on the information sheet. Subsequently, they are linked with corresponding items in the TECHNOLOGY and OBJECTS sections. Similarly, the institute directors in the SITES section are registered on the corresponding information sheets. These entries are linked in turn to the PEOPLE section; bibliographical references to the holdings of the LIBRARY, etc.

In addition to the obligate internal links, the information sheet also provides space for *free references*. Each sheet includes a section for commenting and discussing the presented item. In this space, an author is free to set links to any location in the VLP's holdings. This option is particularly useful in those cases where the technology or supplies required to carry out an experiment are neither shown in the image nor mentioned in the source text.

NAVIGATION & THE STRUCTURE OF THE VLP: The information sheets form the "deepest level" of the sections. The branching structure of the VLP was held quite shallow, as a whole, in order to avoid the well-known problems associated with highly hierarchical structures.¹² The time-consuming process of 'swinging through' the individual branches of a complex tree structure was eliminated from the VLP at the outset, for a maximum of four hierarchical levels are

12 (1) In order to reach certain data of an information tree, the user must know the entire path. (2) The majority of information about the contents of a certain sheet is located in the nodes in the vicinity of the sheet and not in the nodes in the vicinity of the roots. This, too means that the user must know a great deal about the path in order to find his destination. (3) The information necessary to find a sheet frequently is not located at the nodes (cf. collectively Gloor, 1990; 1997).

used throughout. Take the main page of the EXPERIMENTS section as an example: the reader has access to a sub-category in the vario area, e.g., the topic ‘Heart & Circulation’ (1). After clicking this topic, a list is displayed in the stage area (2), which allows the reader to jump directly to an information sheet (3). This information sheet is, itself, already the ‘leaf of the tree’.

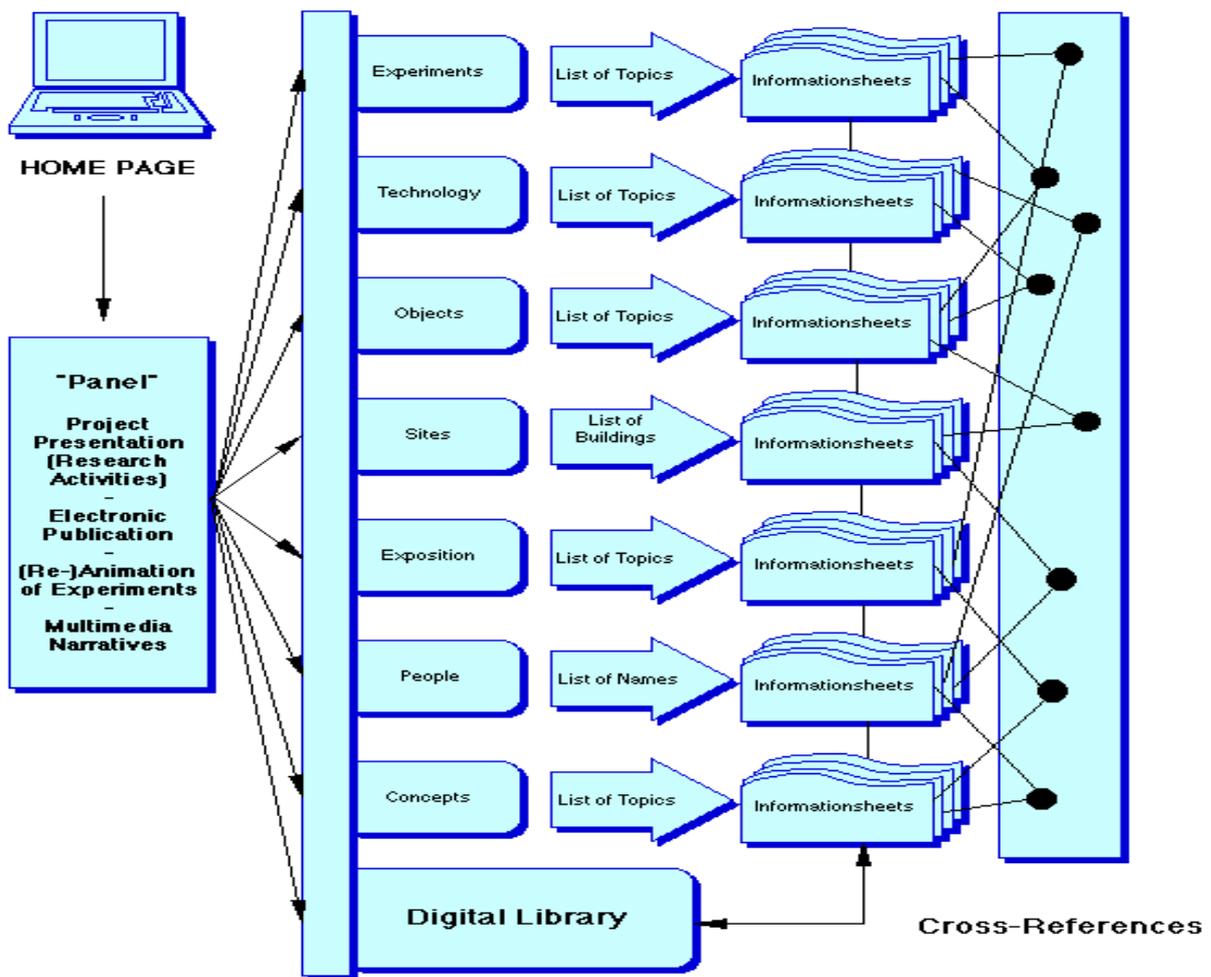


Fig. 5: The Shallow Hierarchical Structure of the VLP

If the reader, having selected a topic from the vario area (1) still is not clear about the destination of his search, he or she can jump to another sub-category (2) in which the vario area is displayed. There, as a sub-item of the topic ‘Heart & Circulation’, for instance, is a keyword such

as 'Blood Pressure'. Clicking this keyword prompts an overview display in the stage area (3), containing small illustrations of the object in question (thumbnails) and a short explanation. This overview is the last level above the information sheet (4). Here, at the latest, it should be clear to the reader whether the search is proceeding on the right path or whether a new search should be started at a higher level.

Moreover, the VLP provides the opportunity to jump back multiple levels from any location. All topics belonging to the selected section can be accessed directly in the vario area. The upper navigation bar allows the reader to switch between sections (for example, from TECHNOLOGY to SITES) while the lower menu bar provides the option of leaving any section to return to the HOME page or the PANEL.

Guided Tours through the Holdings of the VLP

The following tours through the holdings of the VLP prototype illustrate the potential of crossing the sections horizontally, facilitated by the cross-linked references. This structure allows experimental activities to be illustrated in their entire complexity: in terms of space, instruments, personnel and texts.

(I) INSTITUTES FOR PHYSIOLOGY AS FACTORIES FOR KNOWLEDGE PRODUCTION

Experimental physiologists like Carl Ludwig (1816-1895) and Emil Du Bois-Reymond (1818-1896) referred to the factory-style organisation of their institutes. With this they meant not only the institutes' division of labour and the hierarchical personnel structure, which so resembled those of their factory counterparts, but also the use of power engines in the physiological laboratory.

When the TECHNOLOGY section is selected, the 'Energy & Power' topic category in the vario area thus contains two types of machines whose invention in the nineteenth century was to slow the decline of the crafts in the face of competition from the factories. Opening the information sheet of one of the gas engines listed there first displays information about the engine itself. If the reader then wishes to learn, for instance, in which kind of experiments such an engine was used, the link presented for the experimental set-up 'Graphical Recording of the Blood Pressure' must be selected. This opens the information sheet in the EXPERIMENTS section illustrating an experimental arrangement of a kymograph powered by a drive belt. A list of hyperlinks references the instruments used in this experiment, including instruments not visible in the illustration but listed in the descriptive source text. If a reader accesses the link 'Machine Driven Bellows', for instance, he learns that the artificial respiration of the laboratory animal was accomplished using a power engine.

The list of respiration apparatus accessed here is reproduced in the TECHNOLOGY section and shows a selection of machine-driven bellows. At the same time, the vario area opened for the 'Artificial Respiration' topic category reports that the TECHNOLOGY section also contains manual and pedal-driven bellows. On the information sheet on one of these bellows, clicking the reference to an experiment carried out using this instrument brings the reader to the set-up of corresponding experiments in the EXPERIMENTS section. Back in the experimental set-up

‘Graphical Recording of the Blood Pressure’, an older version of the engine-powered set-up previously viewed can be opened by clicking ‘next’ in the upper right corner of the information sheet.

With this simple circulatory movement within the cross-linked information sheets of the TECHNOLOGY and EXPERIMENT sections, the reader thus learns that similar historical processes were under way in the physiology of the nineteenth century as in the worlds of skilled labour and factories. In the history of physiological laboratories, too, crafts were replaced by motor power.

(II) GENEALOGIES OF PSYCHOLOGICAL REACTION TIME EXPERIMENTS

Wilhelm Wundt (1832-1920) is considered one of the pioneers of modern psychology. In 1879 his Institute for Experimental Psychology opened its doors at the University of Leipzig.

Besides information about the person Wilhelm Wundt (PEOPLE), the VLP also grants access to the research institution where Wundt worked (SITES), to the experiments carried out there (EXPERIMENTS) and to the instruments used in these experiments (TECHNOLOGY). These data are complexly “inter-linked” to each other.

For instance, the EXPERIMENTS section lists under the topic ‘Experience & Behaviour’ experiments on reaction times which were decisive for the research activities in Wundt’s institute. An example of the experimental set-up from the first edition of Wundt’s *Grundzüge der physiologischen Psychologie* (1874) is illustrated. Also presented, however, are previous forms of the experiments, including those performed by the astronomer Adolphe Hirsch (1830-1911) at the observatory in Neuchâtel to measure the ‘personal equation’. Each information sheet presents detailed information about these experiments.¹³

A central component of these experimental set-ups was the “chronoscope”, a precision clock which permitted the measurement of the minimal time intervals (as small as 1/1000 sec.). Proceeding from the information sheet about the experiment ‘Measuring the physiological time in humans, 1874’, one can move to the TECHNOLOGY section by clicking the keyword ‘Hipp Chronoscope’ to view a number of illustrations of such instruments. As the illustration from Kuhn’s *Handbuch der angewandten Electricitätslehre* (1866) shows, the chronoscope was also used in physics. Among its uses there was the empirical verification of the laws of gravity.

13 From the generation of such series of experimental set-ups, we expect more detailed elucidation of the “invisible connections” between different fields of knowledge, and also about the connection between science and technology (see Schmidgen, 2000).

The utilisation of this instrument in other fields also is documented in the VLP. Thus, the experimental set-up ‘Measuring the velocity of falling bodies’ can be accessed from the information sheet on Kuhn (‘Hipp Chronoscope 1866’). This switches the reader back to the EXPERIMENTS section and presents relevant information about the use of the chronoscope in physical experiments. From the corresponding information sheet one can even consult the associated original publication by Oelschläger from the year 1849. Like other source texts used in the VLP, it is located in the digital LIBRARY and can be consulted as a scanned facsimile.

Still, there are other ways to move through the sections. Remaining on (or returning to) the TECHNOLOGY information sheet for the ‘Hipp Chronoscope 1866’, the reader can call up more detailed information about Matthias Hipp (1813-1893), who is considered to be the inventor of the chronoscope. Clicking on this name sends the reader to the PEOPLE section, where an information sheet is displayed containing not only a portrait and his dates of birth and death, but also information about Hipp’s body of work.

Of course, the PEOPLE section also contains an information sheet on Wilhelm Wundt, accessed using the ‘next’ and ‘previous’ buttons displayed at the top and the bottom of the information sheets. From the sheet about Wundt one also gains access to the Institute for Experimental Psychology he led, as it looked in the year 1909. By clicking on the relevant link, the reader moves to the SITES section. There the ground-plan of Wundt’s institute, an overview map of the immediate vicinity and a map of Leipzig (from the year 1888, however) can be viewed. A list of the dissertations completed in Wundt’s laboratory is also presented.

To simplify the exploration of the prototype, here is a list of the topics about which materials are provided:

EXPERIMENTS	Heart & Circulation Experience & Behaviour
TECHNOLOGY	Inscription of Movement Time & Velocity Artificial Respiration Energy & Power
SITES	Institutes & Laboratories Other Sites
PEOPLE	A-E, F-K, L-O, T-Z
LIBRARY	Simple Search Journals

The following texts are presented in the PANEL:

Sven Dierig & Henning Schmidgen, “Frog Bells and Contracting Telegraphs: Emil Du Bois-Reymond and the Pedagogical Regime at the Institute for Physiology in Berlin”

Sven Dierig, “Urbanization, Place of Experiments and How the Electric Fish was Caught by Emil Du Bois-Reymond” (Abstract)

Workshop, “Physiological and Psychological Practices in the Nineteenth Century: Their relationships to Literature, Art, and Technology”

The sections OBJECTS, CONCEPTS and EXPOSITION are still under development.

HISTORY OF THE PROJECT

The VLP was originally conceived by Sven Dierig in the fall of 1997. Together with Jörg Kantel, the head of the computer department at MPIHS, Dierig established the first version of the VLP.

The basic idea was to illustrate how the technical conditions of physiological research evolved throughout the nineteenth century using the advantages of the World Wide Web. In terms of its content, the VLP was centered on the physiological institute established in 1877 by Du Bois-Reymond in Berlin. Advanced technologies such as the animation of images were already explored at this early stage of the project. From the computational perspective, the administration and organisation of large amounts of visual data were the prime challenge.

The first version of the VLP was modelled after a plan of the Du Bois-Reymond physiology institute in Berlin. The spatial division into different departments (lecture room, collection of instruments, library etc.) was meant to facilitate intuitive orientation through the holdings of the VLP. Given the rapidly growing body of historical materials, however, it turned out that effective navigation required more specific criteria. Using a textbook from the late nineteenth century as a model, Dierig and Kantel began to specify research fields (the physiology of muscles, brain & nervous system etc.) and to reorganise the holdings of the VLP accordingly.

This resulted in a twofold structure of the VLP: one purely architectural, the other more thematic. Consequently, it appeared necessary to restructure the VLP. At the same time, it was deemed desirable to connect the VLP more closely to the historiography of science, focussing on experimentalisation as its main topic. Starting in September 1998, Henning Schmidgen joined the team in its efforts to meet these new challenges. Dierig, Kantel and Schmidgen began to reorganise the holdings of the VLP according to the following sections: EXPERIMENTS, TECHNOLOGY, OBJECTS, SITES, EXPOSITION, PEOPLE, LIBRARY and CONCEPTS. Moreover, the archival function of the VLP was to be complemented by a history forum, the PANEL, where people working with the VLP can prepare and present the results of their studies, ranging from illustrated articles to stories, dedicated to the virtual reconstruction of experiments.

Along with the contents of the VLP and its new navigation concept, the technical basis changed as well. While the VLP was initially a collection of hand-generated *Hyper Text Markup Language* (HTML) pages, the development and management of the VLP increasingly involved the implementation of script tools and databases. In the following section we describe which tools were used and why these tools were selected.

From April through August 1999, the project team collaborated with design experts Christian Berndt and Thomas von Mandel to prepare a VLP prototype. The enclosed CD-ROM was produced with the skillful assistance of programmer Bastian Rietdorf.

TECHNICAL ASPECTS OF THE VLP

In addition to the conceptual demands, there were also a number of technical requirements to be fulfilled in realising the VLP. The computer infrastructure of the MPIHS consists almost exclusively of *Macintosh* equipment; even the Institute's server is an *Apple Macintosh* server. These factors had to be taken into consideration in the realisation of the VLP, along with the fact that the MPIHS is already equipped with a 'literature server' and a library catalogue based on *FileMaker*. The solution we implemented needed to be compatible with the existing system. At the same time, the VLP was to be installed as a communication platform for scientists working in the international arena. Thus the implemented project had to take the needs of *Mac users* at the MPIHS into consideration as well as the interests of readers in the heterogeneous world of networks outside the institute. In other words, the VLP must be platform-independent.

The magnitude of the project presented additional requirements. At present, the version installed on the institute's server (not the one saved on the enclosed CD-ROM) is approx. 2.5 Gbyte. This data inventory primarily consists of scanned pages from the physiological and psychological literature. For a complete VLP installation, the total volume is estimated at up to 500 Gbyte.

Such amounts of data require a powerful web-content management tool. The solution selected for the VLP is a combination of a *FileMaker* database as a tool for data acquisition and *Frontier* as the web-content management tool. The data of the VLP are exported from *FileMaker* and converted by *Frontier* into HTML pages. These pages are then published in the WWW. With this solution the VLP does not run on all conceivable platforms, but smooth operation with the two most common (*Windows* and *Macintosh*) is certainly guaranteed. Moreover, the web sites generated in the VLP can also be filed as mirrors on platforms like *UNIX*.¹⁴

14 At the conclusion of the volume is a directory of the abbreviations used.

Content Management

A collection of digitalised materials of the magnitude of the VLP can be managed only by using powerful data processing tools. The decisive characteristic of such tools is that they be capable of automatically generating and administering the materials of the VLP. In principle, there are several possibilities:

1. The data can be administered in a database created directly in the WWW using a corresponding tool. An example of this is the combination of a *FileMaker* database with *Lasso* or *Tango*. In this case the *FileMaker* interface is reproduced as closely as possible in the Web browser using a specialised Common Gateway Interface (CGI, a standard protocol to generate dynamic web sites). A similar approach is pursued by *4th Dimension*, a database which can place data directly into the Internet using an integrated Web server.

The disadvantage of these solutions is that they are linked very closely to the corresponding database. In general it is possible to use only those features which are also possible in offline database operation; advanced HTML features (like animations, improved layout, sophisticated link options) cannot (yet) be realised. Because the data are not available as HTML files, there is no way for tools like search engines to index data and include them in their catalogues. Another disadvantage is that presentation is only possible with a hyper text transfer protocol (http) server. Offline presentation and offline distribution (by CD-ROM, for example) are not possible.

2. Another possibility is to administer the data in a database, to export them from there, and to use special programs to convert them into HTML pages, which then can be put in the Internet. This solution is quite common for data which are relatively stable. It has been implemented successfully at the MPIHS for projects like the *Cuneiform Digital Library Initiative* or *Galileo's Notes on Motion*.¹⁵ An undeniable advantage is that the data are present as static web pages. They can be found easily by search engines, and also can be distributed (in whole or in part) by CD-ROM or similar data storage media. Because the ISO 9660 standard is applied, the use of CD-ROMs generated with this method is also platform-independent.

The disadvantage is that there is a considerable time lag between the acquisition of data and their presentation in the Internet. The data presented in the Internet are seldom up to date; they always lag behind the current scientific work. Moreover, an additional processing step is always necessary before the data can be placed in the Internet. The scripts which perform the process-

15 See [<http://mpiwg-berlin.mpg.de/cdli/index.html>] and [http://mpiwg-berlin.mpg.de/Galileo_Prototype/MAIN.HTM]

ing of data in HTML pages (in this case: *Perl* scripts) also require new adaptation and programming with each change to the data.

3. Yet another possibility is to store the data in a database and use CGIs to place them into the Internet as dynamic HTML pages. This approach is only marginally different from the solution discussed above, but is generally more flexible and permits free design of the HTML pages. This is the approach currently so popular in the realisation of such projects as *e-Commerce* solutions. The CGI languages generally used are *Perl*, *C++* and *Java*, but other script languages like *Python*, *Tcl* and *AppleScript* are implemented as well. The databases are typically Standard Query Language (SQL) databases like *Oracle* or *mySQL* (cf. Yarger et al., 1999), for which there are excellent libraries to link databases in the languages mentioned above.

The disadvantages here are the relatively high programming expenditure and the increasing complexity of growing data inventories. Moreover, as for all dynamic solutions, distribution on CD-ROM is no longer possible. This solution is another which can be operated only with an http server, and whose pages cannot be indexed by search engines.

4. Finally, one possible solution uses one of the many frameworks available. The best-known framework of this kind is *WebObjects* (by *Apple*), but *Zope* (by *Digital Creations*) and *Frontier* (by *Userland*) are also implemented frequently. Thanks to the object-orientation of the languages upon which they are based (*Java* or *Objective C* for *WebObjects*, *Python* for *Zope*) and/or the fixed “dove-tailing” of these languages with the framework (*UserTalk* for *Frontier*), the solutions generated with this method can be expanded and configured as desired. Any desired mix of static and dynamic HTML pages is possible. Changes can be implemented either by programming CGIs or by using server-side extensions.

However, whenever any of the pages are generated dynamically, the above disadvantages are valid for this approach as well. Moreover, considerable effort is required to learn both the framework and the programming language upon which it is based. Finally, the frameworks generally are not platform-independent. At present, *WebObjects* runs only on *Windows NT*, *Next-Step* and *MacOS X*; *Zope* on *Windows NT* and a number of *UNIX* platforms, *Frontier* on *Windows (95/98/NT)* and on *Mac OS*.

For the VLP we thus decided on an integrated solution which follows in part the approach discussed above in paragraph 2, combined with one (or two, respectively) of the frameworks discussed in paragraph 4. This solution is the result of a process in which the different approaches were tried out and compared with the objectives of the project as well as the conditions at the MPIHS.

The following application servers and Web management/content management tools were tested for suitability for the VLP: *iNet*, *WebObjects*, *Zope*, and *VisualWave*. In view of the requirements of the VLP project, none of these was completely convincing. In *iNet* the support for the *Macintosh* platform apparently has been discontinued. *WebObjects* appeared too large and too powerful for the VLP project. *Zope* may be quite a powerful tool, and scalable for the requirements of the VLP, but only parts of it run on *Macintosh* (see below, "Digital Library"): the comprehensive implementation only works in *Unix* or *Windows NT*. The future of *Visual Wave*, which is based on a *Smalltalk* implementation seems uncertain, as *Smalltalk* increasingly is edged out by *Java*.

The comparative test of the above application servers and web management/content management tools concluded that *Frontier* in combination with a database (presently *FileMaker*) is the web management tool of choice for the VLP. *Frontier* was developed originally as a script language and script environment for the *Apple Macintosh* (cf. Neuburg, 1998). Up to version 5.01 *Frontier* was public domain. Since then it has been developed further and is now distributed by *Userland Software*. The programming language upon which *Frontier* is based is *UserTalk*, a language very similar to *Python*¹⁶, however, it is not as consistently object-oriented as *Python*. *Frontier* builds instead on an integrated object database (ODB), whose contents can be accessed in a variety of ways using *UserTalk*. Ever since *AppleScript* was released as a script language for the *Macintosh*, *Frontier* by *Userland* has undergone continuous development into a web management tool.

Frontier fulfills nearly all expectations for a powerful web management tool. It can deal not only with highly structured databases, but also with weakly structured data. *Frontier* uses a template concept resembling *Document Template Markup Language* (DTML). Moreover, it is a thread-safe tool which also allows CGI scripts supported by *Macintosh* http servers. And finally, *Frontier* and *Python* can be implemented together: an important feature for integrating the LIBRARY into the VLP and maintaining compatibility to the other literature collections at the MPIHS.

16 *Python* is one of the younger script languages which was designed to be object-oriented from the outset (cf. Lutz, 1996; Rossum, 1997). *Python* is freeware which runs on almost all platforms. It uses *Tk*, an extension initially developed for *Tcl*, to implement platform-independent GUIs.

Digital Library

An exception to the *Frontier* web management tool implementation is, as implied above, the digital LIBRARY of the VLP. In order to guarantee compatibility with the ‘literature server’ already established at the MPIHS, it was generated with the Python/DTML solution discussed below. In constructing the VLP digital LIBRARY we referenced this server, which was created by Tilman Sauer, Peter Damerow and Gerd Graßhoff in Department I (Jürgen Renn, director).

The literature server makes scanned documents about the history of science available via web browser to the scholars working at the MPIHS. The original literature server was programmed in *Perl* and ran only on *UNIX (Linux)* and an *Apache* http server. For the specific demands of the VLP, the literature server was entirely reprogrammed in *Python* using part of the *Zope* framework. Thus complete data compatibility to the existing literature server was maintained.

It was decided to reprogram the literature server in *Python* for the following reasons. The roles of scientist, designer and programmer seldom coincides in one person. Therefore the conception of the VLP was to keep separate programming, the selection of the literature to be scanned, the scanning of the literature and the design of the HTML pages so that each of these tasks could be performed by different individuals or groups. Thus, for instance the selection and the scanning of the literature should be carried out independently of subsequent processing. Whoever scans the pages should then save data like the most important bibliographical information in a configuration file which is stored together with the scanned material. This configuration file is an *eXtended Markup Language (XML)* file composed of “pure” ASCII. Thus access to this file remains platform-independent, even over an http server.¹⁷

The design of the HTML pages was also to be kept independent of the programming. Thus a concept was sought with which HTML templates could be created with jokers to allow flexible integration of the variable elements of a page during the actual process of generation.

Finally, a program or script was to be developed which could tie the scanned pages into the HTML documents from the configuration file. Although much spoke for the script language *Perl* (cf. Wall et al., 1997), and although this script language has an excellent port for the *Macintosh* with *MacPerl* (cf. Brown & Nandor, 1998), *Perl* was ultimately rejected.¹⁸

17 Therefore it is planned to use self-programmed web clients to automatically generate a platform-independent table of contents for the entire holdings of the different literature servers at the MPIHS (cf. Wong, 1997).

18 Because *Perl* was not equipped with an HTML template at the time, it was not possible to separate the HTML text and the script program. The same was true for *Tcl*, the second well-known script language (cf. Ousterhout, 1995). Moreover, at the time of this decision, *Perl* had no XML libraries and *Tcl* had only one rudimentary XML library. (This has since changed, at least in the case of *Tcl*, which now enjoys an XML library at least as good as one of the *Python* implementations; however, large parts of this library are commercial.)

The most promising solution was *Python*. Because of its consequent object orientation, a number of outstanding libraries are delivered with this script language. This is also why *Python* has become one of the preferred languages for programming in the WWW. Numerous additional modules for *Python* are available, most of them also free of charge. One of these modules is *Document Template Markup Language* (DTML), also known as *Bobo Document Templates* (cf. Rossum, 1997). This module adds two classes to *Python*: “DocumentTemplate.HTML” and “DocumentTemplate.HTMLFile”. Each of these classes can be used add tags to HTML files, which then are substituted by the corresponding *Python* scripts during “rendering”. The resulting files are clean HTML pages.

HTML comment syntax is used to hide DTML tags from the browser so that the DTML files can be viewed in the browser during the design process. This is the same syntax used when implementing Server-Side-Includes (SSI). A DTML tag has the following syntax:

```
<!--#tag-name attribute1="value1" attribute2="value2" ... -->
```

The name of the tag verifies its type. Each tag typically has one or more pairs of values or attributes which determine its behaviour, for instance, where the data come from or how the data are inserted. Additional tags exist for conditions and loops, designated by an end tag. The following instruction, for instance:

```
<!--#if input_name-->
    Hello <!--#var input_name-->!
<!--#else-->
    Hello World!
<!--#/if-->
```

when the variable `input_name` in *Python* script is handed over to the document template (i.e., when the variable exists and is assigned), will write “Hello Peter!” in the HTML page (if the value of the variable `input_name` is “Peter”); otherwise it will write the default “Hello World!”.

This approach has already proven its value in the framework of the VLP project. Each time the VLP is re-launched after a new page layout design, only the corresponding (two) DTML templates for the library of the VLP must be re-written; the *Python*-Script which generated the actual pages remains intact except for a few “cosmetic” changes.¹⁹ Here it is apparent that the object orientation of *Python* serves to keep both sources conveniently short.

19 For information about the documentation of the source text of the *Python* scripts and DTML templates, cf. Kantel & Dierig (1999).

Nearline Publishing

All contents of the VLP except those associated with the digital LIBRARY are administered, as explained above, in a combination of *Frontier* and *FileMaker*. For these contents a strategy was developed to unify the technology of ‘dynamic publishing’ on the one hand and the ‘creation of static HTML pages’ on the other. Based on the terminology of database technology, this strategy can be designated “Nearline Web Publishing”: it is somewhere between an “offline” solution, in which the data are transformed manually into HTML pages, and an “online” solution, in which dynamically generated HTML pages access the data inventory directly.

The implementation of the VLP in *Frontier* occurs in three steps. First, the *FileMaker* databases of the VLP are reproduced in the ODB of *Frontier*. This ODB is a database for programmers; it does not constitute a comfortable Graphical User Interface (GUI) for entering and maintaining data. For this reason it was decided to leave the acquisition and maintenance of the data in *FileMaker* initially, to take advantage of its excellent, low-maintenance GUI.

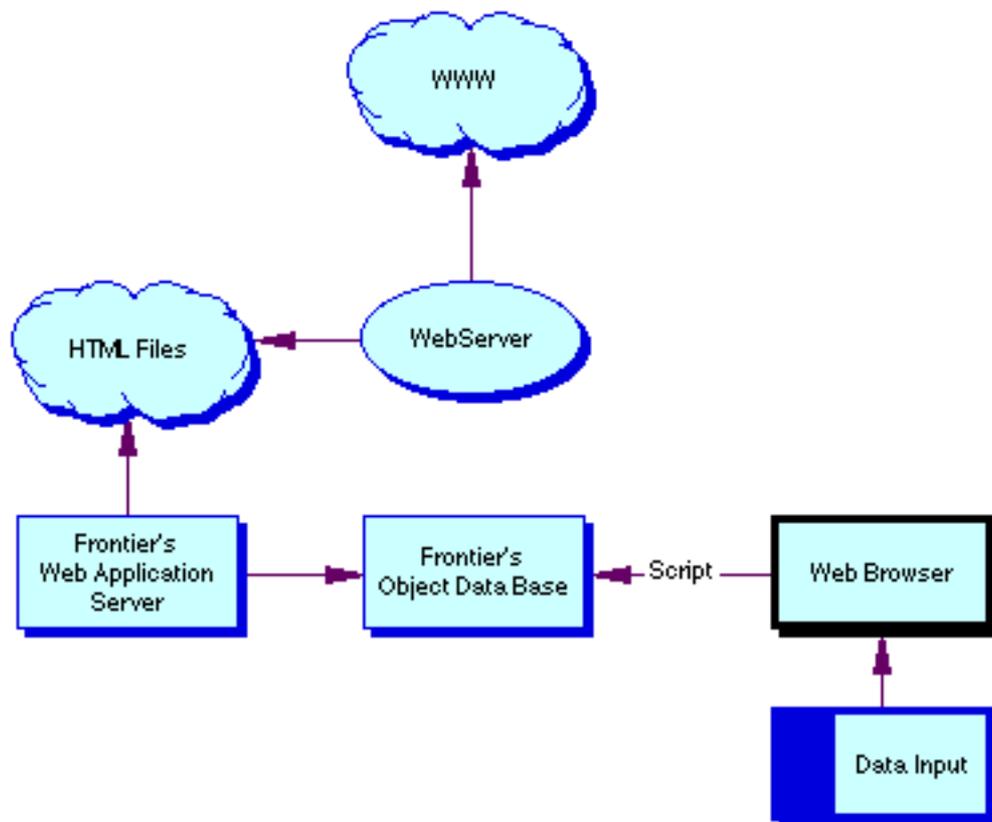


Fig. 6: From data input to WWW

As a second step, import routines were written to import the data from *FileMaker* to *Frontier* at regular intervals. The third step was to generate templates in *Frontier* which represent the web pages of the VLP. These templates contain no data, but serve as references to the entries of the VLP in the *Frontier* ODB. By means of an *Agent* script (corresponding to cron-daemons in *UNIX*), a regular “rendering” of the VLP data sheets was initiated. The resulting static pages, which are transmitted by script to the server of the VLP via file transfer protocol (ftp), thus always contain the current version of the VLP data.

Figure 6 illustrates this process: From *FileMaker*, the data are imported into the ODB of *Frontier*. Templates in *Frontier* access these data in the ODB during the rendering process and generate HTML pages, which then are distributed from the server. All pages are initially static HTML pages, meaning that distribution by CD-ROM or a similar medium is still possible without any special processing.²⁰

20 An exception to this is the literature search. It is realised as a “classical” CGI script in *UserTalk/Frontier*. The enclosed CD-ROM version of the VLP thus must do without this dynamic feature.

OUTLOOK

The development of the VLP is intimately associated with the current research under way in Department III of the MPIHS on the history of “The Experimentalisation of Life”. As reflected in the structure of the VLP, this project is more than history of science research in the strict sense. Sections like TECHNOLOGY, SITES or EXPOSITION demand the participation of other scholars, including historians of technology, historians of architecture and art historians.²¹ In the context of this research work, on the one hand the VLP is designed to function as a kind of archive which grants its readers access to relevant information and sources on the history of the life sciences and supports them in their research. On the other hand, the VLP is conceived of as a forum and a catalyst for working through the history of those processes which formed the modern life sciences.

Through both the material provided and the form of its presentation, the VLP provokes new kinds of questions concerning the history of the life sciences. The structure of categories so carefully thought out and the navigation system based on this structure make it an heuristic tool which opens up new kinds of contextual perspectives. Potential projects concern comparisons of artistic and scientific experiments, the interaction of architecture and science, the connections between the history of instruments and the theory of media, etc.

The VLP also allows new kinds of methods to be used in the reconstruction of experiments. The studies of Gooding (1990) and Sibum (1995a; 1995b) demonstrated the epistemological value of the historical reconstruction of experiments. Investigating experimentation processes in detail not only elucidates the individual steps toward problem-solving and decisions in scientific activity, but also opens that dimension of implicit, “tacit” knowledge which research apparently cannot do without. Since a naturalistic reconstruction is often impossible in the experiments of the life sciences (frequently for ethical reasons alone), *virtual reconstructions* of experimental set-ups are to be realised in the VLP. Such (re)-animations of experimental set-ups, realised using *Java* applets, can make even the aesthetic dimension of experimentation accessible to analysis.

Finally, the VLP conceives of itself as a pioneering publication environment and as a medium of communication between participating scientists. Oriented toward the most advanced current possibilities of web technology, the project attempts to launch a new, multi-media method of writing history, in which not only black-and-white or colour pictures, but also animations,

21 Cf. the MPIHS Preprint No. 120 on the workshop “Physiological and Psychological Practices in the Nineteenth Century: Their Relationships to Literature, Art and Technology” (with articles by H. Schmidgen, S. Dierig, M. Stingelin, P. Ziche, Ch. Hoffmann and S. Jansen). An English summary of this workshop is contained on the CD (accessible over the PANEL of the VLP).

sounds and, ultimately, even films can be integrated into historical studies. This new kind of historical writing is also associated with the potential for making contact and seeking new forms of co-operation with other scholars through or via the VLP. Such collaboration may include the exchange of ideas by Email, the publication of data over the WWW and the introduction of forms of collaborative writing (cf. Speck, 1999). Because collaborative authoring requires effective communication between the members of the writing collective, newsgroups, chatrooms and other forms of communication related to the Internet will be established to provide the authors with a forum for discussion and the exchange of information.

In addition to expanding the existing VLP structure and perfecting the present acquisition routines, the next phase of VLP development will concentrate on the following issues.

Expansion of the Digital Library

The library is to be expanded to become an electronic subject library for the history of the life sciences in the period from approximately 1830 to around 1930. To date, the holdings of the digital LIBRARY consist of digitalised journals, laboratory manuals and instrument catalogues. At present, a database is being prepared in which relevant literature (tables of contents of journals, book titles, etc.) is listed systematically. Further planning includes making the holdings of the library and the other areas of the VLP accessible for full-text searches. A search option for the holdings of pictures is also to be set up. *Frontier* offers convenient possibilities for performing such dynamic search inquiries over the entire contents of the VLP.

The ongoing process of collecting published sources on the history of the life sciences is to be extended through the acquisition of unpublished material. We hope that in the coming months a suitable example, something along the lines of a manuscript, correspondence, or a laboratory diary can be digitalised and integrated into the VLP library. The MPIHS already enjoys the required technical infrastructure. Accordingly, more intensive contact is being sought to libraries, archives and museums in the interest of entering co-operative arrangements.

Further Development of the VLP to a Research Tool of Internationally Co-operating Scientists

The VLP is to be equipped with a browser interface which, in principle, allows data acquisition and maintenance to be performed on any computer with access to the Internet. This is to be achieved either through CGI scripts or using *Frontier*'s highly developed editing tools (*main-Responder, Manila*). In this case *Frontier* will be configured as a server, either as a stand-alone

server or as a supporting server running behind a classic http server like *WebStar* or *Apache*. Such a configuration offers outstanding potential for user administration, including the management and assignment of access rights.

Another step to improve the interactive aspect of the VLP concerns implementing means which allow readers to compose comments on individual pages of the VLP. These comments can be either personal notes visible only to the reader, or can be defined as “general”, and thus viewable by other visitors to the VLP.

Thanks to the extensive scripting possibilities of *Frontier*, input masks over web browsers are not the only way to realise workgroups. Another option under consideration is to automatically process contents sent by Email or as text files to the *Frontier* server of the VLP, and then to automatically transform them into web pages. The only manual step required would be a release note. This possibility has already been tested successfully. Commenting options could also be expanded significantly in this context. Discussion groups can work jointly on a publication and comment on it until a publishable page for the VLP has been produced, without any extra steps required in *Frontier*.²²

Achievement and Diffusion of Standards

Publishing in the WWW is still subject to a number of open questions. In contrast to the fields of book or journal publication, such problems as authorship, intellectual property, copyrights and citation conventions are not yet resolved or not yet subject to binding regulation. In the processing of historical materials, such questions gain additional importance. The situation already has been addressed in numerous conferences and by style guide,²³ but it appears that these questions are far from resolved. Evidently such discussions are not productive “only in theory”, but must be associated with concrete projects and initiatives. Any progress the VLP prototype could contribute to dealing with these questions would be more than welcome.

Another important problem in the digitalisation of historical documents concerns the flexibility and re-usability of the data saved, both during work on a project and thereafter. Much discussed

22 An example of how such discussion groups can be implemented in *Frontier* is the *Userland* web site, see [<http://www.userland.com/>].

23 For instance, at the conference “Using the World Wide Web for Historical Research in Science & Technology”, organised by the Sloan Foundation and Stanford University (August 20-21, 1999) or through the text by Sean Townsend, Cressida Chappel & Oscar Struivjé, *Digitising History: A Guide to Creating Digital Resources from Historical Documents*, [http://hds.essex.ac.uk/g2gp/digitising_history/index.html].

in this context are the proprietary, generally data-base specific storage formats. Not even *Frontier* is an exception to this. Thus it is planned, at least for long-term storage (backup, etc.), to utilise XML (cf. Behme & Mintert, 1998). *Frontier* itself offers a number of excellent XML tools and can both import and export XML files (while keeping the XML structure). The current *Frontier* parser checks only the form of the data, not whether they are correct (i.e., it does not require *Document Type Definition* [DTD]). But it is to be expected that validating parsers soon will be made available. Likewise it is to be assumed that in the long run a version of Tom Megginson's *Simple Application for XML* (SAX) will also be available for *Frontier*.

In converting to XML, it then may be necessary to perform a data "re-launch" in *Frontier*'s ODB and to transform the current "classical" shallow structure of records into a hierarchical XML structure. This would have no influence on the way the rest of the VLP web site works, however. Presently the only complication is the lack of standards for meta-data like XML-DTDs. Unfortunately, only rudimentary steps toward the solution of this problem have been taken, as, for example, with the *Dublin Core* or the *Text Encoding Initiative*. In other words, there is much in flux to which active contributions would be welcomed.

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ABBREVIATIONS

ASCII	American Standard Code of Information Interchange
CGI	Common Gateway Interface
CSS	Cascading Style Sheets
DTD	Document Type Definition
DTML	Document Template Markup Language
ftp	file transfer protocol
GUI	Graphical User interface
HTML	Hyper Text Markup Language
http	hyper text transfer protocol
ODB	Object Data Base
SQL	Standard Query Language
SSI	Server Side Included
WWW	World Wide Web
XML	eXtended Markup Language

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