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The Prior eArchive as Virtual Research Environment: towards Serendipity and Explorability

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Abstract

The Prior Virtual Lab is an online research collaboration which aims to transcribe and make public manuscripts, notes and letters by (or sent to) the logician and philosopher Arthur N. Prior (1914-1969). This article explores and discusses the Danish Prior Internet Resources (PIR), which the Prior Virtual Lab is part of, and argues that it constitutes a Virtual Research Environment (VRE). The article also argues that a significant challenge for future work with the PIR is applying the knowledge of the iHumanist. In particular, we shall argue that part of what is required when moving into the digital humanities is a shift from a needy-user paradigm (emphasizing search for missing information) to an explorability paradigm (which emphasizes serendipity).

Keywords: Virtual Research Environments, Serendipity, Explorability, Needy-user paradigm, eArchive, iHumanist, eResearch, Interdisciplinary Research Collaboration, Research Infrastructure, Arthur Prior, Digital Humanities.

1 Introduction

In 2011, Norbert Loussau predicted that “virtual research environments will establish themselves as the norm in the coming five to ten years, and become as entrenched as the use of email and internet in the everyday life of a researcher.” (Lossau 2011, p. 156, [31]) While the prediction has three more years to be fulfilled, virtual research environments (henceforth VREs) are a long a way from becoming the norm. However, interest in VREs has not diminished, and a significant amount of research today takes place as eResearch (Jeffery and Wusteman 2012, [26]), where researchers explore and make use of modern technologies to facilitate research, research communication and research collaboration. Loussau encourages librarians to play a role in the development of eResearch by arguing:

Transcending the borders between disciplines, librarians will be able to apply themselves to their genuine tasks of cataloguing, administering and safekeeping the accessibility of knowledge in the age of internet and at the same time take on an essential role in the research process. »Librarians Go Research!« could become the catchy motto for libraries in regard to virtual research environments and should not be frightening but, rather, an incentive for bringing our basic competencies and experience to the new digital world of collaborative research, which is new to many researchers and librarians alike. (Lossau 2011, p. 156, [31])

As information professionals (the term was explored in Engerer and Sabir, 2018, [17]), we strive to play such a role in the Danish-based eResearch project *The Primacy of Tense: A.N. Prior Now and Then* (often shortened to the *Prior Project*). Here we support an interdisciplinary group of domain researchers¹ in their use of eResearch tools and their endeavour to transform the physical Nachlass of Prior into an enhanced *virtual* Nachlass, thus moving from a traditional archive to an eArchive.

¹“Domain researcher” is a term from information science that refers to colleagues from other disciplines [24]. In the Prior Project case this means the logicians, philosophers and historians, that the information professionals collaborate with and support with general expertise in digital information systems.

This article discusses the ongoing work of developing the domain group's main tool for eResearch: the Prior Internet Resources (PIR). Based on a discussion of how to define VREs, we argue that VREs are characterized by being online systems that support and facilitate research communication and research collaboration, data management and analysis, project management, and that functions via a participation architecture. We will argue that the PIR has many of the elements that characterize VREs, but not all of them, and that it has them to different degrees. However, we argue that this does not pose a problem for the characterization of the PIR as a VRE, as the list should not be evaluated as a collection of necessary characteristics, but merely as characteristics a VRE might have. Crucially, only the characteristics that are relevant for the particular domain group that the VRE is supposed to serve should be included. Moreover, we shall argue that the typical characteristics of VREs that the PIR lacks should be evaluated as potential developmental issues, not as disqualifications.

Due to our experience of keeping the PIR updated, we have come to believe that discussions of VREs and the PIR would benefit from an iHumanist-approach, where the discussions and developmental work are enhanced by the concepts and ideas of the digital humanities. Here we argue that VREs and other online systems for supporting and facilitating eResearch should undergo a shift from what we shall call a *needy-user paradigm*, where information professionals support the domain groups in their *search* for information, to an *explorability paradigm*, where information professionals support the domain group in *exploring* information. Here we argue that *serendipity* is a key concept in developing modern eAchieves: adequate online systems for eResearch like VREs should not just offer search based information, but should facilitate serendipitous research.

We proceed as follows. Section 2 presents the Prior Project. Here we argue that the project has enabled the Nachlass material, left behind by the New Zealand philosopher and logician, Arthur N. Prior, to move from a physical archive into an eArchive. In Section 3, we discuss the concept of VREs and present a list of characteristics a VRE typically has. Against this background, we argue that the PIR constitutes a VRE. We also argue that by making use of the knowledge of information professionals with humanistic backgrounds, *iHumanists*, the PIR has the potential to be enhanced and expanded. In Sections 4 and 5, we develop

these ideas further. In Section 4, we argue for a shift from the needy-user paradigm to an explorability paradigm. In Section 5, we argue that VREs such as the PIR could be significantly enhanced by emphasising an explorability paradigm with a focus on serendipity. Based on readings of selected literature, we present a tentative list of design features for explorable systems that foster serendipitous discoveries. Section 6 concludes.

2 From archive to eArchive

The Primacy of Tense: A.N. Prior Now and Then was launched in the autumn of 2016 as an interdisciplinary research collaboration with two different, but connected, goals. One was to explore the link between the ideas of the New Zealand born logician and philosopher Arthur N. Prior (1914-1969) and modern temporal, modal, and hybrid logic. Another was to study and expand *The Nachlass of A.N. Prior*, thereby making more of Prior's work accessible not only for researchers, but for anyone interested in Prior's logic and philosophy (see the project description at <https://www.prior.aau.dk/>). A significant background resource supporting these endeavours is the Danish Prior Internet Resources (PIR) consisting of the following sites:

Name	URL
<i>Prior Studies</i>	https://priorstudies.org/
<i>The Virtual Lab for Prior Studies</i>	https://research.prior.aau.dk/login_user.php
<i>The Nachlass of A.N. Prior</i>	https://research.prior.aau.dk/nachlass/

The first site, *Prior Studies*, offers traditional resources such as bibliographical lists and information about the Prior archives at Aalborg University and Oxford. The site also links to the YouTube channel *PriorStudies*, where talks on Prior's logic and philosophy can be found.

Since the spring of 2018, the PIR has been undergoing reconstruction: the design has been updated, making the site more user-friendly, and new features of have been added (the site was originally launched in the nineties, and several features needed updating).

One expansion of the research resources was the addition of a list of web resources users might find relevant for their studies. A more

notable addition to the site was the development of a research community, where researchers are invited to join a Prior-community and receive news relevant for their study of Prior.

In addition, *Prior Studies* functions as a gateway for exploring the archives at Aalborg University, the Bodleian Library, and Oxford University. One element of the gateway is information about the content of the material contained at these physical Prior archives. Another element of the gateway is the link to *The Nachlass of A.N. Prior*. Here researchers may find transcriptions of physical content from the Bodleian Library and from Aalborg and Oxford Universities.² At the time of writing, *The Nachlass of A.N. Prior* contained transcriptions of 68 previously unpublished letters and papers from the Prior archives. Furthermore, *Prior Studies* links to *The Virtual Lab for Prior Studies*, where photographs of the material in Oxford (more than 6000 individual photographs) may be accessed. Presently, only a limited amount of the material at Aalborg University is to be found in the Virtual Lab, but more is being added. The establishment of *The Virtual Lab for Prior Studies* was a significant contribution to research on Prior, and it was officially inaugurated at the Arthur Prior Centenary Conference held in 2014 in Oxford. This timely event was the culmination of several earlier events aimed at preserving Prior's legacy.

In 2007, Prior's widow, Mary Prior (1922-2011) granted Peter Øhrstrøm (Aalborg University) and Per Hasle (then at Aalborg University, now University of Copenhagen) permission to make use of and publish archival material from Prior located in Oxford.

The archival material was received shortly after the death of Prior in 1969, after Mary Prior and the philosopher Peter Geach (a friend of Prior) had sorted and organized notes, scientific material and letters written or received by Prior into twenty-nine boxes. These archival boxes were handed over to the Bodleian Library, where the material underwent a second ordering at the hands of two Oxford librarians, David and Steffi Lewis. From then on, researchers with written permission from the Prior family have been able to access and study the material of twenty-two boxes in the Bodleian's Special Collections Reading Room,

²We will describe the transcription process shortly. Here we will simply remark that the result of the transcriptions process (the files which are accessible in *The Nachlass of A.N. Prior*) are searchable PDF files. For a discussion of what they call the *transcription loop* see [16].

while seven boxes can be studied at the Philosophy Department Library, 10 Merton Street, Oxford.

Then, in 2010, the Bodleian Library allowed the Danish research group for Prior Studies to store digital photographs of the boxes' contents on the condition that the library retained the rights to the photographs and that access to them was to be suitably restricted. This second condition was met by the creation of the online research platform *The Virtual Lab for Prior Studies*. Via this portal, the photographs of Prior's archival material could be accessed from anywhere in the world, but only by users who had been assigned a user profile and login. Once registered, users could download the photograph material, but were not permitted to distribute it.

Further development of *The Virtual Lab for Prior Studies* took place in 2017, when the son of Arthur and Mary Prior, Martin Prior, donated a collection of letters, notes, scrapbook material and some of Arthur Prior's personal books to Aalborg University. More recently, in late 2018 and early 2019, Martin Prior donated further material (all of these additional documents are currently in the process of being scanned and added to the lab).

However, the main purpose of *The Virtual Lab for Prior Studies* is to make the archival material accessible for examination and transcription. Registered users are free merely to browse and download the material, but the hope is that they will become active transcribers, converting this material, into searchable digital material (PDF files). It is worth noting that the transcription process makes *two* distinct changes to the accessibility to the Prior material. First, it converts it from an (unsearchable) image format to the standard format for digital documents, namely PDF files. Second, transcription transforms the ownership. The Bodleian Library retains the rights to the images, but the rights to the transcribed material reside with the Danish Prior Group.³ All in all, transcription plays a pivotal role in the PIR, and we need to discuss it further.

When a researcher has undertaken and completed the work of transcribing a document in the Virtual Lab, another researcher (with expertise, on the one hand, in Prior's logic or his philosophy or the historical development of his work, and, on the other hand, significant experience with reading Prior's handwriting) proofreads the transcription.⁴ Once

³The copyright holders are Per Hasle, Peter Øhrstrøm and David Jakobsen.

⁴Mary and Arthur Prior's son, Martin Prior has over the years played a significant

approved,⁵ the document is uploaded to its final destination: *The Nachlass of A.N. Prior*. The path of the Prior material can be illustrated in the following way:

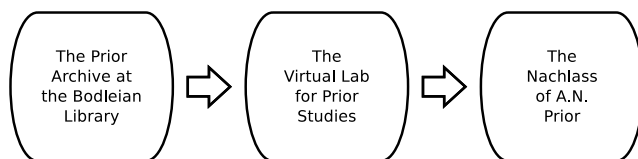


Figure 1: From Archive to Nachlass

Another way to think about the transformation of material is described by Engerer and Sabir:

Here is another way to think about it. The contents of the boxes in the Bodleian Library might be thought of as Prior's 'physical Nachlass'. The photographs of this raw material in PVL [The Prior Virtual Lab⁶] might be thought of as Prior's 'virtual Nachlass'. And the transcribed and commented material available on the internet site, <https://nachlass.prior.aau.dk/> (the Nachlass of A.N. Prior) might be thought of as Prior's 'digitally enriched Nachlass'.

(Engerer and Sabir 2018, p. 16, [17])

Figure 2 illustrates this description of the relationship:

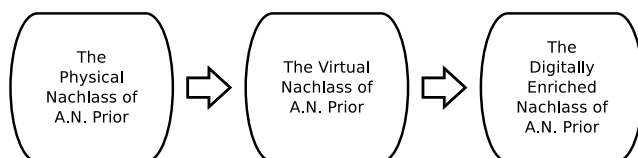


Figure 2: Different types of archives

In short: *The Nachlass of A.N. Prior* offers an eArchive of transcribed documents from *The Virtual Lab for Prior Studies*, which contains digital

consultative role in the transcription process, resolving numerous issues ranging from idiosyncrasies of handwriting to providing background information.

⁵Approval has to be granted by either Per Hasle, Peter Øhrstrøm or David Jakobsen.

⁶In other articles, PVL abbreviates *The Prior Virtual Lab*. However, *The Virtual Lab for Prior Studies* is the correct name.

photographs of the physical material held for the most part at Oxford. Broadly speaking the goal of the PIR is to increase accessibility to the works of Prior. Viewed from this perspective, how does it fare?

While access to both the physical Nachlass at Oxford and The Virtual Nachlass in *The Virtual Lab for Prior Studies* are restricted (the documents at the Bodleian Library can only be accessed after traveling to Oxford and obtaining a written permission from the Prior family to study the material, while the Virtual Lab requires a user profile and login) the Virtual Nachlass clearly offers more convenient access conditions. The first and the most obvious advantage is that the lab is accessible from anywhere in the world. A second difference is that the assignment of a user profile and login to the lab functions through a peer-system; probably a more transparent and open process. Third, the site makes available certain meta-information about the material stored at Oxford. These are contained in the so-called 'box-descriptions' made by Per Hasle on priorstudies.org; these offer guidelines to the content of *The Virtual Lab for Prior Studies*. These guidelines also apply to the Physical Nachlass at Oxford, and indeed they are called box-descriptions because they describe the content of the 29 physical boxes in Oxford.

The Digitally Enriched Nachlass of A.N. Prior is even more assessable, as the material in *The Nachlass of A.N. Prior* can be accessed and searched by anyone from anywhere in the world. Furthermore, since the documents in *The Nachlass of A.N. Prior* have been enriched with comments from both the transcriber and the expert who did the proof-reading, the documents offer more guidance to the study of Prior's logic and philosophy. Thus, the PIR (constituted by *Prior Studies*, *The Virtual Lab for Prior Studies*, and *The Nachlass of A.N. Prior*) does fulfil its basic functions in enhancing the opportunities to study Prior.

But can its potential be enhanced and expanded? In the next section, we discuss the PIR as a Virtual Research Environment, and argue that useful development paths may be partially identified by viewing it through the lens of VRE theory.

3 On Being a Virtual Research Environment

The arrival of the personal computer, followed by their interlinking, and then, a decade later, the widespread use of the internet, transformed research, research collaboration and research communication. Before

this, research interaction tended to be limited to local environments, and was only rapid in limited contexts, such as face-to-face discussion at conferences and workshops.⁷ Today, research has the potential to be both fast and global. With tools like email, video conferencing, online writing platforms, and discussion forums, research communication and research collaboration have substantially changed, so much so that it is tempting and plausible to rethink research as eResearch (Jeffery and Wusteman 2012, [26]).

However, the internet, the personal computer, and the tools they provide not only alter research communication and research collaboration, they alter the nature of research itself. Under these new conditions for research, Ankeny and Leonelli have argued that the Kuhnian idea that scientific change takes place as scientific problems accumulate (Kuhn 1962, [28]) does not offer an adequate picture of how contemporary research functions. Scientific changes, indeed scientific revolutions, are not merely the result of researchers and their scientific findings, but are also (and perhaps more importantly) the result of changed conditions for conducting research. These changed conditions influence and alter the scientific questions and problems that researchers ask and try to solve (Ankeny and Leonelli 2016, [1]).

Labels for the new transforming conditions, all designed to embrace the nature of eResearch, include 'e-research communities', 'collaborative virtual environments', 'gateways', 'science gateways', 'portals', 'virtual organizations', 'virtual research communities', 'cyber-environments' and 'virtual research environments'. Although these labels differ in meaning, definition, and the particular technologies they inhabit, they all seem to point towards the same phenomenon: digitalization of research (Bracken et al. 2014, [7]; Carusi and Reimer 2010, [9]). However, as evolving concepts, and with many different technological manifestations, the definitions of technological solutions which enable and enhance eResearch, are subject to considerable debate (Bracken et al., 2014, [7]; Carusi and Reimer, 2010, [9]; Jeffery and Wusteman 2012, [26]).

⁷The history of Prior's own research demonstrates this. Living in New Zealand, attending academic conferences was not easy, and many of Prior's research discussions with other scholars took place by letter. For example, the Smart-correspondences shows how research topics were discussed, and in one of his letters to Prior J.J.C. Smart writes, "You've missed a few things out, surprising as it may seem!", and then goes on to list events in academia, that might have interested Prior [36].

In 2010 the UK Joint Information Systems Committee (JISC) suggested VREs as significant for eResearch.⁸ In their report, JISC argued that a VRE is a technological, internet-based support system, which enables eResearch to take place while potentially crossing boundaries of disciplines and locations. In their search for a definition, JISC offered the following:

The term VRE is now best thought of as shorthand for the tools and technologies needed by researchers to do their research, interact with other researchers (who may come from different disciplines, institutions or even countries) and to make use of resources and technical infrastructures available both locally and nationally. The term VRE also incorporates the context in which those tools and technologies are used. The detailed design of a VRE will depend on many factors including discipline, context, and security requirements.

(JISC in: Carusi and Reimer 2010, p. 13, [9])

That is: the key element of VREs is technological support of research in a way that has the potential to cross the boundaries of discipline and geography. Given the wide scope of this definition, determining what is and what is not a VRE can be challenging. Here, Jeffery and Wusteman have argued that the concept of VRE risks being diluted by too wide an application due to a tendency to call any online research facilitation a VRE:

[...] as the concept of the VRE becomes more widely recognised, the tendency to describe every portal, gateway and

⁸From the many different labels for technologies that support eResearch we have chosen to discuss the PIR solely as a virtual research environment, even though other labels might have been relevant. However, as the JISC report and Jeffery and Wusteman argue, the different labels overlap significantly, and VREs stand out as a broad and flexible concept (they have many different features, not all of which need be incorporated in any particular VRE). Moreover, eResearch is frequently discussed in the context of VREs. The emphasis on multiple many different features and the non-excluding nature of the VRE-concept makes it useful for discussing the PIR – we need a flexible concept. We also remark that much discussion of eResearch takes place in a natural or social science setting, and not all features of eResearch here are relevant for eResearch in the humanities. A flexible concept helps us to transfer and open the discussion of eResearch in a humanistic setting.

digital library as a VRE needs to be guarded against. Whilst these applications may be central components of a VRE, the latter is more than a digital library, or even a portal or gateway to a range of digital libraries. A VRE should describe an environment in which research collaboration is facilitated, not just a resource to be used in research.

(Jeffery and Wusteman 2012, p. 135, [26])

In the light of this, Jeffery and Wusteman argue that the system they explore (OJAX++) is “demonstrating the next generation of Virtual Research Environments.” (Jeffery and Wusteman 2012, part of the title of their article, [26]). They argue that OJAX++ facilitates research in “sharing of data; support for communication within a team; provision of access to tools; services or an infrastructure; support for project management; collaborative annotation of data; and analysis and processing of data.” (Jeffery and Wusteman 2012, pp. 135–36, [26]). Jeffery and Wusteman further add that OJAX++ as a VRE offers “data and services that facilitate “remixing” with other data and services, [and functions] via an “architecture of participation”” (Jeffery and Wusteman 2012, p. 135, [26]).

Examining Jeffery and Wusteman (henceforth J&W) and the definition of VRE by the Joint Information Systems Committee (JISC), we find the following formulations, which indicate characteristic elements of VREs:

1. “Tools and technologies needed by researchers to do their research” (JISC)
2. “interact with other researchers (who may come from different disciplines, institutions or even countries)” (JISC)
3. “make use of resources and technical infrastructures available both locally and nationally” (JISC)
4. “incorporates the context in which these tools and technologies are used” (JISC)
5. “more than a digital library, or even a portal or gateway to a range of digital libraries” (J&W)

6. “describe an environment in which research collaboration is facilitated, not just a resource to be used in research” (J&W)
7. “sharing of data” (J&W)
8. “support for communication within a team” (J&W)
9. “provision of access to tools” (J&W)
10. “support project management” (J&W)
11. “collaborative annotation of data” (J&W)
12. “analysis and processing of data” (J&W)
13. “data and services that facilitate “remixing” with other data and services” (J&W)
14. “architecture of participation” (J&W)

This rather long “double” list gives grounds for characterizing VREs as online systems containing many different features relevant for the conduct of modern research. However, in some cases merely keeping to the list above, or more precisely, keeping to the exact wording, would give an oversimplified picture when we wish to discuss an online system. For example, the first item on the list gives too broad a definition of VRE: “Tools and technologies needed by researchers to do their research” could refer to just about anything from blackboard and chalk to computers and spaceships. Likewise, item 2, which requires that the system enables researchers to “interact with other researchers (who may come from different disciplines, institutions or even countries)”, could be fulfilled by email. Conversely, simply sending an email clearly does not count as making use of a virtual research environment; a key element of a VRE is indeed research communication (item 8), but also research collaboration, which is why email alone is not sufficient.

When discussing a system as a VRE, or arguing why a system perhaps does not constitute a VRE, one should keep in mind that merely holding one of the features of the list is not sufficient to qualify as a VRE (which is why simply offering a digital library, or guiding researchers on to other websites, does not qualify as a VRE (item 5)). Only when

a system incorporates a selection of the items, does it qualify as a virtual environment for eResearch. The key is that the different elements *together* facilitate research (item 6), and thus the system must offer ways of managing and analysing data (item 7, 9, 11, 12 and 13). Furthermore, the system should support project management (item 10).

Note that the third item on the list suggest that a VRE should allow research to take place ‘both locally and nationally’. Here we remark that changing this to locally, nationally *and globally* seems better, as VREs are online systems that can be used anywhere.

The fifth point (VREs being more than just digital libraries or gateways) means that if we were merely looking at priorstudies.org and its function as a gateway to *The Virtual Lab for Prior Studies* and *The Nachlass of A.N. Prior*, we would *not* be dealing with a VRE. However, we shall argue below that, as a whole, the PIR does much more than simply provide these points of entry.

Being global and transnational is all very well and good, but the fourth item from the list demands that VREs also be sensitive to the context of the research. Locality is also crucial. We interpret this as meaning that VRE must be sensitive to the particular needs of the domain researchers using the VRE.

Finally, VREs operate with an “architecture of participation” (item 14). For the PIR, the drive to enter the lab is to study novel Prior material, and the motivation to undertake the work of transcription seems to be stimulated by being credited as a transcriber when, after peer review, the document goes from The Virtual Lab for Prior Studies into The Nachlass of A.N. Prior (we will say more about this later in the article).

Thus, in the interest of simplicity and compactness, we propose to condense the previous “double” list down to the following items. A VRE is an:

1. *Online System*, which facilitates
2. *Research communication and research collaboration*,
3. *Data management and analysis*, and
4. *Project management*, that works through a
5. *Participation architecture*.

That is, we argue that a VRE should facilitate and integrate tools for research communication and collaboration and in doing so it should offer technologies for data management and analysis, be online accessible and have a participation structure. This rather broad definition leaves sufficient room different VREs to display different features depending on the particular domain of eResearch.

Taken individually, the three different domains of the PIR do not qualify as VREs. However, taken together the PIR does exhibit many of the features that characterizing VREs. We will argue that the fact that not all features are included, and some are only built-in to a limited extent does not disqualify the PIR as a VRE. The “level of fulfilment” should not be seen as binary yes or no, but be evaluated as a scale. Furthermore, in the article “Information Professionals meet Arthur Prior” (2018, [17]) it was argued that it is important for information professionals supporting domain groups to take an iHumanist approach, to explore the particular needs of the domain group, and to develop the online support system to reflect these needs. Bearing this in mind, let us now consider in more detail why the PIR should be considered a VRE.

Let us start with item (a) from our five item summary list. Obviously, the PIR is an online system and thus has the first characteristic of a VRE: the PIR can be accessed globally. That said, it is worth noticing that the different domains of the PIR vary in openness (as discussed in the previous section). While both *Prior Studies* and *Nachlass* are publicly accessible, *The Virtual Lab for Prior Studies* is restricted to assigned users. This somewhat mutes the goal of enhancing access to material on Prior’s logic and philosophy.

Now for item (b). Research communication and research collaboration are an important part of *The Virtual Lab for Prior Studies*, where researchers ask for input, and comment on and discuss transcriptions. An example of this is the interaction shown in Table 1 between two researchers, where a user of *The Virtual Lab for Prior Studies* points out a minor (but significant) mistake to the transcriber.

The example shows how researchers use the lab to facilitate discussion and thereby collaborate on gaining knowledge from the archival material. However, there are some obvious limitations: neither participants nor administrators are notified when a question is posed, nor when it is answered. Which is also demonstrated by the example by the a big time lag between the initial comment and the response.

Table 1: Correspondence from The Virtual Lab for Prior Studies.

<p>Researcher A: – latest edit of comment: 09-01-2015 13:28:35 (GMT+1)</p> <p>This letter is Sobociński’s explanation of two Leśniewski’s systems - Ontology and Protothetic. The unusual notation which is used here is explained in the footnotes 7 and 8. If you find it not sufficient or if you find some mistake, please inform me. I will correct it.</p> <p>In this letter Sobociński used merely Polish notation.</p>
<p>Researcher B: – latest edit of comment: 10-06-2018 19:19:20 (GMT+1)</p> <p>The formula in the second paragraph, CfpCfNpfp, has been transcribed incorrectly. It should be CfpCfNpfq. The last symbol in the formula is q , not p.</p>

Record no. 1157

Title: Sobocinski to Prior 16.09.1953

Fetchd by user Fatima Sabir

Recently, however, *Prior Studies* has started to expand its support for a research community. Researchers and scholars are now invited to join the network by creating a profile, which provides information about their current work place and links to personal website. Such features help to identify relevant researchers and potential collaborators for studies of Prior’s work. Thus, the PIR does facilitate communication and collaboration. Nonetheless, the facilities are still rather basic; for example there is no chat forum. More remains to be done here.

Item (c) from our summary list says that a VRE should offer tools for data management and analysis. Indeed, Jeffery and Wusteman argued that it should also facilitate “remixing” with different tools (Jeffery and Wusteman, 2012, p. 135, [26]). In our case, data is constituted by the digital photographs of the archival material; here *The Virtual Lab for Prior Studies* offers a structured way of accessing this material, and

The Nachlass of A.N. Prior offers digitally enriched documents from the Prior archive in Oxford and Aalborg. Also, before they enter *The Virtual Lab for Prior Studies*, researchers can freely consult information about the content of the Prior archive at the Bodleian Library using the list of box contents compiled by Per Hasle. On *Prior Studies* one finds the categorizations “Box 1-11”, “Box 12-21”, “Box 22”, and “Box 23-29”. Here researchers may find information like the following description of “Box 22”:

This box contains the full manuscript for Prior’s unpublished book ‘The Craft of Formal Logic’ (Finished in december 1951 and submitted to Clarendon Press 6/12/1951). A full overview of its contents is given in Craft-of-logic/table of contents, and a description of its place within Prior’s authorship is given at the related manuscript Items from a dictionary of formal logic/box 6.

A part of the manuscript has been published as *The Doctrine of Propositions and Terms*, ed. by P.T. Geach and A.J.P. Kenny. University of Massachusetts [sic] Press, Amherst, 1976 (1976a).

Prior’s work on ‘The Craft of Formal Logic’ is described in Kenny 1970 as well as in the introduction to ‘The Doctrine of Propositions and Terms’ (the latter overlaps somewhat with Kenny 1970, but naturally also adds some details). From ‘The Craft of Formal Logic’ the book brings Part I, chapter 1 and 2, and Part IV, chapter 1–3; these five chapters together “make up a self-contained account of the traditional doctrine of propositions and terms” (Geach and Kenny’s Introduction, p. 9).

The manuscript found in box 22 is a gift from J. L. Mackie (no full copy was found among Prior’s own papers after his death in 1969).

P. 549 and p. 600 are missing.

— Per Hasle

(www.priorstudies.org)

Information of this sort, describing the content of the box, provides researchers with a starting point for determining which documents in the

Virtual Lab that might be relevant to her/his research interests. In some cases, however, the information about the boxes are rather limited, like the one for “Box 20”:

- 1) Scott, Dana: Advice on Modal Logic. 1968. MS 71 p. Later published in volume ed. by K. Lambert.
- 2) Scott, Dana: Formalizing Intensional Notions. 1968. MS 71 p.
- 3) Scott, Dana: The Logic of Tenses. Dec. 1965. MS 8 p.
- 4) Scott, Dana: A Proof of The Independence of the Continuum Hypothesis. Stanford University. 1966.
- 5) Segerberg, Krister, Modal Logic Based on a Three-valued Logic. MS 12 p. Published in *Theoria* 1967.
- 6) Sellars, W.,The Identity Approach to the Mind Body Problem. MS 21 p. 1963.
- 7) Sellars, W.,The Intentional Realism of Everett Hall. MS 22 p.
- 8) Sellars, W.,Theoretical Explanation. MS 17 p.
- 9) Sengupta, S.S., Schotch, P., Czarny,P., Relevance: A Logic and a Calculus, University of Waterloo
- 10) Shwayder, David, Appendix On Time and Tense, p.200-267. MS. [...]

(<https://www.priorstudies.org>)

Thus, in the case of “Box 20”, researchers merely have a list of titles to help them whether or not the material is relevant for study and transcription. As with the tools for communication and collaboration, however, the tools offered for data management and analysis are rather simple, for example it would be useful if registered users could add further comments on the items listed or perhaps remix by drawing attention to other items. But such options are not yet available.

Item (d) on our list is that VREs are tools for facilitating project management. In *The Virtual Lab for Prior Studies*; data is organized using a color system. Thus, documents that are in the process of being transcribed are marked with red; the document is locked by the transcriber (though the administrators can still access it). Data that has

been transcribed, but is still awaiting proofreading is marked yellow. Finally, documents that are both transcribed, proofread and published in *The Nachlass of A.N. Prior* are marked green in *The Virtual Lab for Prior Studies*. This very simple marking system offers gives a basic indication of progress on individual documents, but to claim that it qualify as “facilitation of project management” seems rather generous. The list of box content on *Prior Studies* also offers some overview of available data, but as has already mentioned, the level of detail and usability could be significantly improved. Data management is also part of *The Nachlass of A.N. Prior*, but only in the sense that researchers can explore transcribed documents through keyword search.

Finally, we come to item (e): that a VRE should work through a participation architecture, meaning that the system should facilitate user contribution. In the case of the PIR, the architecture of participation is built into *The Virtual Lab for Prior Studies*, and one of the incentives it offers is both powerful and interesting.

While one incentive to work in *The Virtual Lab for Prior Studies* and transcribe material might be the altruistic goal of making the philosophy and logic of Prior more accessible, the often time consuming work of reading and transcribing is demanding. The accrediting of researchers for this labor seem to be a key building block in the architecture of participation; so to speak, the altruistic goal is nudged by the reward of recognition.

While it is possible to merely study the material in *The Virtual Lab for Prior Studies*, the incentive to go further and undertake the work of transcribing the material is fostered by researchers being credited with the effort. An example from Nachlass is the following, where David Jakobsen and Martin Prior are credited for the transcription of “Letter from J.J.C. Smart to A.N. Prior, October 9, 1951” [36] with the help from Martin Prior in the following manner:

Editor’s note: The letter is in the Prior archive box 3 at the Bodleian Library in Oxford and has been transcribed and commented by David Jakobsen and Martin Prior.

However, another more scholarly incentive to participate (and perhaps the most powerful one) is the opportunity to discover interesting, perhaps even completely new, material on Prior, or to discover novel links between the data. That is, in our view, a key incentive to participate

in the VRE is the opportunity to explore data and make *serendipitous* discoveries. This is a point we will pursue in the following sections.

Our discussion of the PIR considered as a candidate VRE is summarized in Table 2:

Table 2: Elements of VREs in the PIR.

Elements of VREs	PS	VL	NL
Online System	✓	✓	✓
Research communication and research collaboration	(✓)	✓	×
Data management and analysis	(✓)	✓	(✓)
Participation architecture	×	✓	×
Project Management	×	×	×

Legend: PS = Prior Studies, VL = Virtual Lab, NL = Nachlass.

✓ = Fully implemented. (✓) = Partially implemented.

× = Not implemented.

4 Digital humanities: from searching to exploring

Now that we have isolated five key elements for VREs (they are on-line systems, facilitating research communication and collaboration, enabling data and project management, and fostering participation), and discussed their relevance and degree of realization in the current PIR, we turn to consider the PIR from the perspective of the digital humanities. This discussion takes as its point of departure an ongoing paradigm shift in information science: the move from *searchability* to *explorability*. The former has its roots in the what we have called the needy-user paradigm, which still largely characterizes *the pre-digital humanities* approach to VREs; the latter, *explorability*, acknowledges a more open, even experimental research landscape in digital humanities which is no longer driven by information needs and knowledge gaps alone. By shifting the focus from the searchability of digital resources to the explorability of digital objects in eResearch, tangible consequences for the

developmental goals of VREs in general and the PIR in particular are emerging.

There have been numerous attempts to define digital humanities (see, for example, the collection of definitions in Terras, Nyhan, and Vanhoutte 2013b, [38]) and much work in the area focuses on enumerating concrete digital projects and digitization initiatives, which in some way are supposed to define the area (Deegan and McCarty 2012, [14]; Flanders 2012, [18]; Hockey 2012, [25]; Warwick, Terras, and Nyhan 2012, [40]). However, this extensional strategy (defining by enumerating exemplars of a class) is not a shortcut to determining the essential property the exemplars have in common (the intensional approach to definition). Knowledge of such a property (or a set of properties) might prompt richer understandings of the digital humanities.

An early and frequently cited paper by Unsworth can be seen as a first step towards such an intensional definition (Unsworth 2013, [39]). Drawing on still earlier work by Davies Shrobe, and Szolovits (1993, [13]), Unsworth describes ‘doing digital humanities’ (or humanities computing as the current term was at that time) as a special practice of knowledge representation. He proposes viewing ‘digital humanities’ as a kind of attribute, a property all digital resources have, more or less, to a certain degree. His exemplification implicitly suggests a scaling of what it means for a digital system to be digital humanities-like. In full, his charlatanism-argument goes like this:

[D]egree matters, and one way in which that degree can be measured is by the interactivity offered to users who wish to frame their own research questions. If there is none offered, and no interactivity, then the project is probably pure charlatanism. If it offers some (say, keyword searching), then it can be taken a bit more seriously. If it offers structured searching, a bit more so. If it offers combinatorial queries, more so. If it allows you to change parameters and values in order to produce new models, it starts to look very much like something that must be built on a thoroughgoing representation. If it lets you introduce new algorithms for calculating the outcomes of changed parameters and values, then it is extremely well designed indeed.

(Unsworth 2013, p. 37, [39])

We can extract three main stages from this citation, two of which are rather straightforward (stages 1 and 2), one rather less so (stage 3):

1. Digital humanities and interactivity go together: the more interactive, the more digital humanities-like the system is.
2. Digital humanities means, among other things, searching: the more sophisticated the search options are, the more digital humanities-like the system is.
3. Digital humanities enables system manipulation (we propose another term below): the larger the researcher's possibilities are to modify the system (for example, to change parameters and introduce new algorithms), the more digital humanities-like the system is.

Interactivity (1) is a popular and comprehensive concept in information science (Borlund 2013, [6]; Ruthven and Kelly 2011, [32]), human-computer interaction (Lazar, Feng, and Hochheiser 2010, [29]), computer-mediated communication (Herring, Stein, and Virtanen 2013, [22]) and established disciplines such as psychology and sociology (Kioussis 2002, [27]). Searchability (2), however, seems to be the exclusive domain of information science (Case and Given 2016, [11]). However, compared with stages 1 and 2, stage 3 seems far more nebulous. Nonetheless, we find a further hint of what Unsworth means by it in a remark a few sentences later:

But you see the principle implied by this scale – the more room a resource offers for the exercise of independent imagination and curiosity, the more substantially well thought-out, well designed, and well produced a resource it must be.
(Unsworth 2013, p. 38, [39])

Here Unsworth makes the move from digital humanities-like systems to the digital humanist her/himself. Digital humanities is something practiced by researchers with “independent imagination and curiosity”. This shift in perspective comes with a shift in focus: needs-triggered search behavior moves to the background, while in the foreground we instead have researchers engaging with a digital system, driven by exploration and curiosity to discover something unexpected.

Information science has traditionally been allied with stage 2 rather than with stage 3. The challenge for a search-centred information science (and the agenda of information professionals guided by this theory) is its reliance on the scenario of an 'information need', perpetuating the picture of the 'needy' individual who is urged to apply information seeking strategies (or seek professional assistance) to meet these needs (Batley 2005, [2]; Beghtol 1986, [4]; Borlund 2013, [6]; Case 2012, [10]; Cooper 1971, [12]; Derr 1983, [15]; Limberg, Sundin, and Talja 2012, [30]; Wilson 1981, [41]).⁹ No doubt, the needy-user concept has its legitimacy and merits in many areas of information scientific investigation and practical work. It is by no means an irrelevant or inappropriate scenario: historically, the need for information and the actions we take to obtain information is a basic human condition (Sandstrom 1994, 1999, [33-34]). However, in a digital humanities context, the needy-user paradigm seems somewhat conservative: it evokes a set of traditional professional values drawn from information science. These values do not seem to adequately reflect the conditions found in eResearch.

The traditional idea of information as *information-about* (Beghtol 1986, [4]), which is linked to the concept of information systems as secondary supportive resources that are encoded in searchable knowledge organizing systems, has given way in the digital humanities to the idea of information as a digital research object in its own right. Accordingly, information systems such as research databases (Hider 2012, [23]) are no longer regarded as shortcuts to information somewhere external to the system or 'signposts' to knowledge about the outer world; they are to a higher degree viewed as explorative structures which lend themselves directly to research-related investigation.

Turning to the case of the Nachlass and Prior's digitized papers, by exploring whole networks of digital records of his handwritten works (letters, draft papers and so on) research questions can be inspired by information that exists exclusively in digital form. There may be nodes connecting several drafts of a manuscript with recurring concepts de-

⁹The focus on the needy-user and the overemphasis of searchability in system design furthers the tendency to interpret researchers' actual digital explorative activities from stage 3 as stage 2 search activities. Resulting misfits can then lead to information systems that still are primarily designed for information search, although researchers approach them practically without pronounced information needs. Therefore, we make the point in this paper that we need systems more designed for explorability, and less for searchability, in the digital humanities.

veloped in series of letters, or nodes indicating changes in Prior's philosophical concept of determinism in the light of critical feedback he received. Notions such as 'access to the letters' or 'information on this or that logical concept' are then not the only ways to address a Prior scholar's research interests in a digital context. Consequently, Prior researchers' motivations for using the PIR do not arise solely, or even primarily, from the information gaps they might have experienced. Far from being needy, they are curious, experimental, and fond of discovery. This perspective offers an alternative account of Prior researchers' motivation to becoming involved in the lengthy and difficult transcription process.

5 Explorability and serendipity

Serendipity occurs when a researcher discovers something interesting by chance; the discovery was not planned or specifically sought out (Björneborn 2017, [5]; Foster and Ellis 2014, [19]). At first glance it may seem that there is a tension between serendipity and the more systematic, anticipatory and expectant attitude of the researcher. Moreover, it may seem that the very idea of serendipity (which emphasizes the idea of pure chance) is further attenuated when purposeful research activities in digital environments (of the sort conducted in the PIR) are discussed. But these tensions seem resolvable. Indeed, the tension between purposeful explorations versus serendipitous findings resonates well with a well established characterization of serendipity as a kind of research strategy opposed to pure chance discovery. This connection had already been noted in Cannon's book *The Way of an Investigator* in 1945 (Cannon 1945, [8]), as Foster and Ellis note (Foster and Ellis 2014, [19]). In the book, Cannon (referring to the well-known dictum due to Pasteur: *chance favors only the prepared mind*) identifies researchers' prepared minds as the feature which distinguishes chance discovery from serendipitous findings (Foster and Ellis 2014, [19]). In more concrete terms: the researcher observes a surprising datum, evaluates its significance, and uses it eventually in theoretical reflection and new hypotheses (Foster and Ellis 2014, [19]).

We might say that both serendipity and explorability cover central phenomena in the digital humanities, but emphasize different aspects of eResearchers: the notion of *serendipity* puts focus on the more emotional,

psychological attributes of digital humanists involved such as inventive, imaginative, curious, while *explorability* highlights the systematic, experimental nature in achieving serendipitous experiences. This interdependent relationship between serendipity and explorability highlights the combination of the *systematic-exploratory* attitude of researchers and the more accidental nature of the resulting event in which something unexpected is found. Exploring and having a serendipitous experience are not the same, but they are connected.

What makes exploring attractive for researchers is the possibility of serendipity; what makes systematic exploring particularly attractive for researchers is that the probability of achieving more than one serendipitous discovery is increased; and, last but not least, what makes the ‘surprising’, ‘emotional’ element in serendipity compatible with the planned, rational systematic exploration, is the condition of a ‘prepared mind’ in scientific serendipity (Foster and Ellis 2014, [19]). By connecting explorability to the notion of serendipity and exploiting the strong interdependencies between these two concepts, we can get a clearer picture what happens when researchers engage with a digital resource.

In digital humanities there is a close connection of exploring a digital resource and serendipitously encountering an interesting piece of information. It thus surprises that serendipity is not explicitly treated as a topic in three milestone publications on the digital humanities, namely the volume *Debates in The Digital Humanities* (Gold 2012, [21]), the partly retrospective reader *Defining Digital Humanities* (Terras, Nyhan, and Vanhoutte 2013a, [37]), and the most recent handbook *A New Companion to Digital Humanities* (Schreibman, Siemens, and Unsworth 2016, [35]). The potential of serendipity as an informational concept in the digital humanities does not seem to have been noted, yet alone fully explored. As far as we are aware both the link between explorability and serendipity on the one hand, and between serendipity/explorability and the digital humanities on the other (as targeted at by Unsworth) have not been previously noted.

How to build explorability features into eResearch systems in a way that encourages serendipitous discoveries is a difficult topic and one we cannot discuss in detail here. However, based on a selective literature review of influential studies of serendipity and exploration phenomena (Bawden 1986, [3]; Björneborn 2017, [5]; Foster and Ford 2003, [20]; Unsworth 2013, [39]) we find that serendipity and explorability features

are a matter of how the digital researcher interacts with a system (1, Interface & search features), how she/he moves around in it (2, Navigation features), which content she/he is confronted with at several stages of her/his interaction (3, Content presentation), what the underlying representational characteristics of information items are like (4, Metadata structure), how prepared and open the systems is for interaction with researchers with different disciplinary backgrounds (5, Interdisciplinary features), and the degree to which a researcher can manipulate system features her/himself (6, User engagement). Thus, based on this review, we tentatively point to six design categories, that may guide us towards building VREs in a way that reflects a move from a searchability-paradigm to an explorability-paradigm and enhances the chance of serendipitous discoveries:

1. *Interface & search features* (Bawden; Foster and Ford; Unsworth)
2. *Navigation features* (Björneborn)
3. *Content presentation* (Bawden; Björneborn)
4. *Metadata structure* (Bawden; Foster and Ford)
5. *Interdisciplinary features* (Bawden; Foster and Ford)
6. *User engagement* (Bawden)

This list reflects six areas that have been identified by research as being relevant for systems' explorability and hence to enhance the chances of serendipitous discoveries. These six categories are not clear-cut, nor are they exhaustive or mutually exclusive, and more work needs to be done on examining them individually and the links between them. Thus, these six categories are, beyond their heuristic value for further discussions, also hypotheses as to which system aspects have an impact on researchers' explorative behavior.

6 Conclusion

We have argued that while significant work has been conducted to enhance the Prior Internet Resources (PIR) as a resource that will foster research and expand knowledge on Prior's logic and philosophy, further developmental issues can be identified by thinking systematically about virtual research environments (VREs) and the digital humanities. Following a discussion of VRE-theory, we argued that the PIR qualifies as a VRE, but also suggested that it could be improved by incorporating better tools for research communication and research collaboration, and adding tools for project management. Furthermore, we argued that the architecture for participation could be enhanced. Here we have suggested that a fruitful way to approach this developmental issue might be to include the notions of serendipity and explorability, which we regard as central to the digital humanities. Based on a literature review of influential selected contributions to the notions of explorability and serendipity, we suggest that further developments of the PIR should focus on six areas of system design and information architecture: 1) Interface & search features, 2) Navigation features, 3) Content presentation, 4) Metadata structure, 5) Interdisciplinary features, and 6) User engagement. This list calls for further research, but for the moment we argued that it offers a tentative program for the development of an enhanced explorability and a user-centered, serendipitous system that invites Prior researchers' open, prepared, and curious minds, thus making pioneering discoveries in the eArchives of Prior more likely.

We should admit that there is a risk here. When discussing and designing VREs, Jeffery and Wusteman warn that one should be aware of the danger of trying to put *too* many features into a VRE:

The temptation for software developers to reinvent the wheel is often overwhelming. The wish to create a "perfect" application for a perceived need can over-ride the option of adopting a good-enough, widely-supported and simpler solution. Commonly, such developments result in either a replication of existing software with very little added value or software which exhibits some added value but supports only a subset of the functionality of existing products. Academic-related software has appeared particularly prone to this syndrome.

(Jeffery and Wusteman 2012, p. 136, [26])

The fundamental problem of such an endeavour is that one risks compromising integration in the VRE; too many functions without clear and central purposes risk hindering researchers' use of the VRE. Therefore, the VRE should focus on integrating tools researchers already use. However, such an approach might also limit the VRE significantly in a way that does not enable researchers to gain all the benefits that the world of VREs offers (Jeffery and Wusteman 2012, p. 137, [26]).

Clearly, we want to avoid this danger in the case of the PIR. We believe that thinking about its development in terms of the higher-level concepts of serendipity and explorability will help us to do so. A significant purpose of the PIR is to help researchers explore the logic and philosophy of Prior by enabling restricted, but significantly easier access relevant material through an eAchieve. Although researchers and scholars may enter *The Virtual Lab for Prior Studies* with the altruistic goal of making Priors logic and philosophy more accessible to a wider public, a significant motivation for participating in *The Virtual Lab for Prior Studies* is to discover material relevant for their own research. Like all other researchers, they enter the archive to discover new questions, ideas, answers and inspirations. In such an endeavour, serendipity seems vital and might be nurtured by an architecture that encourages explorability.

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