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Project Document Cover Sheet

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JISC Final Report

Acknowledgements

The VRE-SDM was funded under the VRE2 Programme by the JISC as a two year pilot project to demonstrate support for documentary and manuscript scholars. The project was led by the Humanities Division at Oxford University and was based at and greatly supported by the Oxford eResearch Centre (OeRC)[i]. In writing this report particular thanks go to John Pybus (Technical Manager of the VRE-SDM), Pin Hu (VRE-SDM developer) and Katie Portwin (VRE-SDM Contractor). Thanks also to Professor Alan Bowman, Dr Charles Crowther, Dr Mike Fraser, Dr Marina Jirotka, Professor Roger Tomlin, Professor Kathryn Sutherland, Elaine Matthews, Sebastian Rahtz, Henriette Roued and Dr Segolene Tarte.

Executive Summary

The VRE for the Study of Documents and Manuscripts addresses the user needs of documentary, textual and manuscript scholars. Focusing in the first instance on the requirements of ancient documentary specialists working in the fields of Epigraphy and Papyrology, the pilot has adapted Open Source tools to enable sophisticated annotation and document viewing and makes use of existing VRE tools to facilitate communication and collaboration between scholars. As such the project provides an exemplar for the construction of Virtual Research Environments across the broader humanities research community.

The project aimed to create a pilot VRE through which one might:

- View, manipulate and enhance digitized images of documents and manuscripts within a portal framework
- Search across multiple, distributed data sets, images and texts
- Select, store and organise items from the above, in a 'personal workspace'
- Add annotations to these items to store personal thoughts and responses
- Support collaboration by allowing multiple researchers in separate locations to share a common view of the workspace, in conjunction with real time communication via Chat, VoIP and desktop integration with Access Grid
- Allow a collaborator to comment, point/highlight, discuss and annotate the items in the shared workspace
- Gain comprehensive user requirements and expand the use of the VRE for documentary and manuscript scholars in other fields of humanities research

Although the pilot focused initially on ancient documents, it is constructed so as to be usable by textual specialists working in other languages, periods and cultures. The context has also been extended through the potential use of the XDB Arch[ii] system by treating documents not as disembodied texts but as artefacts which can and should be related to their original physical context. This enlarged perspective opens up the possibility of collaboration between documentary scholars and archaeologists in their respective implementations of VRE technologies. Such collaboration is not only of benefit to both communities, but also provides a model for the integration of separate VRE implementations across related disciplines.

Background

The VRE-SDM project builds on the outcomes of the 'Building a Virtual Research Environment for the Humanities' (BVREH)[iii] project which was funded under the VRE 1 programme. The BVREH project defined the range of services that a Virtual Environment should offer - from information about researchers and their interests and about conferences, lectures and seminars, to integrated communication and collaboration tools to support advanced research. Specifically Humanities researchers in many disciplines asked for a secure area in which they can store material such as saved searches, images and texts; create notes and annotations and use tools to enhance, manipulate and compare items. As manuscripts and degraded documents are common to researchers in many humanities disciplines and as the project team were already working with Ancient Documentary scholars within the Classics Faculty the VRE-SDM pilot project was conceived to address these needs, working in the first instance with the Classics-based user group with the intention that the pilots functionality would be applicable to researchers within other disciplines. The project is also part of a broader programme of activity within Oxford in which we are developing a very broad agenda of VRE development encompassing research in all fields represented in the Humanities Division (and therefore all major disciplines in the Humanities). This broad programme is being led by the Humanities Division but is based in the Oxford e-Research Centre (Director Dr. Anne Trefethen).

Aims and Objectives

The aim of the VRE-SDM project was to construct an integrated environment in which the data (documents), tools and scholarly instrumenta would be available to the scholar as a complete and coherent resource. In the first instance the project validated the pilot VRE against the requirements of researchers drawn from the Papyrological and Epigraphical communities and then investigated extending the system to further humanities disciplines including a collaboration with the Virtual Research Environment for Archaeology (VERA)[iv] based at Reading and through discussions with an English Faculty project which is currently developing a digital archive of Jane Austen's Fiction Manuscripts, led by Professor Kathryn Sutherland[v].

The original objectives of the project were to:

- View, manipulate and enhance digitized images of documents and manuscripts within a portal framework
- Search across multiple, distributed data sets, images and texts
- Select, store and organise items from the above, in a 'personal workspace'
- Add annotations to these items to store personal thoughts and responses
- Support collaboration by allowing multiple researchers in separate locations to share a common view of the workspace, in conjunction with real time communication via Chat, VoIP and desktop integration with AccessGrid
- Allow a collaborator to comment, point/highlight, discuss and annotate the items in the shared workspace
- Gain comprehensive user requirements and expand the use of the VRE for documentary and manuscript scholars in other fields of humanities research

The project has completed its objectives finding that not only were the developments timely and in great demand but that there is still a great deal more to do over and above the original aims. It should be noted that prior to the pilot project the ancient documentary specialists had none or very little of the functionality described above and as our requirements gathering process went on an ever expanding list of desirable features were added to the list, many of which had to be labelled out of scope of the current project during prioritisation (see Prioritising User Requirements below).

Methodology

The project was planned on an iterative development cycle allowing for four iterations of the pilot VRE over a two year period. The project began by working with documentary specialists to draw up a detailed list of user requirements. Initially the project carried out unstructured one-to one interviews with a small number of individual researchers aiming to get a thorough understanding of the nature of

their research and the way in which they work with ancient documents and digitised images day to day. Through unstructured interviews it was possible to allow the course of conversation to develop naturally, allowing interviewees to discuss their processes of work openly, suggesting ways in which a Virtual Environment might provide benefit to their research and to consider what elements they might like to see integrated into the pilot.

The initial interviews and filming were followed by ongoing testing of implementations of the pilot by researchers at the Centre for the Study of Ancient Documents (CSAD)[vi] sometimes with the use of wire frames and diagrams to illustrate the potential for further functionality. These sessions generally took the form of a gathering of up to three researchers, each of whom specialized in a different area of Papyrological or Epigraphical documentary scholarship. Viewing documents of particular relevance to their own work, researchers were asked to view the images as though they were working to decipher a text, imagining that they might utilise any of the electronic resources which would usually be at their disposal. In this way they tested the usefulness of the earliest versions of the workspace, commenting on what they did and did not like and what might be useful and what could be discarded. At the end of each session the project team, together with the scholars prioritized the outcomes of the session and endeavoured to add the most useful elements to the workspace for the next round of testing. The project also filmed documentary scholars collaborating to read a degraded text scratched onto a wooden stylus tablet. The aim of this filming was to discover the practices inherent in deciphering a text and how the collaborative process currently works between ancient documentary scholars; this work is described in more detail below.

Implementation

During the initial interviews there were a number of key issues that came up repeatedly. In order to decipher a text a scholar must be able to read a text accurately and to zoom in and out, adjusting the brightness and contrast, cropping and resizing images as they work. Each of these processes would usually be carried out in Adobe Photoshop, however interviewees agreed that functionality to compare texts; to view texts together on the screen, zooming in and out of each independently; to view partial transcriptions next to an image and to annotate individual sections of that image would make the workspace an extremely valuable resource over and above what was currently possible. It was also felt highly desirable to be able to highlight or click on a word, phrase or name within an image and then to use this as a search term in a relevant database. For example one researcher suggested that they might highlight a name, and then choose the Lexicon of Greek Personal Names (LGPN)[vii] from a drop-down box. At this point the search across the LGPN would be performed within the workspace, displaying the results next to the original image.

Around this time Professor Alan Bowman, Professor Roger Tomlin and Dr Charles Crowther began collaborating over a number of months to decipher a Latin text written on a wooden stilus tablet found at Tolsum in the Netherlands in the early 20th Century. The team decided that this would offer an excellent opportunity to refine user requirements for the VRE for the Study of Documents and Manuscripts, and filmed the researchers' collaborative meetings for use as a case study. The aim of the filming was to discover and document the inherent practices, tools and processes which are currently used to decipher ancient texts and to establish ways in which a Virtual Research Environment might emulate, support and advance these practices. The process was designed to gain requirements for the construction of the VRE, not to test the VRE interface itself. Between February and May 2008 the VRE team filmed four collaborative meetings between the three experts. It should be noted that these meetings were organized by the scholars to address a real research question and the filming was designed to be as unobtrusive as possible.

Figures 1 and 2 – Video stills showing Professor Alan Bowman, Dr Charles Crowther and Professor Roger Tomlin collaborating to decipher a degraded text found at Tolsum in the Netherlands.

Iterative Testing, Prototyping and Filming

The filming and observation of the scholars at work provided an excellent insight into how ancient documentary specialists decipher texts without the self-consciousness of having to explain their actions or the need to remove themselves from their collaborative environment to try to describe each action. One of the most revealing findings that came from filming scholars in this way was just how complex the annotation functionality would need to be to properly address the needs of documentary scholars. Far from the basic, originally envisaged (and discussed) functionality of drawing a rectangular box around an area of an image and writing text which would appear when one scrolled over the selected area, it became clear that scholars were working in a much more sophisticated fashion and that the requirements for this part of the VRE needed far more consideration than originally planned. Although the need for private workspaces and collaborative projects were envisaged from the start, differing levels of notes and annotations such as 'dialogues' (Private conversations), 'Working Papers' (not for publication but collaborative and explorative) and 'Publication' (comments and annotations to be published for all to see) only came to light in discussions drawn directly from observing the three scholars at work.

As the team began to deliver versions of the VRE for user testing and provided wireframes detailing potential, additional functionality (see Figure 1) many more requirements came to the fore. Added to the initial thoughts and ideas from the earlier interviews, the researchers were now able to see a tangible demonstration of the workspace and as such the ideas and thoughts for moving the workspace forward became richer. More detailed tools were requested such as cut and copy tools, through which you might 'cut' a section of the document and send it to someone else to ask their thoughts, or perhaps to 'cut' out an 'n' and compare it to another 'n' in another document to see if they compare. At this stage prioritization became essential as more and more requirements meant that the team were less able to deliver everything within the ever shortening time scale. As such, requirements which were out of scope of the current pilot were agreed with the users and alternative ways of implementing these developments were considered by the project team and in discussions with other closely connected projects (see 'Implications' below).
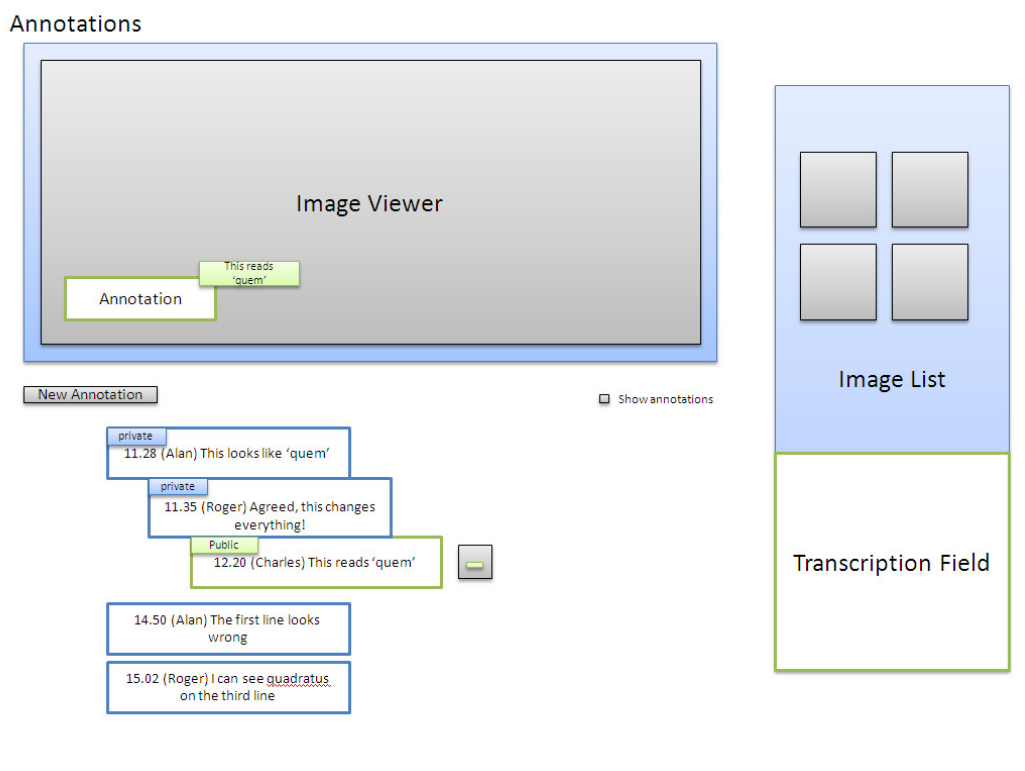
Figure 3 – Example of one of the wireframes detailing the potential for threaded private and public annotations and notes

Prioritising User Requirements

The following list of 'essential', 'desirable' and 'additional functionality' is an example of how requirements were prioritized by the user group of ancient documentary scholars and refined over a number of rounds of requirements gathering. This particular list was made after the basic system was already in place including the ability to view and manipulate images and to select and store items using one's own 'personal workspace'. From the list it becomes immediately clear that for each of the high level objectives (detailed above in 'Aims and Objectives'), there were a great deal of specific requirements involved and that the top priority for the scholars became the enhancement of the pilot's annotation functionality to assist in the reading and discussion of texts and that previously high priority objectives of the project such as searching across a broad range of datasets became somewhat less of a priority:

Essential:

1. Make annotations on the images and store them on an annotation server
   a. Chronological list of annotations
   b. Threaded list on annotations
   c. Provide functionality to tag groups of annotations e.g. Group all annotations on Line 1 together
   d. Right click to edit existing annotation
   e. Delete annotations
   f. Switch annotations on and off individually (display/don't display)

2. Separate field for transcriptions distinct from annotations and notes
   a. Functionality to highlight a word and activate a 'dot this' button

3. Tiled image viewer to allow large documents to download quickly

4. Tools to zoom in and out and toggle from small screen to full

Desirable:

5. Texts to be opened from selected databases or from researcher's own collection (relates to requirement 11)
6. Thumbnail viewer available when at high zoom (relates to requirement 4)
7. Adjust contrast/brightness of whole image and parts of image
8. Study/view a number of different/related documents side by side
   a. Photoshop-style layers
   b. Fit multiple fragmented pieces together
9. Space to write transcriptions and notes
   a. Functionality to highlight a word and activate a 'dot this' button
10. Rulers and grids

Additional Functionality:

11. Integrated searches across databanks of texts and images, e.g. Duke Databank of Documentary Papyri, Heidelberger Gesamtverzeichnis, APIS, Vindolanda Tablets Online, databases of Greek and Latin inscriptions; and on-line reference resources, dictionaries, Lexicon of Greek Personal Names, LDAB, Fayum Villages Database etc.
12. A tool to highlight selected section of the text or image with magnification facility
13. Turn images, upside down independently of other texts open in the workspace
14. Cut sections of text from elsewhere in the document to see if a word or a group of letters fits elsewhere
15. Flush-fit an image that may have gaps due to poor mounting
16. Cut a word/letter or section of text and send it to a colleague to ask for an opinion
17. Have a (private) view of the workspace (perhaps on a laptop), but be able to toggle to a shared, interactive view at any point
18. An online community with discussion lists, contact to colleagues to discuss problems and solutions
19. A snapshot of the workspace which user can work on offline when logged out
20. Databank of alphabets: grids to drag letters from digitised texts to build up a custom alphabet for that document and stored for cross-searching
21. Ability to place documents in archaeological context (on-line where possible) and connect with related documents and other artefacts.

The project endeavoured to implement as many of the above requirements as possible, concentrating in the first instance on the viewing and annotation capabilities. This capability has surpassed our original expectations and with a small amount of further work has the potential to have far reaching implications for scholars across the Humanities. With a greater emphasis on the annotation functionality, some objectives were paired down slightly with the agreement of the user group. This had the biggest impact on the second of our main objectives (Search across multiple distributed datasets), however the project still covered a lot of ground integrated searches across the Vindolanda Tablets database[viii], the LGPN and through the XDB Arch project extended the context of these searches by providing the potential to link between the VRE-SDM and the IADB database through a collaboration with VERA VRE project.

Some of the aims of the VRE-SDM are also being (incidentally) addressed by the JISC funded ENGAGE project, entitled 'Integration of image processing tools for epigraphy and papyrology within the Documents and Manuscripts VRE'[ix]. Within the VRE-SDM there was a need for simple tools to alter the brightness and contrast of images, a need that also falls within the remit of the eSAD project[x] and that was implemented by them early in their work to support image processing algorithms. When

eSAD and VRE-SDM came together to begin the ENGAGE collaboration, a project which uses the power of the National Grid Service (NGS) to embed image processing tools within the VRE, it was agreed that there should be no duplication of effort between the two projects and as such tools developed by the eSAD project would be available for use within the VRE both as portlets, addressing the needs of the ENGAGE project and as API's for use by the VRE-SDM developers. This has been an effective way of making use of a sophisticated system, bypassing the need to create our own system to facilitate image processing on the VRE server. The ENGAGE project is due to finish slightly after the funding period for the VRE-SDM and as such these small but vital elements of functionality will be added to the VRE before the end of June 2009.

The project also demonstrated the system to scholars working in the English Faculty, particularly those working on the digital archive of Jane Austen's Fiction Manuscripts which produced a very positive reaction and generated a host of further requirements. The projects were unfortunately not at a mutually convenient stage to take the collaboration further, however it was agreed that many aspects of the system including the viewing and annotation functionality were particularly useful to the English scholars. Prior to our meeting the English Faculty project had looked for alternative viewing/annotation systems finding nothing that accurately met their needs, this proved the need for VRE tools such as these in disciplines other than ancient documentary scholarship and is a collaboration we hope to continue to pursue in the future.

Technical Implementation

As detailed above, the project followed an iterative development process, delivering working versions to the user community regularly. This allowed technical development to mesh with the user engagement and evaluation elements of the project, and helped ensure that requirements were kept in line with actual user needs. The project made use of the Trac[xi] bug and feature tracking tool and the Subversion[xii] version control system, to manage all software components developed for the project. The VRE was created as a set of portlets accessed as a web application. These were deployed within an instance of uPortal 2.4 which supports Java portlets and conforms to the JSR-168 standard[xiii]. We configured uPortal to use the Shibboleth protocol for authentication. Through this members of other institutions (specifically members of the UK federation) can easily be given secure access to the VRE. The String Templates Library[xiv] was used to separate the logic and structure of the application from the HTML mark up of components. This allows the look and feel of the site to be customised more easily without needing to make changes to the portal or servlet code. We used a simple design based on a default uPortal template, however the system would still benefit from more work in terms of design and user interface development, which unfortunately was not possible within this project.
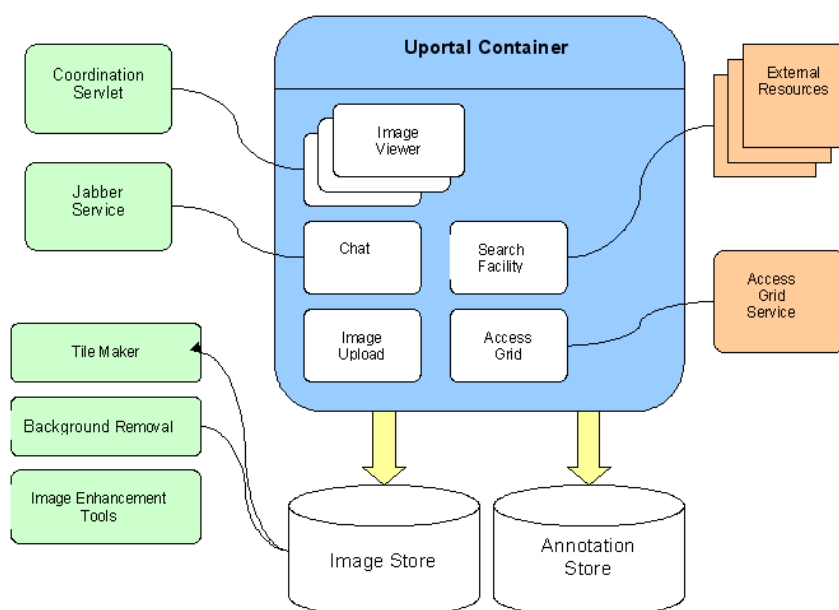
Figure 4 -VRE-SDM Architecture Diagram

Although the uPortal environment and its JSR-168 portlet support was helpful in allowing us to provide a customisable interface with multiple components on the page, there were some limitations. As we made more use of javascript and AJAX techniques to update our components dynamically we found the need to work around the portal container in our code. Developing for the portlet model with its full page refresh did make things more complicated. Some of the JSR-168 limitations are being addressed with the follow up specification JSR-286, although this was not finalised until the final half of the VRE-SDM project and it will be a while before production-ready support is available. However, developing portlets within a java system was still rather heavyweight for some of the components we were building and in light of the recent trend towards HTML/javascript-based components for building web mash-ups; we will give serious consideration to an API such as Google's Gadget spec/OpenSocial[xv] as we continue development in the future.

Initially all the data which supported the web application was stored within a PostgreSQL relational database. As the project progressed we made the decision to migrate this to an RDF-based triplestore and used the Jena libraries and the Joseki[xvi] web service to offer a SPARQL compatible interface to the data. Using RDF gave us considerable flexibility in the data we stored and was a good fit to the various types of data/metadata which different parts of the system used, it also allowed us to deal with the patchy metadata which was uploaded to the system from the wide variety of images from many differing sources. We did find that, being a much younger standard, there were fewer tools available to help with developing queries against a SPARQL endpoint rather than SQL against a typical RDBMs, but overall the experience was a good one.

We adapted the image viewer from an earlier AHRC/EPSRC e-Science demonstrator project 'A Virtual Workspace for the Study of Ancient Documents'[xvii], which is based on the GSIV (Giant Scalable Image Viewer) for use within a portal environment. This javascript viewer works in all popular web browsers and allows very large images to be displayed in the browser, downloading individual tiles of the images on demand as the user drags their mouse to pan and zoom. The viewer was extended to support the addition of annotations to selected regions of the image.

The project designed an Ontology to represent the annotations and other metadata within the RDF triplestore. This was based on the Annotea vocabulary. Examples of the data are given in Figs [5&6]. Following feedback from user testing in our earlier iterations, we extended the data model to support responses to annotations, allowing threaded conversations related either to an image or an annotated region of an image. As users of the system come to agreement about the reading of a particular region of the document, they can add this to the final transcription of the document. We worked with Henriette Roued who, as part of the eSAD project, is constructing an online editor for transcriptions in EpiDOC XML format. This is additional functionality to the original aims of the project which we will continue to explore.
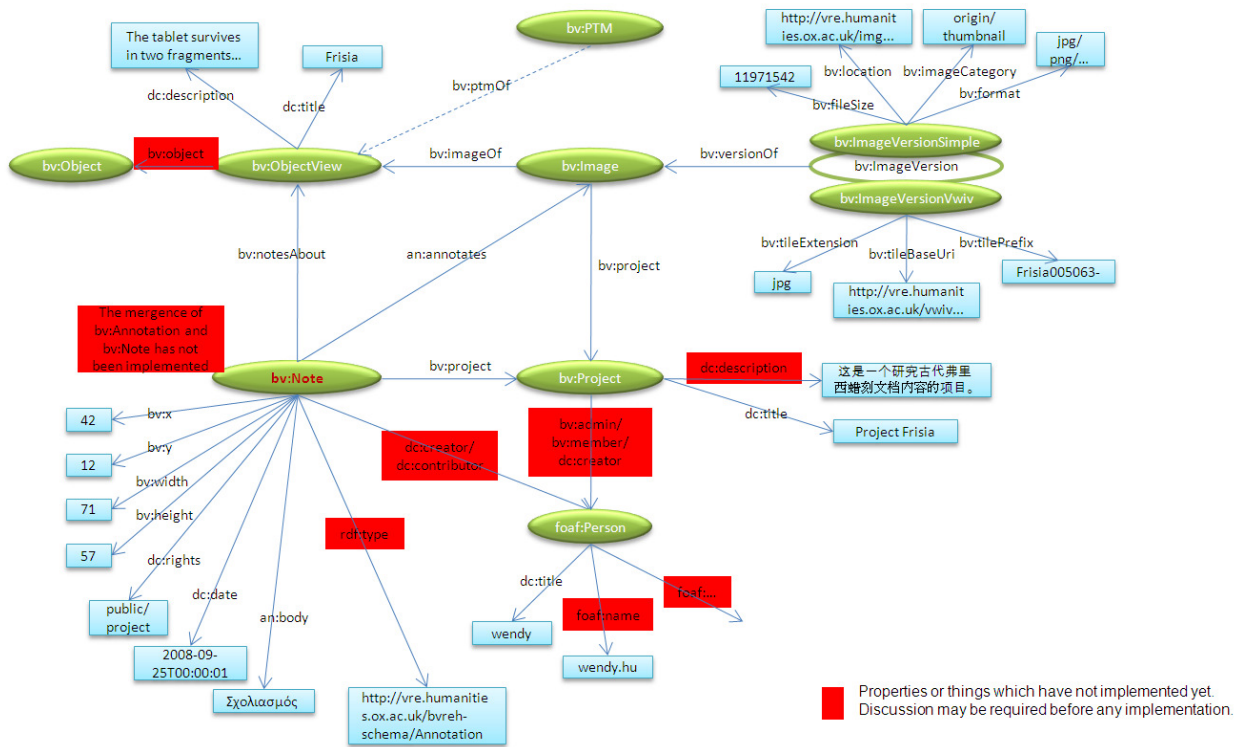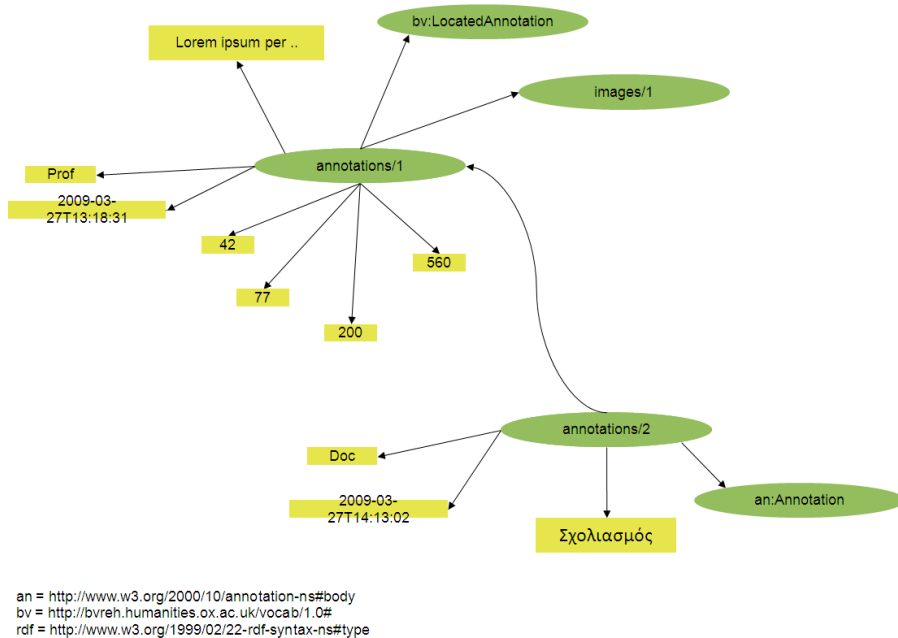
Figure 5 – VRE-SDM Data Model

an = http://www.w3.org/2000/10/annotation-ns#body
bv = http://bvreh.humanities.ox.ac.uk/vocab/1.0#
rdf = http://www.w3.org/1999/02/22-rdf-syntax-ns#type

Figure 6 – VRE-SDM Example Data

Although lowered slightly in priority, an important part of the project was linking to other data sources. With many thanks to the team at the LGPN, We linked to the Lexicon of Greek Personal Names by taking advantage of REST style web services which the project had recently made available. This allowed access to the LGPN dictionary directly from a user's workspace within the VRE. At the time of writing the LGPN web services are at an experimental stage, and the whole of the LGPN database is not exposed, but it is an extremely useful resource none the less. The Vindolanda database of writing

tablets was also making much of its data available as published XML files so it was possible for us to write conversion scripts to parse the data allowing metadata for the Vindolanda images to be imported into the VRE alongside the images.

Together with the VERA VRE project at the University of Reading we investigated linking up archaeological data from the IADB with Vindolanda data stored within the VRE-SDM. Built on an architecture based on the Tycho[xviii] java peer-to-peer communications middleware, a query service utilising the CQL query language was created. We constructed an adaptor to our RDF triplestore which connected into a test system hosted at Reading (named XDB-Arch). It allowed a user to search across publically accessible material in both databases. This could easily be exposed within the VRE-SDM via a portlet, though given the experimental nature of the service and the lack of significant overlaps in material to be searched across the two datasets; we decide not to do so as part of this project.

Outcomes

The projected outcomes of the VRE-SDM project (as stated in the project plan) were to:

- Transform current research practice in the study of documentary and textual sources
- Mediate collaborative activities in ways not yet exploited
- Allow new possibilities for collaborative work including decipherment and analysis available on demand
- Allow documentary specialists to work with archaeologists through real-time recording and communication of finds

It is clear (and documented elsewhere in this report) that the outcomes of the project have not only met the above criteria but have in many cases exceeded it. As such one of the most significant outcomes of the project is that in order to continue to support and transform research practices and collaborative processes, more work is now needed to extend the capabilities of the pilot system to ensure a stable, trusted deployment of a VRE capable of being embedded within disciplines right across the humanities.

Figure 7 – Screenshot of the VRE-SDM showing some of the viewing and annotation capabilities

Conclusions

Working with the extensive user requirements generated from interviews, filming and discussions, the pilot VRE has adapted Open Source tools to enable annotation and sophisticated document viewing, making use of existing VRE tools to facilitate communication and collaboration between scholars. The project reused and re-purposed tools and software wherever possible, choosing to concentrate on the

development of user requirements rather than writing proprietary software that would be specific to our system. With this in view, we established an instance of the uPortal framework which offers interoperability with other Virtual Research and Virtual Learning Environments and allows us to reuse JSR-168 portlets from other projects whilst making our components easier for others to reuse (JSR-168 portlet containers have been used by a number of other VRE pilot projects). The uPortal open source software, developed by a consortium of Universities additionally allowed us to provide a framework which can be customized directly by the users who will be able to compile their own interfaces using portlets which offer the tools and services relevant to their own research. It should be noted that there are now newer standards for integrating components within a web environment, the most significant open effort being Google's gadget/OpenSocial initiative[xix] and the VRE-SDM project is now investigating extending our VRE environment to also support components built to these as well as JSR standards.

This means that in the longer term the pilot VRE-SDM has demonstrated that it will be able to provide tools to researchers across the humanities. Some, such as the viewing and annotation tools, are relevant to the broadest range of scholars, while other more specialist tools can be added by the individual users or groups as and when needed. For the ancient documentary specialists the VRE is an environment which emulates the decipherment process, with the extra benefits that scholars can conduct real time meetings and annotate digitized, degraded texts. Additionally, the VRE offers an area within which other more specific tools may be deployed, such as those from the eSAD project (to aid the decipherment of degraded documentary texts through character recognition and decision support software)[xx] along with the functionality to search across specific datasets such as the Lexicon of Greek Personal Names (LGPN), the Vindolanda Tablets Online texts and more besides. This approach of adding elements relevant to the individual scholar or specialism creates a customized workbench re-workable and reusable across the humanities.

Implications

There are many implications of the VRE-SDM work, both in ongoing and future collaborations as well as the impact the pilot project has had on the scholars working with documents and manuscripts; in particular those working with ancient documents. The potential for broadening the pilot tools to researchers in other disciplines and widening the range of tools available is clear, we already know that researchers within the English faculty at Oxford would have use for such a system and there are many disciplines across the humanities who work with similar artefacts requiring much of the same functionality. The potential of the VRE not only allows researchers to work with documents in a way otherwise impossible; allowing the integration of viewing, annotation, image processing and real time collaboration, but also holds the possibility of speeding up the publishing process for scholars. Whereas in the past a text may be deciphered by an individual over a period of time and published only when they have had the time to write up the entire process, the collaborative aspects of the VRE allow not only for a reading to be discussed and deliberated by as many colleagues as one might wish, but using the 'private' and 'public' areas of the system also enables the reading of the text to be published immediately with the individual credited for their work prior to print publication. This dramatically increases the speed at which fellow scholars might discuss or comment on the work, leading to a greater understanding of how the text fits into our knowledge and understanding of history.

As the VRE-SDM is a pilot implementation it is clearly not yet the finished article ready for use instantly by scholars in other disciplines. As has been discussed earlier in this report a vast quantity of requirements have been generated by the project, both for specific functionality for historians concerned with the ancient world and for more generic use for scholars in English, Music, History and many more besides. Expanding the scope of the pilot and investigating its further potential will be essential in encouraging users to work within the VRE, knowing that they can store their research safely and with longevity with the added guarantee of continued improvement of function. Extra features have already been envisaged by our original user group, including the provision of a system for palaeographical databases of letter forms on which the project hopes to commence work shortly. Equally the pilot would benefit from some expert work on the user interface to provide a more 'user friendly' experience to scholars; an area which was highlighted throughout the project but for which we were unable to address due to lack of expertise within the small project team and due to logistical difficulties. The project hopes to address this issue and implement further features to establish the

VRE for further use in other disciplines using a small under spend in the project budget along with some extra funding.

Collaborations with the eSAD project both through ENGAGE and through our ongoing close links with the project also provide significant implications for the future of the VRE-SDM and its value to users. Ongoing discussions with the Jane Austen Manuscripts Online project and other English based projects will also enable the project to move forward embedding the pilot in the ongoing work of Humanities researchers across disciplines.

References

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[ii] XDB Arch Project http://xdb.vera.rdg.ac.uk/about.php

[iii] The BVREH User Survey is available at: http://bvreh.humanities.ox.ac.uk/news/Survey_outcomes

[iv] The VERA VRE Project http://vera.rdg.ac.uk/

[v] Jane Austen Manuscripts Online - Professor Kathryn Sutherland, St. Anne's College, Oxford, Digitisation of Austen manuscripts. The project's technical team is at the Centre for Computing in the Humanities

[vi] The Centre for the Study of Ancient Documents http://www.csad.ox.ac.uk/

[vii] The Lexicon of Greek Personal Names http://www.lgpn.ox.ac.uk/

[viii] The Vindolanda Tablets Online http://vindolanda.csad.ox.ac.uk/

[ix] ENGAGE http://engage.ac.uk/engage

[x] Image, Text, Interpretation (eSAD): e-Science, Technology, Documents http://esad.classics.ox.ac.uk/

[xi] Trac http://trac.edgewall.org/

[xii] Subversion http://subversion.tigris.org/

[xiii] JSR 168 Standard http://jcp.org/en/jsr/detail?id=168

[xiv] String Templates Library http://www.stringtemplate.org/]

[xv] More details at: http://code.google.com/apis/opensocial/

[xvi] Jena and Joseki http://www.joseki.org/

[xvii] http://bvreh.humanities.ox.ac.uk/news/e-Science_Demonstrator

[xviii] Tycho http://www.acet.rdg.ac.uk/projects/tycho/