Collaboratories: Connecting Researchers

How to facilitate
choice, design and uptake
of online research collaborations

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Management Summary

Aim of the report

This report aims to assist the research community, including support staff, in the choice, design and uptake of online collaboratories. It was commissioned jointly by SURFfoundation and SURFnet. SURFfoundation wanted an instrument to assist and advise researchers in their search for and choice of an online collaborative environment as an outcome of the SURFshare programme; SURFnet wanted input for its Collaboration Infrastructure (COIN) project. This two-pronged approach to the study has made it a wide-ranging one. It covers the spectrum from technical detail and functional aspects to organisational, managerial and cultural issues involved in setting up collaboratories.

Definition 'collaboratory'

As definition of the concept 'collaboratory' the study uses the description of collaboratory in the SURFshare tender projects:

> A Collaboratory, or virtual research workplace/environment, is a web-based collaboration environment for researchers. The literature also describes it as: "*an organisational entity that spans distance, supports rich and recurring human interaction oriented to a common research area, and fosters contact between researchers who are both known and unknown to each other, and provides access to data sources, artifacts and tools required to accomplish research tasks.*"[1] It thus offers a solution for collaboration during the research process with researchers within and outside the researchers' own institute[2].

For clarity's sake the phrase 'collaboratories' or 'collaboratory projects' is used in this report for the actual collaboration (activities) between researchers in their subject area; the phrase 'collaborative environments' is used in this report for the software.

Scope

The field of collaboratory projects and collaborative environments is diverse and growing fast, nationally and internationally. With a view to the scope and timeframe of this study, the approach has been to give an impression of the landscape, rather than attempting a comprehensive overview. The report gives a comparison of eight software systems; it provides experience and evaluations from 12 Dutch collaboratory projects; it places collaboratories in the larger context of e-infrastructures; and it gives a sketch of international developments in collaborative systems and projects. It also aims to provide some insight into the social and cultural aspects of collaboratories in the field of research.

For the comparison of available collaborative software, the following eight systems were selected:

Products	Software as a Service platforms
• Alfresco	• Adobe Share
• Drupal	• Google Apps
• Liferay	• Microsoft Office Live Workspace
• Sakai	
• Sharepoint	

Table 1: *The eight chosen collaborative software systems*

These systems were compared as regards functionality, interoperability and maturity; the results have been summarised in matrices that are attached to this report as Appendices A, B and C.

[1] Bos et al. 2007. From shared databases to communities of practice : a taxonomy of Collaboratories. *Journal of computer-mediated communication* 12(2): 652-672]
[2] SURFshare tender 2008

Chapter 4 covers recent developments of two 'second generation' collaborative environments aimed specifically at the research community, and SURFnet's COIN project.

Twelve projects were studied in order to gain insight into experience with the design, construction and implementation of collaboratories: six from the SURFshare programme and six not funded by SURFshare.

SURFshare	Other
• Collaboratory for Evidence Based Critical Reviews	• Alfalab
• Hublab	• Collaboratory.nl
• Tales of the Revolt	• Digital Collaboratory for Cultural Dendrochronology in The Low Countries
• Testweeklab	• eLaborate
• Virtual Knowledge Studio	• LabsOnline
• HBO Automotive	• PARTNER

Table 2: *The twelve projects that were studied*

HBO Automotive is set in the applied research and education environment. LabsOnline has an educational focus. Collaboratory.nl is set in the industrial R&D environment. This variety was sought so as to check for similarities and differences. The experience and evaluations of these Dutch projects were also compared and complemented with findings from the literature (Dutch and international) and interviews with a number of experts in the field. The experience gained is summarised in chapter 5, followed by analysis in chapter 6, and recommendations in chapter 7. A checklist with questions that can be used when setting up a collaboratory is attached to this report as Appendix D.

Collaboratories in respect to e-infrastructures

Collaboratories are components in the national/international e-research infrastructure. That infrastructure aims at providing integrated ICT and services solutions for handling research data and information at various levels. Collaboratories are virtual locations where researchers can work together on data and publish their results, in an ongoing process. The awareness that sound solutions for data handling are important has grown substantially; this is an incentive for institutions to adopt and support the development of such solutions – including collaboratories.

As part of this wider e-infrastructure, collaborative systems need to connect up with other systems and tools, within and outside the parent institution(s). This places demands on systems with respect to options for interoperability or integration. The present generation of software varies considerably as regards this aspect; the more modular the software is, the easier the interoperability becomes. Service-oriented architecture and newer generations of systems provide for this need for interoperability and integration without significant programming effort. There are also collaborative systems under development that are geared specifically towards the research community and the research life cycle; they too take the need for 'plug-in functionality and tools' as a starting point. SURFnet's COIN project also starts from this philosophy.

Standard open source and commercial software offers a range of functionalities that can be overwhelming, superfluous, or seemingly unsuited to the needs of researchers. But standard software does not necessarily imply standardisation of use. Most systems are very adaptable and can be 'downgraded'.

Implementation

To assess needs and align focus and extent of functionality carefully with the aims and complexity of the collaboratory, *dedicated support and guidance is necessary for successful design and implementation*. Practice proves that such support and guidance makes all the difference in perception and uptake of a new system, and its continued success. Experimenting with different models, iterative development/adaptation of the required functionality, and a combined 'bottom-up

– top-down approach' in implementation are also conducive to success. These approaches allow for quick roll-out on a larger scale once the first experiments have generated a number of workable models and basic experience for support staff.

Support

Dedicated and qualified support staff (e.g. ICT, Library, instructional or functional designers) are necessary for the start-up, but remain necessary for the later phases. Growth in use of and experience with systems triggers further demand – for functionality and support. Support staff can assist collaboratory leaders in building the necessary collaborative community and other tasks. *The right people in the right place may be a more important success factor than the choice of the right software.* Enthusiastic leadership, strong project management, sustained quality support and timely PR and communication throughout the project are frequently mentioned, nationally and internationally, as some of the most important success factors.

Success factors

Other 'non-technical' factors contributing to success that are mentioned often are:

- clear **vision and goals** – and spending time clarifying them
- creating a **common language** and learning to understand each other in the diverse setting of a collaboratory project
- sustained **support** from institutional management and research leaders, also in the longer term
- sufficient **time**, to go beyond successful technical and functional implementation and gradually address the more difficult sociological and cultural issues that arise because new systems change traditional behaviour
- **willingness** or urgency to join the experiment and deal with some inconvenience to explore promising possibilities beyond what one knows already – for *all* parties involved
- a clear or clarifyable **need** for the new solution and concrete benefits – not everybody needs a collaboratory.

Such organisational, managerial and cultural issues naturally play a more important role in cases where data management and the introduction of collaboratories are part of institutional policy, in collaboratories that form part of a larger-scale infrastructure, and in collaboratories that support long-term research programmes or a range of research programmes. Where collaboratories support shorter-term or 'one-off´ research projects, the systems and the managerial/organisational structure can be more lightweight because sustainability is less important.

Some other issues that have come up as important to deal with – by means of project management, research or institutional leaders – are:

- **legal issues**: privacy and security with respect to data, IPR of materials used and produced in the collaboratory, jurisdiction in case of external storage in SaaS-platforms;
- **access, rights and permissions**; not everything can be open access for everyone: early work in progress, certain data, the connection between internal systems and the partly external collaboratory – these require fine-grained access mechanisms;
- career assessment criteria need to be added that show **recognition** of the value of a different kind of output than journal articles – e.g. for research on data, involvement in collaboratory development, development of management skills.

For an in-depth overview of all recommendations, see chapter 7; Recommendations.

Role SURF

Approaches to solve these issues need collaboration across institutional borders; SURF can play a role as knowledge centre and facilitator of a 'collaboratory of collaboratories' in which experience can be shared and the more complicated questions can be tackled through dialogue and experimentation.

Final conclusion

One thing that has become very clear in the course of this study is that *'software', though important, is not the crucial issue*. It may ultimately be more about the question of 'how to deal with differences' – in applications, needs, tools, and software. And about the ambition and ability to tackle that question.

The Dutch translation of this management summary can be found in Appendix F, page 81.

1 Introduction

This study was set up to provide a comparison of collaborative environments that can be used for online research collaboration – so-called 'collaboratories'; and a description of current developments in this area. It was commissioned jointly by SURFfoundation and SURFnet, each of whom had its own specific interest in the outcome:

- SURFfoundation wanted an instrument to assist and advise researchers in their search for and choice of an online collaborative environment – as and when they are in need of one;

- SURFnet wanted input into its Collaboration Infrastructure (COIN) project; they wished to assess the suitability of currently available systems for development of a Proof of Concept of a collaborative environment solution to be offered to (researchers, educators, students at) Dutch Higher Education Institutes.

SURFfoundation was therefore focused on finding out what currently available environments have to offer; to what extent that covers researchers needs, depending on their specific circumstances; and what other factors play a role in the choice and implementation and uptake of such an online collaborative tool. SURFnet's focus was primarily on maturity of available products/services and their measure of interoperability, to be able to provide a best possible solution (as a successor to SURFgroups).

This bi-focal approach to the study has made it a wide-ranging one. It covers the spectrum from highly technical detail of specific interest to programmers, systems developers/integrators and systems operators, via functional specifications and organisational issues, to policy and cultural aspects relevant for those responsible for the successful implementation of collaborative environments. The resulting report aims to **facilitate the research community (including support staff) in the choice, design and uptake of online collaboratories.**

2 Approach / methods used

2.1 Impression instead of overview

The field of collaboratory projects and collaborative environments is diverse and growing fast, nationally and internationally. The scope and timeframe of this study did not allow for an extensive, structured investigation of available environments and active or nascent collaboratory projects, not even just in The Netherlands. It would have been outdated before it was finished. Rather than trying to give an overview of the landscape, like a film would do, this report therefore gives an **impression** of it, as in a series of snapshots; and tries to reach conclusions and recommendations by induction from the experiences reported on.

2.2 Selected Environments

There is a large number of collaborative environments available; to get an impression, see http://en.wikipedia.org/wiki/List_of_collaborative_software.[3] To keep the study manageable, the Terms of Reference for the study selected **eight environments** for the comparison in functionality, maturity and interoperability. This selection consists of:

Products:
1. Alfresco
2. Drupal
3. Liferay
4. Sakai
5. Sharepoint

Software as a Service platforms:
6. Adobe Share
7. Google Apps
8. Microsoft Office Live Workspace

A few other important environments currently in development are covered summarily in chapter 4. Google Wave, though potentially interesting, has not been included because of its stage of development and its relatively wide target audience.

2.3 Selected projects

SURFshare projects
For the coverage of collaborative projects, starting-point were the SURFshare tender projects of 2007 and 2008:

- Collaboratory for Evidence Based Critical Reviews (Utrecht University)
- Hublab (International Institute of Social History)
- Tales of the Revolt (Leiden University, National Library of the Netherlands)
- Testweeklab (University of Amsterdam)
- Virtual Knowledge Studio (Erasmus University Rotterdam , Royal Netherlands Academy of Arts and Sciences, Maastricht University)[4]

These projects are all set in the academic research environment. In addition, one project set in the applied research and education environment of the Universities of Applied Sciences was approached, because it has characteristics of a collaboratory; and it was relevant to check for any

[3] www.cmsmatrix.org/ provides comparisons of a wide range of Content Management Systems, including collaborative environments. It is not known how accurate and up-to-date the site is.
[4] Read more about these projects on www.surffoundation.nl/nl/themas/openonderzoek/collaboratories

significant differences between the academic and applied research environments. This project, HBO Automotive, is funded under a different heading of the SURFshare tender projects 2008 (knowledge dissemination in applied research and education).

Other projects
To widen the base of experiences to draw on, an effort was made to identify other Dutch collaboratory projects not funded by the SURFshare programme. This was not simple, because of the varied use of the terminology. The timeframe for the study put further constraints on the range that could be investigated. Six projects, that were found via a Google Search or tips by interviewees, could be contacted for an interview or further information:

- Alfalab
- Collaboratory.nl
- Digital Collaboratory for Cultural Dendrochronology in The Low Countries
- eLaborate
- LabsOnline
- PARTNER

Influence of discipline
Quite a few of the selected projects stem from the Social Sciences and Humanities. This may have the effect that some of the experiences are discipline-specific. One example is that the collaboratories in the Social Sciences and Humanities are often relatively small groups – e.g. five people.

2.4 Approach surveys

For the functionality, maturity and interoperability surveys of the eight selected collaborative environments, the primary approach was **desk research** of online and paper documentation on available systems and on projects using specific environments. This was followed up by a **check with some experts**, and **demonstrations of a number of current projects**. For all three topics, lists of items/questions to be covered were provided by SURFnet; they were to a large extent drawn from SURFnet's project COIN (see § 4.1.2).

2.5 Approach functionality

As to functionality, the Terms of Reference aimed for a comparison of both generic and more specific discipline-oriented functionalities/tools. For discipline-oriented functionalities/tools, however, that appeared to be not only very hard to do – because it is impossible to get a complete, up-to-date picture, as pointed out before; it also appeared to be less relevant to know what specific functionalities are around and what they require. More relevant was the question **whether 'standard' collaborative environments would allow easy integration of such specific functionality**.

2.6 Developments

To gain insight in current and future developments, and in organisational, policy, and cultural issues involved in implementation, **interviews** were conducted with the project managers of the SURFshare tender collaboratory projects and the six additional projects. The experiences and evaluations from the interviews were compared and complemented with findings from (international) **literature** plus interviews with experts at **JISC**, **the Knowledge Exchange**, and elsewhere in the field.

A list of (re)sources is given in Appendix E.

2.7 Definition of collaboratory

As definition of the concept 'collaboratory' the study uses the description of collaboratory in the SURFshare tender projects:

> A Collaboratory, or virtual research workplace/environment, is a web-based collaboration environment for researchers. The literature also describes it as : "*an organisational entity that spans distance, supports rich and recurring human interaction oriented to a common research area, and fosters contact between researchers who are both known and unknown to each other, and provides access to data sources, artifacts and tools required to accomplish research tasks.*"[5]
> It thus offers a solution for collaboration during the research process with researchers within and outside the researchers' own institute[6].

The differences encountered between the projects discussed are seen as a representation of the wide range of application collaboratories have in practice.

No attempt has been made to categorize the projects according to type of collaboratory; the numbers, and the findings in the interviews, did not seem to make it necessary for better understanding. If differences *do* matter, it is indicated in the text.

> The Science of Collaboratories project in the US has done extensive research on a.o. categorizing collaboratories. They report on this in their article From Shared Databases to Communities of Practice: A Taxonomy of Collaboratories.

Collaborative environments vs. collaboratories or collaboratory projects
In this report a distinction is made in the text between the phrases 'collaborative environments' and 'collaboratories' or 'collaboratory projects'. The first phrase is used for the software, the second for the actual collaboration (activities) between researchers in their subject area.

2.8 End-users

There is less information directly obtained from end-users on their experiences than anticipated at the beginning of this study; the information on end-users has mostly been obtained indirectly, from project managers and the literature. In two current SURFshare tender projects, user surveys were about to start at the time of the interviews. Rather than duplicating that effort within the limited timeframe of this study, it seemed more practical to run those in parallel. Results of those shall be made available at the SURFshare wiki.

[5] Bos et al. 2007. From shared databases to communities of practice : a taxonomy of Collaboratories. *Journal of computer-mediated communication* 12(2): 652-672
[6] SURFshare tender 2008

3 Results of the technical and functional comparisons

The findings from the comparative desk research into functionalities, interoperability and maturity of the eight selected systems have been summarized in matrices. These are attached to this report as Appendices A (functionalities), B (interoperability and maturity).

- Appendix A compares the selected systems on a range of **functionalities connected with content management, collaboration, teaching & learning** (because of Sakai) **and systems and administration**; these include the functionalities that were researched in the COIN Technology Scouting.
- Appendix B takes those COIN Technology Scouting functionalities as a starting-point and compares the systems on the **standards** they support for those functionalities. Additionally it compares the systems on **factors that contribute to the maturity** of the system.

Commentary based on **practical experience** with environments is reported in chapter 5.

4 Developments

4.1 Collaborative environments

In the following chapters, the developments in four collaborative environments are discussed:
- SURFgroups
- Project Collaborative Infrastructure (in progress)
- Microsoft Research Information Centre
- eSciDoc

In chapter 4.1.5 some other environments are discussed

4.1.1 SURFgroups - SURFnet End-user survey 2009

SURFgroups is a standardized collaborative environment offered by SURFnet to (students, researchers, educators and other staff in) the Dutch higher education sector, as a 'software as a service' solution. SURFgroups was established in 2005 and originally based on Microsoft Sharepoint 2003. In the meantime, SURFgroups migrated to a newer Sharepoint version: the current version is based on Sharepoint 2007.

A 2009 User Survey[7] showed that there is a definite interest in shared collaborative environments (85% of respondents), but relatively low acquaintance with the presently available Sharepoint-based SURFgroups. Almost 40% of respondents knows it, almost 20% uses it. Interest in it is over 20%. On the whole, **interest in, acquaintance with and use of SURFgroups has grown** since 2008, in some target groups substantially. **Appreciation varies**; objections are that it is too MS-oriented, the interface is not user-friendly and intuitive, and the web-conference facility (Adobe Connect) presents problems. Furthermore, better multiplatform support is wanted, as well as better integration with institutions' own intranets. These findings tally with those in the reported collaboratory projects using Sharepoint or SURFgroups.

4.1.2 SURFnet's project Collaboration Infrastructure (COIN)[8] - Results first phase

In the first half of 2009, SURFnet initiated a technology scouting[9] to look into a new generation of open collaboration infrastructure technology and generic components for supporting collaboration services or 'Federated Collaboratories'. This was in response to the growing need in SURFnet's target audiences – also apparent in the User Survey - for open collaborative environments in which services of the institutions, SURFnet and third parties can be joined into one transparent environment[10]. Fundamental to the SURFnet Collaboration Infrastructure is that it must support collaboration in Virtual Organizations.

Virtual Organizations (VOs) exist in many forms within research and education. Use cases in VOs might be:
1) as basic as a group of individuals using the same set of (online) applications, or
2) as complex as a pan-European research project where multiple institutions share research infrastructure and collaborative tools.

With the launch of its collaboration platform SURFgroepen[11] (SURFgroups) in 2006, SURFnet has been able to facilitate many of the online collaboration needs for use cases of the first scenario. However, in the mean time web based collaboration applications have become widely accepted.

[7] www.surfnet.nl/Documents/indi-2009-10-016%20(Eindrapportage%20Eindgebruikersonderzoek_2009).pdf
[8] The project was initially called "Collaboration Infrastructure and Federated Collaboratories" (CIFC).
[9] Text taken from the introduction to the Report: www.surfnet.nl/Documents/indi-2009-07-020%20(Report%20Collaboration%20Infrastructure).pdf
[11] SURFgroepen, https://www.surfgroepen.nl

Also the strong rise of so called 'Social Networks' opens new opportunities for relation centric collaboration. Due to these trends and because of the monolithic nature of the SURFgroepen platform, a shift of the concept of online collaboration towards a more open model was an obvious next step for SURFnet.

As for serving the second scenario, it became clear that a more infrastructural approach was needed. Such an infrastructure should offer a number of supporting services for facilitating collaboration in a multi-domain environment. Among these are federated access, group management, inter-application messaging and tools for provisioning and deprovisioning (remote) applications. Furthermore, a set of commonly used tools for collaboration should be offered. For example a portal environment is introduced to aggregate information provided by the distributed applications being used. Finally the infrastructure should support open interfaces for maximum interoperability with tools and resources outside the domain of SURFnet.

The results of the first phase of the COIN project were presented at a seminar (December 14th 2009). The results, presentations and videos of that day can be found at the SURFnet website[12] (Nota bene: all material is in Dutch).

4.1.3 Microsoft Research Information Centre

The Research Information Centre (RIC) is described as a **virtual research environment** that is being developed by Microsoft's Technical Computing Group together with The British Library. They are now in beta-test stage. The first official release is scheduled for 2010.

The RIC's purpose is "to support researchers in managing the increasingly complex range of tasks involved in carrying out research. Specifically, to provide structure to the research process, easy access to resources, guidance and tools to manage information assets, along with integrated collaboration services. Research builds on previous research. RIC is being designed to encompass all aspects of this research lifecycle"[13]. This cycle comprises the stages 'Idea, Discovery and Design', 'Obtain funding', 'Experiment, Collaborate, Analyze', and 'Disseminate findings'.

Figure 1: *Research Lifecycle as envisaged by Microsoft Research*

[12] www.surfnet.nl/nl/bijeenkomsten/archief/Pages/InformatiebijeenkomstCollaborationInfrastructure.aspx
[13] Roger S. Barga, Stephen Andrews, Savas Parastatidis, 'A Virtual Research Environment (VRE) for Bioscience Researchers,' advcomp, pp.31-38, 2007 International Conference on Advanced Engineering Computing and Applications in Sciences, 2007

The first implementation is in the area of biomedical research, but it can be re-used in other research areas. Amongst other things it intends to provide direct access to rich information sources (such as UK PubMed Central) and a manuscript submission system; it works with the OAI-PMH and OAI-ORE protocols for the im- and export from/to Open Access Repositories; and it will support Enhanced Publications.

The Dutch experience
In the Netherlands, the 'Tales of the Revolt Collaboratory' project was signed up as a beta-version user following a call for volunteers from Microsoft in March 2009. The RIC specifications promised to cover approximately 90% of the project's functional requirements. Delivery of the source code was in June 2009, a month later than promised. Installation was problematic: instructions were very concise and the installer was not well developed. It took roughly two weeks, with a lot of 'self-help' from the university's IT-group, to get to a reasonably functioning environment. At the time of the interview with the project manager (late September 2009) there were still problems that prevented use of RIC in the project; especially the bug that as a newly registered user you cannot log in. The new release in which this should have been fixed has also been delayed[14].
These problems have made the project opt for a plan B: implement on the basis of standard Sharepoint, with some extra development[15] for the essential functional requirements that Sharepoint does not cover. So, **no experiences with the use of RIC in the project environment can be reported yet.** In the background, outside the project context, they continue to experiment with RIC, with involvement of SURFnet people. In due course, they expect to be able to migrate to RIC without too many problems, because it is Sharepoint-based.

4.1.4 eSciDoc

eSciDoc is described as an **eResearch environment** developed by Max Planck-Institute and FIZ-Karlsruhe. Development was started in 2004, with funding from the German Ministry of Education and Research; it has by now reached version 3. It is developed specifically for global and interdisciplinary collaboration of scientific and scholarly communities. It has a service-oriented architecture, is open source (it has also integrated available open source components) and supports a number of open standards. It comprises core functionality including a Fedora repository (eSciDoc Infrastructure) to ensure sustainability; a set of complementing services (eSciDoc Services) to connect and disseminate data and applications built on top of the infrastructure and the services (eSciDoc Solutions) to visualize, publish, manage, and work with data (including the creation of Enhanced Publications[16]). eSciDoc supports the entire work process of researchers in a collaborative setting, and provides services for object storage, search and indexing, statistics and reporting, persistent identification, workflows, validation, and transformation (see Figure 2 and 3).

[14] Microsoft has contracted out the development of the RIC to a third party.
[15] By e-Office, The Netherlands
[16] www.surffoundation.nl/en/themas/openonderzoek/verrijktepublicaties/Pages/default.aspx

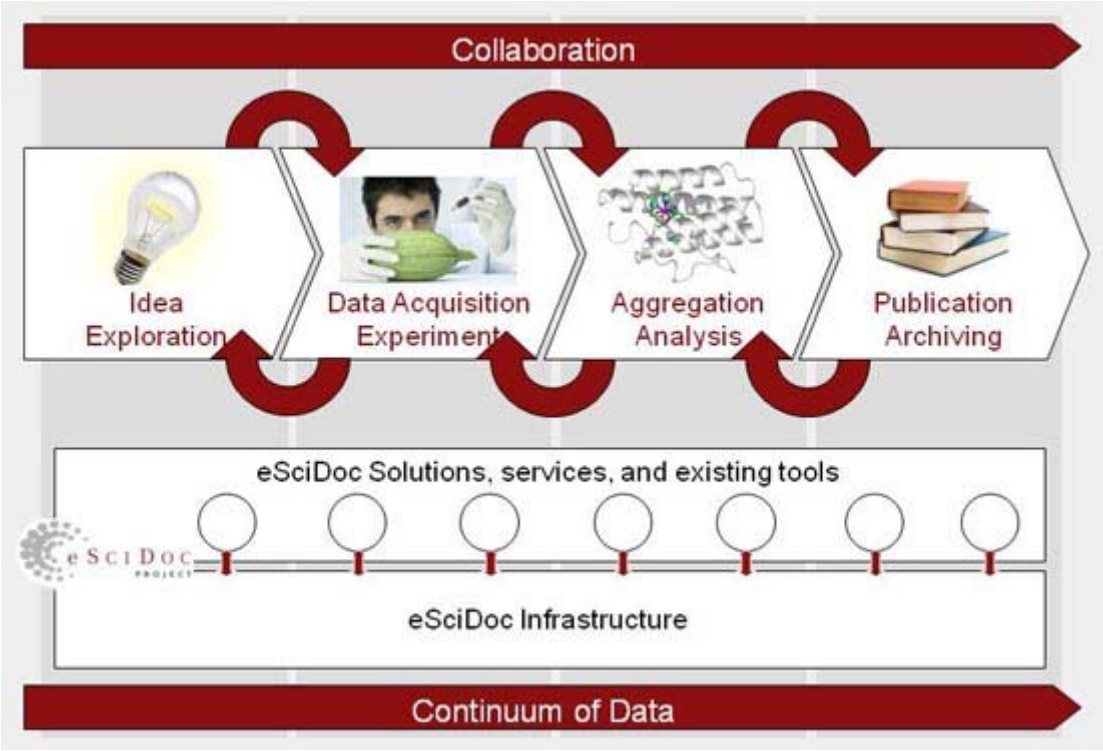


Figure 2: *eSciDoc covers the whole scientific and scholarly workflow*

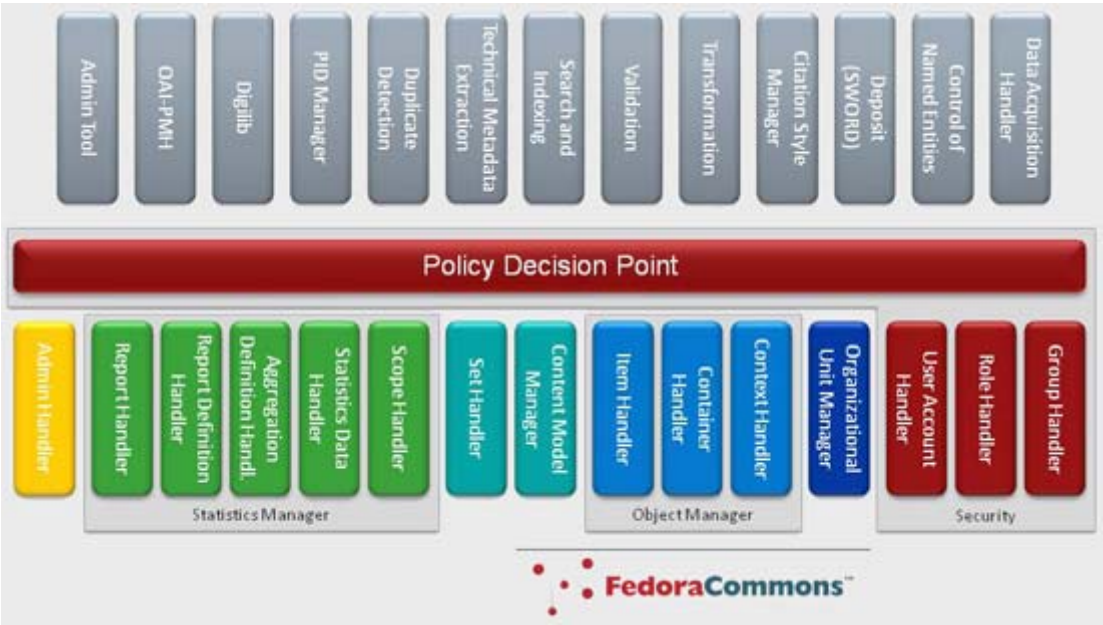


Figure 3: *eSciDoc Core, Intermediate, and Application Services*[17]

Prospect

There is a growing number of interested parties, prospects and partners: almost thirty parties, mainly from Europe, some from Japan, and the University of Minnesota in the US. The project, and the latest version of the environment, were presented at the European Conference for Digital Libraries in October 2009; some spokespeople judged it to look so good that "it's time for renewed acquaintance". Like Microsoft's RIC, it is a 'next generation' collaboration environment specifically aimed at the (work process of the) research community. Compared to MS RIC, eSciDoc promises to

[17] Retrieved from https://www.escidoc.org/JSPWiki/en/GeneralConcepts 16 December 2009.

score better on openness, modularity and possibilities to integrate specific discipline-oriented tools and solutions fairly easily.

4.1.5 Other environments

Many interviewees report that within their institutions, a variety of collaborative software is used – at researchers' own initiative, through another partner, custom-built (e.g. 3D development, around Grid) or publicly available (e.g. Web 2.0 tools, Google Docs/Sites). But there is no clear picture of what, where and how much. It is seen as a given. A lot of activity seems to revolve around exchange of information and communication.

Publication environments and repositories
Related environments, that support part of the functionality needed by a collaboratory, are also of importance in viewing the landscape. Examples are publication environments, such as arXiv, or Institutional Repositories such as Fedora. eSciDoc shows how such environments can develop into more elaborate collaborative systems; however, in the case of eSciDoc the initiative to develop a collaboratory making use of the repository system Fedora resides with research institutions. The developers of those original systems so far do not seem to go down that road.

Research tools
Similarly, a range of research tools offer very popular, partial, functionality, e.g. Zotero and Mendeley. An extensive list is available at Dirt – Digital Research Tools wiki (http://digitalresearchtools.pbworks.com/) and shows the sheer number and variety of available tools. Here, too, it will be a given that people work with such tools, and want to be able to continue doing so – or be offered comparable functionality and ease or fun in use.a

4.2 Collaboratory projects

4.2.1 SURFshare programme

The SURFshare programme is a four-year programme that runs from 2008 - 2011; it follows up on the DARE programme which established Institutional Repositories and Open Access publishing in the Netherlands, as a nationally stimulated and coordinated effort. SURFshare aims to build on this by "creating a common infrastructure that will facilitate access to research information and make it possible for researchers to share scientific and scholarly information". **Focus is on the researcher, and on support for him/her in the process of conducting research and disseminating its results** with the highest possible impact.

> "Not only does ICT speed up standard research and communication processes, it also changes the nature of the research cycle itself. The growing number of facilities for knowledge sharing and dissemination mean that traditional publications, tools (for example models, algorithms, and visualisations), and research data are increasingly interwoven."[18] The SURFshare programme therefore has an integrated approach of the research cycle and deals with a wider range of components in it.

Collaboratory projects
One of the components in the research infrastructure SURFshare aims to support is 'Collaboratories'. Both in 2007 and in 2008, Calls for Tenders were issued. The 2007 tender projects focussed on short-term projects developing and implementing environments. The 2008 tender projects looked for widening and deepening the first experiences of the 2007 projects, e.g. by increasing experience in more disciplines/institutes, gaining more insight in user experiences and in the impact of the collaboratories on their work. The funding supported the following five collaboratory projects; two of the 2007 projects were continued in 2008.

[18] www.surffoundation.nl/en/themas/openonderzoek/Pages/default.aspx

Collaboratory for Evidence Based Critical Reviews *(2007)*

- A collaborative tool in **Sharepoint**; it is part of the Utrecht University PARTNER programme (see § 4.2.2).
- It supports the interactive process of creating Evidence Based Critical Reviews at Utrecht Medical Centre in accordance with the relevant protocol, requiring a dedicated workflow.
- It is now in use in one medical course, and discussions have started about possible implementation in others – also in another field, for another purpose (Educational Psychology, for students' theses).

Hublab (2007 and 2008)

- A user-friendly, 'light' tool for communication, data gathering and data sharing using **Liferay**.
- It was developed and tested in the 2007-project by five international collaboratories in social and economic history supported by the International Institute of Social History/Royal Netherlands Academy of Arts and Sciences (KNAW). Two of them have external parties participating.
- Aim of the 2008-project is to improve the environment based on feedback from users in the first phase ('more simple and straightforward'); and to gain insight in the actual use of the adapted environment (operational since August) by six research groups. At the time of the interview, the user survey was about to start.

Tales of the Revolt (2008)

- Development, implementation, and testing of a collaboratory, using **Sharepoint / MS Research Information Centre**, for the Tales of the Revolt research programme at Leiden University.
- It will facilitate collaboration in the field of data management and knowledge sharing between the scholars involved and between the research group and libraries and archives. It will also aim at improved interaction between the research programme and the public.

Testweeklab (2007)

- Collaboratory for the Department of Psychology/University of Amsterdam. It combines an online collaborative environment (**Sakai**) with a repository (**Fedora**) for the long-term storage of surveydata.
- It supports researchers in their collaboration on the preparation, execution and processing of psychological surveys among first-year Psychology students.
- The project has successfully built a technical and functional prototype, including a workflow which takes into account the privacy-sensitive nature of the information. The project is not active now, progress depends on the researchers involved who have to populate the system with 40 years' survey data.

Virtual Knowledge Studio (2007 and 2008)

- The 2007-project has developed, implemented and tested a collaboratory for the VKS, using **Sharepoint-based SURFgroups**.
- The VKS focuses on e-research and its application, and looks at the relation/interaction between research, infrastructure and research practice. The collaboratory supports this interdisciplinary, multi-sited, national and international collaborative venture comprised of several already existing collaboratories.
- The 2008-project aims at further development of the environment, improved user support and research into the practical application of online collaboration and users' experiences.
- The system is mostly used for (communication around) document sharing and shared writing in small collaboratives of 3-4 people. Connection with a repository has been established and a workflow is included. A RefWorks licence within the collaboratory has been arranged and is being implemented. At the time of the interview, a workshop with users to assess their experiences with the system had just been held.

Status of the tender projects

The Tender 2007 projects were all concluded by mid-2008. An evaluation of the four projects was done to serve as input for annual activity plans from 2008 onwards. This resulted in the aim of widening and deepening the experiences of the 2007 projects; due to the short project period,

those projects delivered successful technical implementations but little user experiences. Furthermore it generated questions with respect to standards, rights & permission management in an Open Access environment, and connections with e.g. repositories and other research and publication tools. At the time of the interviews with the project managers the Tender 2008 projects were still ongoing. They were all about to enter their fourth and last quarter; hence, only intermediate results were available.

Choice of software
The five SURFshare Collaboratory projects all use available commercial or open source software. Only in the case of Hublab was the choice based on a comparison test (by people with extensive ICT-experience) of three environments (Sharepoint, Sakai and Liferay).

- Hublab chose Liferay because it wanted a 'light' environment; Sharepoint did not qualify for that reason, Sakai seemed less research-oriented. Liferay seemed sufficiently stable, it is used by a number of large organisations, and has a user community for support.
- VKS chose SURFgroups (based on Sharepoint) for the perceived ease of availability of an installed platform and support.
- The use of Sakai for Testweeklab was the result of University of Amsterdam's choice for an open source environment that could support both education and research.
- The Collaboratory for Evidence Based Critical Reviews' use of Sharepoint is the result of the Utrecht Board of Governors' choice for university-wide implementation of that platform.
- Leiden's choice for Sharepoint[19] was pragmatic: it fits the MS Office environment that researchers are already used to, and there was some experience with Sharepoint in the project group.

Results, experiences and evaluation of the projects are discussed in chapters 5 and 6.

4.2.2 Other Dutch collaboratory projects

As stated in Chapter 2, in addition to the SURFshare tender projects some other projects were approached for information and experiences, to widen the base of the study. One of them was a project by some universities of applied science, also funded by SURFshare:

HBO Automotive
- A joint project of Fontys University of Applied Sciences, HAN University of Applied Sciences and Rotterdam University of Applied Sciences.
- The aim is to enable access to knowledge on automotive topics generated at universities of applied sciences via an Automotive Knowledge Bank, for students and business and industry – including small/medium-sized business in the field.
- The project is focused on developing the means and workflows to extract relevant information from the HBO Knowledge Bank and rework it for the Automotive database, embedding this process in education. The development of a full-blown collaboratory is not part of the project, generating ideas and support for it is.

The other projects were found through a Google search, or via interviewees:

Alfalab
- A joint project by five institutes of the Royal Netherlands Academy of Arts and Sciences (DANS, Fryske Akademy, Huygens Institute, Meertens Institute and the Virtual Knowledge Studio).
- It aims to provide an e-research infrastructure by uniting digital sources and tools for analysis, in order to ease the use of the web for Humanities researchers.
- Phase 1 of the project aims to create the collaboratory Alfalab, including supporting infrastructure. It will bring together **Geolab** with online tools for 'georeferencing', annotating and visualising geodata, and **Textlab** with online tools for cooperative tagging (enhancing) of

[19] For further information on Leiden's planned use of Microsoft's new Research Information Centre see § 4.3.

text data. This will be supported by a supervised learning machine, repositories for data and applications and materials such as index, tutorials, manuals and online dissemination tool.
- AlfaLab also looks at the feasibility of such an environment, and at what is needed for further development. It is in its start-up phase.

Collaboratory.nl

- A R&D project (2003-2006) by Novay (= Telematica Institute), Corus, DSM, Philips, FEI, and University of Amsterdam.
- Its aim was to develop a practical application integrating technology for remote operation of lab instruments with groupware for online remote collaboration in industry between researchers/experts and clients.
- This virtual laboratory allows for remote experimenting and consultation by researchers; storage and analysis of the research results, comparison of the results with those of other analyses and offering analysis capacity.
- The project has produced a working prototype, that has been further developed by one of the project partners into two commercial products (spin-off: secure remote maintenance; collaborative software for analyses). It has also produced results that have led to world standards in the area of security of such systems. A feasibility study was conducted to establish how cost savings could be realised, and what new opportunities would be generated by the system.
- The project had a 'light' connection with education: Ph.D.'s working on the system, and collaboration between one of the project partners and local colleges of higher education.
- To maintain development speed and quality, and to reduce costs, the project used 95% open source software (a.o. portal technology, security software, authentication & authorization, collaborative tools). The working prototype software is also open source.

Digital Collaboratory for Cultural Dendrochronology (DCCD) in The Low Countries

- A project of the Cultural Heritage Agency, in cooperation with DANS and Utrecht University (2008-2010). The project aims at:
  1. the international standardization of dendrochronological data and metadata;
  2. the development of a sustainable and integrated repository of these data;
  3. unlocking these data for interdisciplinary follow-up research, including the development of a controlled four-language vocabulary based on a number of existing vocabularies.
- During the project European data collections with relevance to cultural-historical research in the Low Countries are upgraded and combined for the benefit of large scale research in the field of wood usage and landscape history.
- The project has worked with Cornell University on the international metadata model (in XML), together with 80 people in 13 countries (Jansma *et al.* 2009[20]). This model is now also being introduced in other institutions in Europe and the US. With DANS, a database/trusted repository is developed for storage, search & retrieval and re-use; a stand-alone application based on the new metadata model will be available as freeware for all ('members' and 'non-members' of the collaboratory) for local research administration, up- and downloads to and from the repository and analyses.
- They use, and produce, open source software. Because many of the datasets have been collected (against serious investment) and made available by private companies, the collaboratory will – at least initially – have a (free) membership and permissions system. Non-members can search, but will need permission from a member to actually get access to and use the data from their search results.
- At the time of the interview, the project was in the phase of building the database application, and had some collaborative tools for project communication. At the time of finalizing this report, the VKC-solution offered by the Utrecht University PARTNER programme (see hereafter) had been chosen as a full collaborative environment. An educational module is also planned.

[20] Jansma, E., Brewer, P.W. & Zandhuis, I. (2009): TRiDaS 1.1: the tree-ring data standard, *Dendrochronologia* (online first-doi: 10.1016/j.dendro.2009.06.009)

eLaborate

- A project by Huygens Institute/Royal Netherlands Academy of Arts and Sciences (started in 2004) to realise a collaborative framework (own development) for the creation of text-editions and for textual research in online working environments.
- Researchers can work, individually or with a group of collaborators, on the transcription and edition of a text. The framework allows for the digital presentation of an edition, printing, a flexible system of annotation categories, so that the different stages of the edition (diplomatic transcription, critical edition, translation and commentary, etcetera) can be distinguished, and flexibility in presentation and functionalities. The possibility of uploading large collections of scans or photos of texts and improved rights management are in development.
- The growth of the use of and interest in the system was one of the incentives to start the AlfaLab project described before.

LabsOnline

- A joint project by University of Amsterdam, VU University Amsterdam, Fontys University of Applied Sciences, University of Applied Sciences Utrecht and The Hague University of Applied Sciences (2006-2007), funded by the Digital University.
- The project and its predecessors developed a number of examples of online laboratories in educational settings, and explored the technical and pedagogical implications of remote laboratories in education. Some 20 experiments were developed that students could conduct online; as well as a registration system for the labs and their users.
- Arrangements were agreed to maintain the experiments and the system. To be able to continue, the idea was to set up a community of groups/institutions offering such online experiments, and obtain the funding for the maintenance of the system through a participants' fee. Despite the interest in it, this has not come off the ground. Reasons for this are primarily that the idea of sharing laboratory resources was so novel that many institutions did not feel the need (yet?); furthermore, a set of experiments was developed for a wide range of subject areas and target groups and groups had too little use for experiments outside their own contributed experiment(s). In addition, the still existing gap between universities and universities of applied science played a role; and the project leader changed to another job.
- Part of the project is still alive: The University of Amsterdam and VU University Amsterdam offer their online experiments to secondary school pupils as a 'teaser' to try and raise their interest in a science education.

PARTNER

- A programme led by the Library of Utrecht University, which started in 2006, using Sharepoint 2007 as basis, with adaptations.
- It aims to implement 'virtual knowledge centres' in research groups for various purposes (research, education, internships, involvement of alumni). SURFshare tender project EBCR is one of the projects in this programme.
- The University Library provides programme and project management; implementation is in close cooperation with the groups involved.
- In October 2008 there were 5-6 functioning VKC's, upon which it was decided to roll out on a larger scale. At the moment of the interview there were 11 VKC's operational and a few more in development; at the end of 2009 20 VKC's were operational.

Applications of collaboratories

The projects (both SURFshare and other) show the range of orientations/applications collaboratories can have: collaboration centred around the remote and shared use of lab instruments; embedding such an application in education; collaboration around a digitized text or joint building of a database; collaboration around a diverging set of tools and materials to stimulate e-research.

As stated in Chapter 2, contrary to the Science of Collaboratories project no attempt has been made to categorize collaboratories or distinguish between experiences/results. For the purposes of this study, which focuses primarily on facilitating the choice of collaborative environment, it does not seem to make a crucial difference whether a project sets up a remote lab, dedicated database or joint digitized text. All of them are tools specific to the research conducted; they are a given for

the collaborative environment and as such put demands on the environment for ease of integration and interoperability.

4.3 Wider context

4.3.1 International developments

Within the limitations of this study, some general information has been gathered on developments in the USA and the UK, because they are ahead of The Netherlands; some information on EU-developments has also been included. No further specific information has been obtained on individual countries in Continental Europe and the rest of the world. Based on the impressions of a few spokespeople with good overview, it seems safe to say that in comparison with them, The Netherlands are more or less at a par or ahead of developments.

A more elaborate Landscape Study on Virtual Research Environments/ Collaboratories was conducted by the Centre for e-Research at King's College London and the Oxford e-Research Centre at the University of Oxford (UK); it is commissioned by JISC and due early 2010. This should give more specific and up-to-date information on the international developments.

USA
The Science of Collaboratories (SoC) project in the US started around 2002; it was a research project run by CREW, itself a Collaboratory for Research on Electronic Work. As a basis for its work, it gathered information on collaboratory projects in the US in the first half of this decade; the project website as currently still displayed lists 163 collaboratory projects, with some dating back to the 1960s and '70s – even before the concept 'collaboratory' was defined. Their 2007 Taxonomy article[21] mentions 212 projects. It illustrates the size and growth of the phenomenon, the diversity of its application, and the effort needed to obtain and maintain the information.

The difficulty of obtaining an overview of developments in the US is compounded by the fact that their seems to be no coordinated programme and funding effort in this area. One spokesperson mentioned that the NSF has just released a report on Virtual Organisation, but "there's a lot of talk about it, but no money going towards it." In the past decade, the Mellon Foundation contributed to the development of Sakai, and the NSF to the SoC project. In the Arts & Humanities, the Bamboo project was started in 2008, with funding from the Mellon Foundation; but apparently the financing is affected by the financial crisis.

UK
The UK has a JISC-coordinated 'Virtual Research Environment' programme[22]; it started in 2004, and is currently in phase 3.

Aim and results phase 1
In Phase 1, fourteen projects were funded to **explore the definition of and technological solutions for VRE´s in Research** in the UK. In this phase, it was tried to establish whether the VRE would/could be an extension of the Virtual Learning Environment, which at that time was well-established and used. The outcome was that this was not possible; research is too specific to build one VRE framework into which each research group can subsequently plug their own tools. To find the particularities, projects needed to stay close to the users, start with *their* questions, and find technology solutions for them. This led to the 'figure 8 development model' of participative design and development, which was the basis for Phase 2 of the VRE Programme.

[21] Bos, N., Zimmerman, A., Olson, J., Yew, J., Yerkie, J., Dahl, E., et al. (2007). From shared databases to communities of practice: A taxonomy of collaboratories. *Journal of Computer-Mediated Communication*, *12*(2), article 16. http://jcmc.indiana.edu/vol12/issue2/bos.html

[22] JISC defines VRE as follows: A VRE helps researchers from all disciplines to work collaboratively by managing the increasingly complex range of tasks involved in carrying out research. It is probably te be interpreted wider than ´collaboratories´, which form part of the VRE.

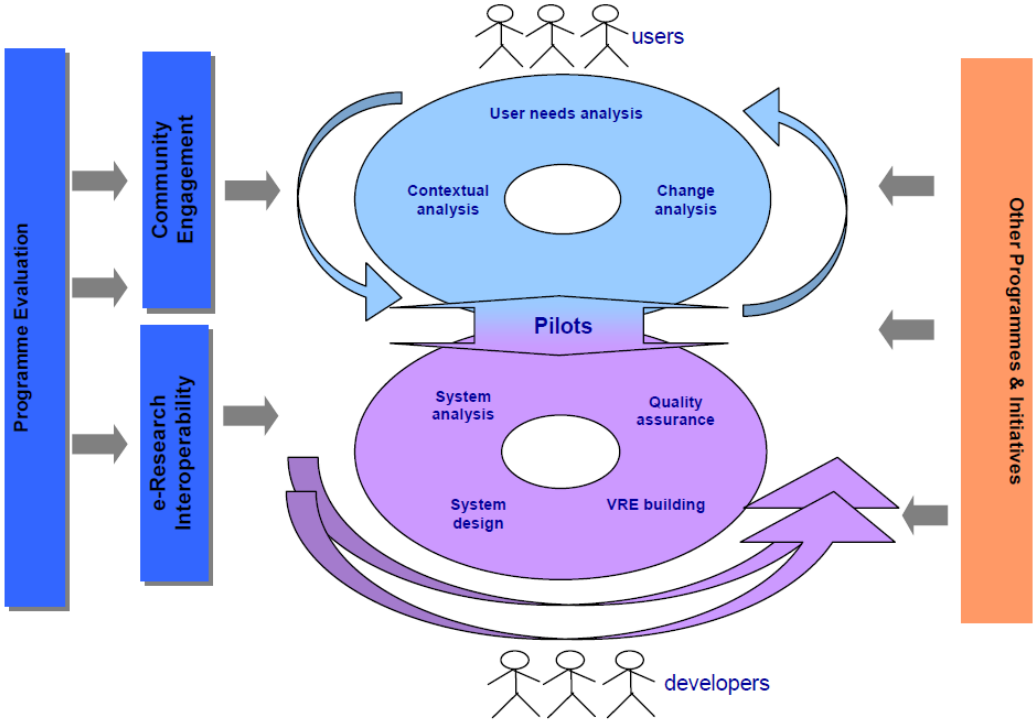


Figure 4: *The JISC figure 8 model of development of VRE's*

Aim and results phase 2

In Phase 2, four pilots were funded that applied the development model to **look at the research process in a particular discipline** and develop a fitting VRE. This phase shows that VRE's may have 3 benefits:

- the same research can be done faster (e.g. data are available much quicker)
- the same research can be done better (access to resources previously not available/accessible, more people involved allowing for other conclusions)
- other research can be done (e.g. based on combinations of data from different sources/disciplines)

Phase 2 was nearing its conclusion at the time this report was written; four reports have been commissioned to finalize this phase, looking at:

- sustainability of phase 1 projects: what has happened after JISC funding stopped
- landscape: general developments in the past five years, also abroad[23]
- impact: where is true impact/change as a result of the project and JISC funding
- young researchers and (change in) their use of these types of environment[24]

All four reports are expected to be available early 2010.

Aim phase 3

Phase three started this year and aims at **dissemination**; rather than financing more pilots, it focuses on the question whether more standardized solutions are possible. It has three priority areas:

1. smaller projects, for development of specialized tools
2. framework projects: how to connect tools within a discipline together in one environment
3. interoperability projects: how do VRE's link to other components in the research cycle or their research institute. This entails involvement of e.g. libraries, institutional repositories.

[23] www.jisc.ac.uk/publications/reports/2010/vrelandscapestudy.aspx
[24] www.jisc.ac.uk/media/documents/programmes/vre/earlycareerresearchers.pdf

Specific activities

To support the successful **embedding** of the larger projects in their organisations, a call has just been issued for small projects; these must address particular problems and issues involved in embedding that could not be tackled in the previous large projects. The call is aimed at young developers in universities, not necessarily in IT departments, with the two-fold purpose

- to support small projects that do not receive funding by the institution,
- to enlarge the community – and thus basis of knowledge - involved in development of VRE's.

Approach

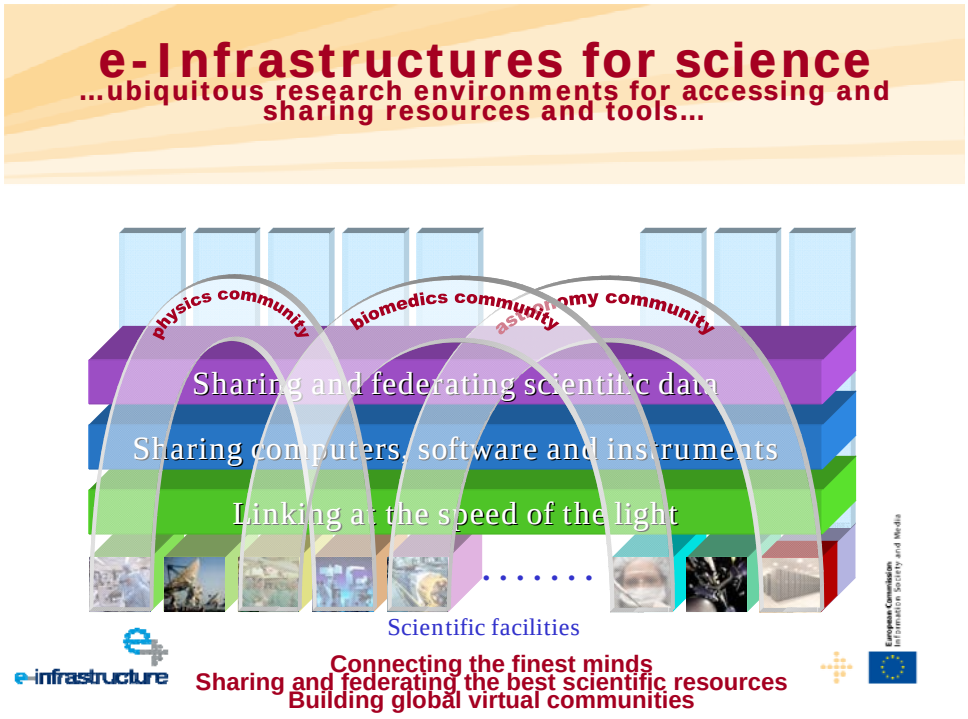
The VRE-programme has followed a **bottom-up approach**: it started out with grassroots projects and is now trying to translate the results and experiences to a larger target group. The difficulty in this approach lies in the generalizations needed for the larger target group, which may make it less easy to apply and absorb[25].

Importance of the community

What has become very clear from experiences so far is that it is vital to build the community simultaneous to building the technology. The issue of collaboration and sharing is one of the few issues generic to researchers in varying disciplines and it is therefore one that can be used to bring them together. Financing this is as important as financing the building of the systems.
JISC plans to **tender the set-up and maintenance of the VRE Community**, where all information and knowledge gained about VRE's can be collected and made available on a continuous basis; this will also support the continuity of the JISC programme.
Furthermore, wider adoption of VRE's is necessary for increased impact: "you cannot do a lot with one telephone either".

EU

The EU, in the context of the Framework 7 Programme, have a Call for Tender[26] focussing on Virtual Research Communities projects – as they phrase it. **VRC's** are seen as **part of the development of e-Infrastructures** in Europe which the EU is stimulating.



[25] JISC's Repository programme followed the opposite, centralized approach; difficulty there was that people had problems identifying with a centralized system.
[26] As part of the FP7-INFRASTRUCTURES-2010-2 Call, http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.CapacitiesDetailsCallPage&call_id=263#infopack

Figure 5: *slide from a presentation by Wim Jansen, EU Commission, at the DRIVER Summit October 2009 in Gent*

The Call aims for:

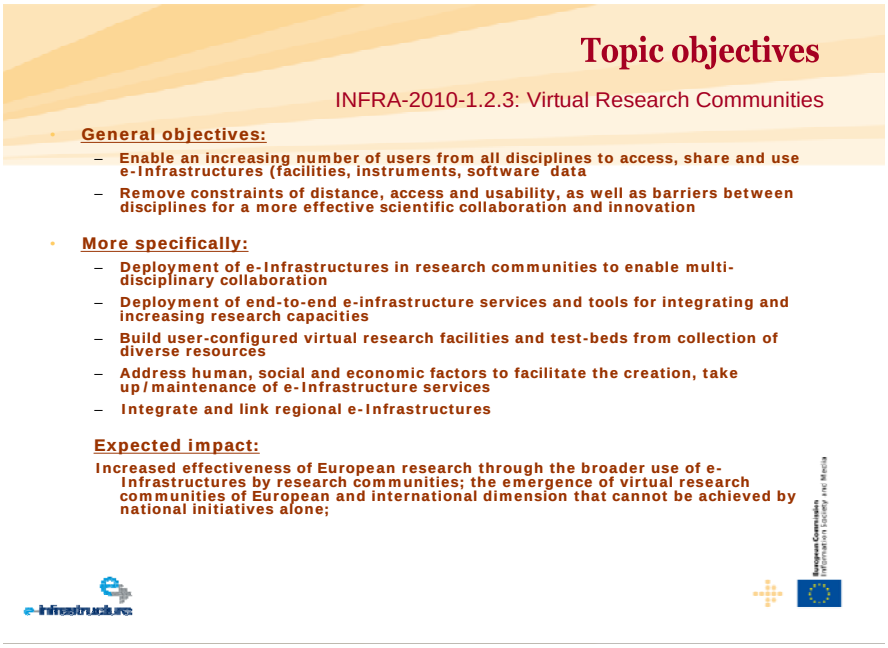


Figure 6: *slide from a presentation by Wim Jansen, EU Commission, at the DRIVER Summit October 2009 in Gent*

The Call closed on November 24, 2009; at the time of writing this report, no information was available yet on number and type of projects submitted or granted funding.

Knowledge Exchange

The Knowledge Exchange, a joint initiative of DEFF (Denmark), DFG (Germany), JISC, and SURFfoundation, has also defined a VRE programme. It is in its early stages, and a workshop is planned for June 2010, where projects will have an opportunity to present their VRE's and next steps to be taken in the field of VRE's will be discussed.

As part of one of the Knowledge Exchange´s other programme activities, a workshop was recently organized with researchers from a range of disciplines about the drivers for re-use of data. Some significant results:

- Humanities and Social Sciences are reporting the need for storage capacity as well as re-use of and tools for audio-visual materials; all of these are surpassing the means and capacity at individual institutes – similar to the sharing of expensive instruments in the (life) sciences.
- Increased acknowledgement that collecting large datasets – which may still start as an individual effort in the Arts & Humanities – is better done in a joint effort.
- A third driver is publishers asking for references to the data covered in a publication.

Since VRE's are often the place where researchers share and work collaboratively on their datasets, VRE activities and research data activities are seen as closely related.

4.3.2 Collaboratories and e-science infrastructure in The Netherlands

e-Infrastructure

As shown already in the EU vision, collaboratories are seen as a component in the larger e-science infrastructure that is developing, on national, European and global levels. In The Netherlands, the thinking and the developments in recent years have led to ideas for the establishment of a new cooperative venture – coordinated by SURF - that builds, operates and manages a high-

performance computing and data infrastructure for e-Science. Also an e-Science Research Centre is foreseen, with the two-fold task:

- to research what is necessary to keep the infrastructure up-to-date; what are generic and specific functionalities; what needs to be connected or not; what is necessary in terms of hardware/software as well as governing principles and agreements
- to encourage and advance e-Science in The Netherlands

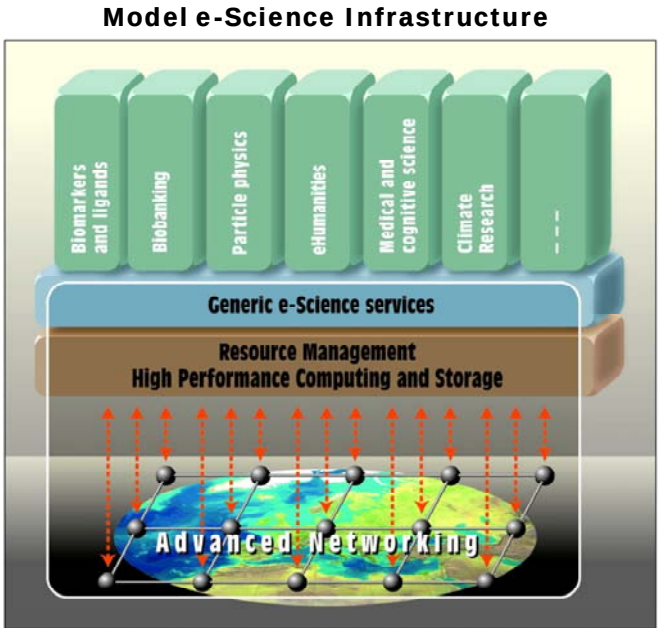


Figure 7: *Slide on e-Science infrastructure from a presentation by Bob Herzberger, University of Amsterdam*

The proposed infrastructure is aimed at providing (better) solutions - integrating ICT and services - for storing, handling, researching, visualizing etc. the increasingly large amounts of data captured (also in the Humanities and Social Sciences) and generated by instruments, simulations and sensor networks. Providing a common infrastructure paves the way for interdisciplinary and multidisciplinary research efforts and collaboration.

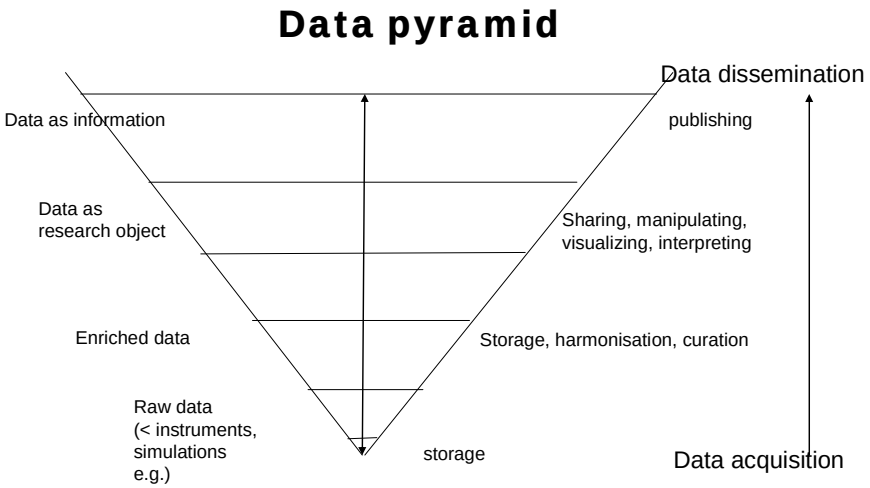


Figure 8: *Visualisation of data handling as an 'up-side-down pyramid', source Hans Dijkman UvA.*

'Data' and collaboratories

Looking more closely at the *concept* of 'data' as the content for this infrastructure, it can be seen to range from 'raw/fundamental' – as gathered from instruments and simulations – to

interpreted/meaningful information – as appearing in publications. Data *handling* covers an equal range, from 'raw data storage' to 'publication'. It can be visualized as an 'up-side-down pyramid' as can be seen in figure 8.

Collaboratories play a role on the different levels of data handling – one could argue that the grid is in fact also a type of collaboratory. The degree of (possible) collaboration does differ at the various levels as illustrated in figure 9.

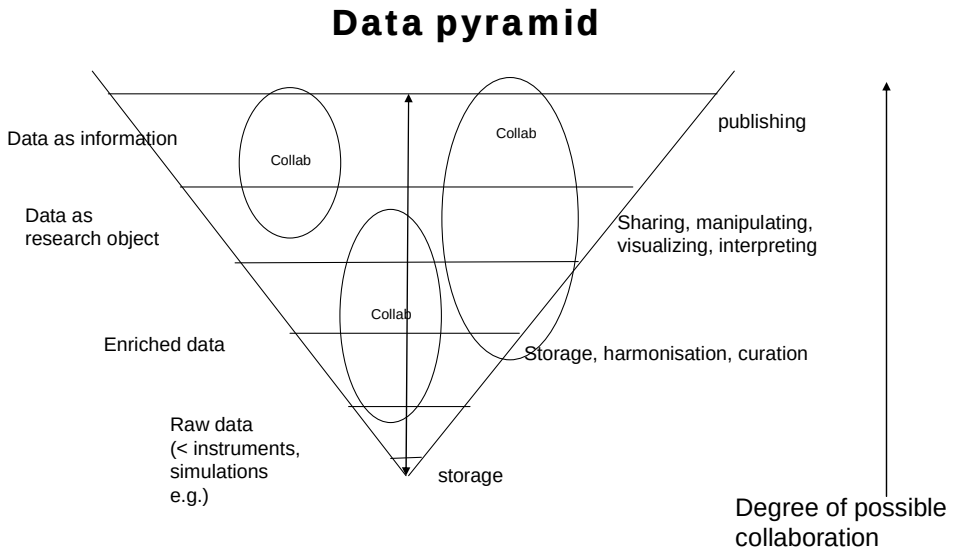


Figure 9: *Degrees of collaboration at various levels in the data pyramid, source Hans Dijkman UvA.*

Awareness of the importance of sound solutions for capture, long-term storage, curation, harmonisation, manipulation, open access compliancy etc. of data has grown substantially in the last few years, across all disciplines. There were too many painful examples of data that have disappeared over time.

At different levels demand is developing for solutions for (large) datasets. Solutions may be found at an institutional level – e.g. for datasets that are deemed not suitable for DANS (e.g. in terms of size, scope, archiving horizon); or at a national infrastructural or international discipline-level - e.g. in CESSDA, DARIAH, and CLARIN[27]. This demand also calls for connections between databases/data-repositories plus a variety of handling tools on the one hand and collaborative environments on the other, to support the different stages of data handling as indicated in the pyramid.

The activities that are necessary to make data suitable for sharing – such as curating, agreeing on standards for linking and integration, harmonizing existing datasets – are typically activities that need to be done in collaboration between parties involved. So they are in themselves an incentive for the formation of a collaboratory; and this may evolve over time into a joint research collaboratory (e.g. the Digital Collaboratory for Cultural Dendrochronology is set up that way). But the time and investment needed can be a deterrent – for the factors influencing this see Chapters 5 and 6.

[27] Large-scale infrastructure projects in the Social Sciences, Humanities and Linguistics that are primarily aimed at making all data accessible and subsequently interoperable based on common standards. This as the first step towards linking data to other sources, tools, publications, questions etc. – the precondition for e.g. new research on existing data, verifying existing research, replication studies and enhanced publications.

Data, collaboratories and enhanced publications
Collaboratories bring together a range of research activities: data gathering, enriching, interpreting and publishing about the research findings. This integrated research environment allows for new ways of presenting and publishing the research – as in enhanced publications.

What is an enhanced publication?
An enhanced publication is a publication – usually a text – that has been enhanced with additional material. The publication may be an article in a journal, a dissertation, a report, a memorandum, or a chapter in a book. It must involve scientific or scholarly research and contain an interpretation or analysis of primary data or something derived from it. The supplementary material may consist, for example, of research data, illustrative images, metadata sets, or post-publication data such as comments or rankings. The option of changing post-publication data allows an enhanced publication to develop over the course of time.

Collaboratories are a most suitable place to work on enhanced publications; vice versa, enhanced publications are a natural stimulus for (work in) the collaboratories. eLaborate can be seen as an example of this, despite the fact there is as yet limited extra collaborative functionality in addition to the tool developed. This is the direction things will be moving in, as can be seen in the RIC and eSciDoc projects, which both support creation of enhanced publications. An impression of its potential can be seen in the SURFshare Tender projects of 2008 that focused on Enhanced Publications (see also the Report on Enhanced Publications – Next steps, by Martin Feijen in Dutch with English summary). Similarly publishers' efforts such as the Cell Press 'Article of the Future' and 'Enhanced Snapshots' projects and PLoS' Exemplar Semantic Enhancements of a Research Article[28] also seem to have been moving towards a more enhanced version of publications.

4.3.3 Publishers

Obviously, publishers are also experimenting with initiatives to support collaborative research work and publications. It is not possible to give an elaborate picture – the more strategic initiatives will be taking place behind closed doors for commercial reasons. Some examples from publishers based in the Netherlands are available, though, and indicate the direction they are looking at.

Amsterdam University Press
AUP is working on two collaborative environments:
- One aims to support a European network of researchers in the Humanities involved in comparative research in the area of 'Performative Literary Culture'.
- The other is a project with IMISCOE (Network of Excellence on International Migration, Integration and Social Cohesion in Europe). They are setting up a collaborative environment for the education and training of master and Ph.D. students in the field; and for the publication of information from IMISCOE in such a way that it will also be useable for national and European policy-makers. The basis will be a series: IMISCOE Textbooks.

Both projects use Sakai, and the infrastructure of the University of Amsterdam. AUP is also involved in projects creating Enhanced Publications - e.g. the Journal of Archaeology in The Low Countries, and initiatives in the social sciences (enhanced monographs) and film studies (integrating a database in online publication platform). These projects seem to focus specifically on the publication (process) but could easily be extended forwards to earlier stages in the research process.

Elsevier
Elsevier started the Grand Challenge initiative in 2008, "an open innovation competition inviting researchers to prototype tools dealing with the ever-increasing amount of online life-sciences information." Lessons learned from this contest gave rise to the concept of the 'new conference', to

[28] Shotton, D., Portwin, K., Klyne, G., Miles, A., 2009 Adventures in Semantic Publishing: Exemplar Semantic Enhancements of a Research Article. PLoS Comput Biol 5(4): e1000361. doi:10.1371/journal.pcbi.1000361

support and facilitate the entire process of setting up a conference and publishing its results in a new, dynamic way. It includes novel approaches to

- identifying emergent communities,
- open selection of speakers and abstracts (including voting),
- communication preceding/surrounding/following the conference on its topics (not just its organisation), and
- publishing (including, possibly, Enhanced Publications).

A pilot project will focus on four issues related to the innovation of research communication and publishing: Semantic Web, Computational Linguistics, Publishers and Libraries (digital repository community) and Sociology of Science. Elsevier Labs will build the environment using the Drupal-based Science Collaboration Framework created at Harvard.

Since 2007 Elsevier has been running the free, though not open sourced, collaborative online research tool 2Collab. Researchers can use this to store, evaluate and share research information. Its main focus is on managing and sharing bookmarks and references. Much like Elsevier's 2Collab, the Nature Publishing Group hosts a similar free and open source reference management tool named Connotea.

Springer

Springer is involved in various technology-initiated experiments, focussing specifically on content-oriented activities (e.g. CiteULike, author-mapping, image dabatases, protocols) rather than medium-oriented activities (such as Twitter or Facebook). As a publisher, they see their role primarily in the organisation of the process to create quality content. And in providing added value – researchers cannot be expected to do that themselves.

Another current experiment is the creation of reference works that are published on a ongoing basis, using wiki-like systems and semantic web-technology. They see such experiments as first steps that will help them understand what these technologies do and bring, what their own role can be in these new processes and what the new business models could be. It will also keep them in the front of developments.

On the other hand, there is the dilemma of the speed of uptake – it could still take decades before these innovations have been fully integrated. In their view, technology is not disruptive in itself. Academia does invent a lot of new things, but is ultimately very conservative with respect to their own traditions.

Potential role of publishers and libraries in collaboratory development

Publishers, repositories, libraries and other research support staff may all have a role to play in the development of collaboratories. Where the demarcation lines will be drawn remains to be seen.
Publishers have the advantage of their experience in discipline-oriented networking with authors and editors; and of existing 'brands' that function as quality labels. They are also well-advanced in ICT-supported publishing workflows and database-publishing; and experienced in turning new project developments into (sustainable) products and services.
On the other hand, commercial publishers' interests may make them less inclined to move quickly or take the lead in innovative developments – for fear of being too far ahead of the market. It is interesting to note, though, that many authors claim that they themselves would be willing enough to try out something new, but their publisher will not allow it. Both parties may be showing signs of what Michael Nielsen calls an **'immune response from an incumbent system'**[29]; the interdependency between the parties keeps them both locked in.

Commercial interests may also make publishers more inclined to **stick to proprietary standards**, rather than supporting open source and open standards. In that sense, publishers are to the creation of content what Microsoft is to the development of software tools. In the debate about data it has in any case been stated that data harmonisation, curation and interoperability should be dealt with in the public domain, to avoid the risk of giving away (again) the possibilities to develop services on top of the data to publishers only.

[29] Is scientific publishing about to be disrupted? Michael Nielsen, June 2009

5 Experiences

This chapter sums up a variety of important experiences and observations reported by the interviewees and the projects covered in this study. Some information from international literature is also included.
Experiences and observations are grouped by aspect:

- technical
- functional
- organisational
- policy/legal/financial
- cultural

The observations are listed fairly randomly within these categories and may be covered in several categories, from different angles. They may contradict each other; no effort has been made to explain that away.

Organisational, managerial and cultural issues
The organisational, managerial and cultural issues play a more important role especially in cases where data management and the introduction of collaboratories are part of an institutional policy (e.g. VKC project at Utrecht University), in collaboratories that form part of a larger-scale infrastructure (e.g. CESSDA) and in collaboratories that support long-term research programmes or a range of research programmes (e.g. Tales of the Revolt, eLaborate). Where collaboratories support shorter-term or ´one-off´ research projects, the systems and the managerial/organisational structure can be more lightweight because sustainability is less important.

5.1 Experiences on technical aspects

Interoperability / integration
As components in the wider e-science infrastructure environment, collaborative environments need to connect with other systems and tools, such as repositories, publication systems, research tools, databases, multimedia files, public websites etc. Several people report that such **connections are not easy to implement yet, and require significant programming effort** – despite the claims about integration possibilities and interoperability in systems documentation. Seamless authentication and authorization is one important issue. This is also relevant for cultural aspects, see also § 5.5. The linking up with repositories has also been mentioned as complicated. Systems are considered not sufficiently modular for research purposes. Sharepoint is mentioned most often as difficult (linking with repositories and systems like RefWorks/Zotero) because of its proprietary nature and intransparent code. This also concerns Sakai, this was confirmed in the White Paper on Sakai 3.0[30]. Nevertheless, Testweeklab managed quite well within the limited timeframe of the project in connecting up with Fedora as a repository.
No complaints were reported from the Hublab project on Liferay in this respect, though they did build in some extras. The project uses the software in a very 'lean and mean' version following the wish of participants for a simple and straightforward environment.

The newer generation of collaborative environments, e.g. eSciDoc, Sakai 3.0 and RIC, seem to tackle this issue in their architecture; but no experiences with these systems were available for this study.

Options to work offline
Even an online collaborative environment may need to offer the option to work offline and upload one's contribution, e.g. in case of insufficient bandwidth or large amounts of data. Provisions for this, such as synchronization and information on who updated which portion of the database/text at what stage, need to be available or implementable.

[30] http://confluence.sakaiproject.org/download/attachments/26444008/Sakai+3+Proposal+v08.pdf?version=1

Examples
In **Hublab**, the communities are spread out over the world, and work from home regularly; they use the environment to co-create large databases. They work on their contribution offline, and upload it. A tool was developed that joins everything together, while the original contribution remains visible and can still be verified.

In the **Collaboratory for Dendrochronology** each member gets a local version of the database in which one works and to which one can connect for exports and imports.

Expert programming help and other support
Adaptations to Sharepoint have been necessary in a number of projects; working with experts on these changes has made things easier. This meant hiring outside help from a specialized supplier. The same has been true for adaptations to Sakai in Testweeklab.

Examples
PARTNER has added an overall calendar that combines agenda items from all different places in the collaboratory, each in their own colour; you only see what you are entitled to see. The web part which made this possible was bought. Also, their contact details application has been extended with extra fields to accommodate the use people started making of it for their CV/profile. The News Channels function combines a number of RSS feeds. For the EBCR project, a repository was added for documents in process. Work is in progress to link up to the Refworks application.

Tales of the Revolt has built an application via 'Lists' to import the bibliographic data collected in Zotero. The RIC system has such a reference management functionality built-in.

A drawback of Sharepoint appears to be that 'things just break down and stop working'. This, too, requires specialized support.

In the earlier phases of the SURFshare tender projects, objections to Sakai were that they had no or a weak release policy, and that there was a relatively small development community. This may be a matter of time, as the product matures (the development of Sakai 3.0 seems to promise this) and the number of installations grows (>170 in August 2009). One of the interviewees is involved in the Sakai community and reports it to be very dynamic, well-functioning and supportive.

5.2 Experiences on functional aspects

Focus of functionality
Sakai has an educational focus. It has been seen as an open source alternative to existing electronic learning environments, also offering more flexibility and capabilities. This focus has prevented its use in a number of cases, where the application was pure research – despite the fact that Sakai is also meant and used for such purposes. Sakai 3.0 will be fundamentally different from the previous versions; amongst other things it will include more and better collaborative content creation and social networking functionality, thus aiming at better application in research and administration.

Sharepoint's development reflects a more organisational focus, and offers a multitude of possibilities ("they try to draw everyone in and therefore put everything in one system").[31]

[31] This also goes for most other systems covered in the functionality matrix in appendix A, but their modularity seems to be better. Drupal was developed in a research environment, which still shows in its focus on collaborative writing (rather than document management).

Extent of functionality
Contrary to Sharepoint's philosophy, however, in practice **one size does not fit all**: some people want to try out all sorts of tools (e.g. participants in the Virtual Knowledge Studio), others do not or do not ask for them (e.g. historians, literary text researchers). They may have difficulties with the simplest features, and do not want much more than Office and/or the bare tool they need for the joint work on their text or database.

The drawback of Sharepoint's extensive functionality is that **overview** is lost. There are too many different ways to do the same thing, it is not clear how things work or where you are in the system; and often it is just a click too many to be able to do what you want. This puts researchers off, even the more experienced ones: if the system does not seem to do what they expect it to do, they stop. If it takes too much time to learn, they stop. They revert to their old and trusted tools, even if they are inferior. If the new system is easy to use and it pays to work with it even for just half an hour, this will not happen.

Sharepoint is quite tweakable though, and can be downgraded. For instance in the VKS project they have opted for simplifying it. In the PARTNER programme, the workspace functionality for projects has been adapted into a portfolio functionality for research master students.
Some Dutch universities of applied science have tried out Sharepoint as a full-blown Electronic Learning Environment, but that does not seem to work well.

The criticism of Sharepoint led one interviewee to the observation that people may have **higher expectations of Sharepoint** than of systems like Liferay; and they may therefore be disappointed, or less forgiving.

Liferay is 'light' compared to Sharepoint; it does need some study, but not to the same extent as Sharepoint. The software is very well suited to the Hublab project's purposes. Liferay works with standard 'portlets' (cf web parts) that can be added as one likes. It is also relatively easy to adapt the look and feel to fit a specific corporate design and personal preferences – which is something researchers really like to have.

Hublab has built a mail tool which includes a member list and the possibility to mail (a selection of) members from within the collab.

There were **no reports of experiences with the complete set of Google Apps**, just with individual items from it. Google Docs is too strongly concentrated on the creation of one document; it lacks too much functionality. Google Calendar was chosen in VKS by the researchers as the joint calendar function, as being more fun and easier than the Sharepoint one.

Growing demand for functionality
Actual use of collaborative environments triggers further demand for functionality, and for linking to more or other resources. Once people start to work in an environment, they start seeing new possibilities and want them realized. A coordinated programme approach as used in VKS, Hublab and VKC facilitates getting them on the table, finding commonalities, prioritizing developments and managing expectations.

Effect of online functionality
Use of collaboratories gradually leads to rethinking the way research is carried out, as has also been pointed out in the JISC and Science of Collaboratories projects. Dutch projects show that online text-editing enables possibilities (such as categorizing and filtering annotations) not available in traditional book publishing, because cost and ergonomic considerations do not play a role anymore. This enables much richer publications, more extensive and complex (quantitative) research and better validation of research results. The Dendrochronology project brings together tree-ring data, covering approximately 8000 years, in one online environment and adds rich tagging; this opens up completely new avenues of (interdisciplinary) research, new ways of presentation and better validation of results. Such improvements in research will help towards being taken more seriously in the funding cycles.

5.3 Experiences on organisational aspects

The people - leadership
Actual involvement of (senior) researchers and local champions, and time spent by them on the project, is crucial. It cannot just be left to junior staff or support staff, even though they can do the bulk of the work. Those projects that are initiated by researchers themselves, with an enthusiastic leader, whether he or she is project manager or not, appear to work best, both in the start-up phase and in the project's continuation. Lack of an active senior champion results in petering out. In a number of cases, (Ph.D. and Master) students do most of the work; this works out well – they like being involved in these new ventures - provided there is continued enthusiastic leadership. If there is not, there are transfer problems with respect to the other collaboratory members. Another important factor here is that the collaboratory is well suited to its target group.

In projects initiated by supporting departments, this **community building** aspect has in some cases been underestimated (importance, time/energy needed). Here, too, strong backing by senior leadership is an important factor.

Enthusiastic leadership fuels participants' enthusiasm. The opportunity for project participants to assume problem ownership and responsibility is important for the development of true collaboration, and requires hands-off management on the part of the project leader. Where the relationship is seen – implicitly or explicitly - as a customer-supplier one rather than a collaborative one, the project has a much harder time coming to fruition.

Examples
The Utrecht University's **PARTNER** programme has dual programme management: a professor and a senior lecturer, both with IT expertise in addition to their original subject specialty, have been appointed part-time. One is responsible for process management, embedding in the organisation etc., the other focuses on the direction of further development of the programme and the VKC environment. This has contributed very strongly to the success of the programme. Individual VKC projects in the programme work best where a senior researcher/educator is closely involved with the project. All projects are set up in close cooperation between PARTNER programme & project management and the research group/faculty.

The project leader of **Collaboratory.nl** points out as a strength of the project that it was a true collaborative relationship, not a customer-supplier one. All partners participated, by providing funds, but also with dedicated time from experts and management ("It is not a hobby on the side").

The people – project management
Collaboratories can be complex and long term projects. In that case, they require stable project management, strong project management skills – which is not equal to knowing Prince2 - and sufficient time and manpower allocation. This appears to be underestimated in many cases (as was also brought forward in the Science of Collaboratory project). In project proposals project management is treated more as 'overhead' rather than as actual time to be spent. A compounding factor may be that funding programmes' financing of project management/support is often fairly limited.
Another plaguing issue is that not all organisations have proper (book keeping) facilities for project administration; this results in a lot of manual work for project leaders in their reporting duties towards the funding agency.

Project management can be done by the senior researcher involved, but can also be delegated provided they maintain good communication and consultation about direction and progress.

Example
The Utrecht University's **PARTNER** programme has appointed two project managers: one for the start-up and implementation of new VKC's, and one for the support and development of existing VKC's. The latter is an important factor for the continued success of a VKC. As people learn to work with the VKC, they start seeing better uses of it for their everyday work; this natural development needs support to keep the VKC alive and improve it.

The people – library staff
Library staff / subject specialists need to be involved in collaboratory development and support. Information resources are an important component in collaboratories. Furthermore, in institutions where it is the Library's policy to provide the support for collaboratories, they have an important part to play in the roll-out of the system. It does require them to adapt in the way they work and collaborate with researchers and educators; for instance it requires account manager's competencies in addition to their subject specialism.

The people - diversity
Creating a common language is part of the project work. Different disciplines (researchers, ICT, Library) are involved in setting up a collaboratory and they need to learn to understand each other. This influences the clarity and duration of the discussion about what functionalities are (really) needed, and how they translate to the functionalities of a standard environment. A mediator can help in this process; this can be the project manager or an outsider with that expertise. The ability and willingness to listen carefully to what users express as their needs is another important factor in keeping them at the table.

Collaboratory.nl mentions the participation of different partners from different organisational cultures as a success factor where there is no direct competition – the diversity enriches the project, lack of competition creates more openness.

Clear goals
Groups that have a clear idea about what they want and need for their research fare well. Being a means to an end, **collaboration will not take off if the end cannot be formulated**. If the goals of the collaboratory are not quite clear in the beginning, time needs to be devoted to clarifying them further. This is not easy if you are truly innovating and do not know exactly where you are going; the project is then partly about finding that out. Especially in those cases, clarifying is helped by quick iterative development (e.g. extreme programming).

Communication, communication, communication
PR and communication about all aspects of the project are a necessity, throughout its lifetime, within the project and to the outside world; this entails **much more than publishing about its results**. This is often not explicitly or sufficiently dealt with, whereas it is vital to the success and continuation of the project. It needs constant attention, and therefore sufficient time and budget allocated to it (not just to materials, but also and especially to manpower), to prevent it from being prioritized away by other concerns. It seems to be another vital part of project realisation that is underestimated.

Developing by experimenting
Experimenting with different models of an environment rather than providing a single solution has proved helpful to discover what is needed, what works and what does not. The same goes for having a workshop in which participants can try out the environment. Quick, iterative development also works well, starting with a simple, 'bare' version and adding functionality step by step. The main idea behind this is **that collaborative environments should be tweaked and customized to the users' needs and wishes** to the best extent possible. Development methods like this do require a dedicated person or team for the creation of the site – whether it is just adapting a standard environment to the specific needs of a collaboratory, or building a dedicated environment. Such methods also require quite some time and energy from the researchers involved; they cannot opt out of this process without harming the development.

Helpdesk / support
A dedicated helpdesk and support for (end-)users is needed from the start, especially for more elaborate systems like Sharepoint. It becomes even **more important as use of the system grows, and knowledge of and experience with the systems grows**[32] (e.g. VKC, eLaborate). Long waits for answers to questions are fatal. So is a lack of proper instruction. Researchers simply give up on using the collab.

The support offered by SURFgroepen appeared to be less than expected. In the case of the Virtual Knowledge Studio a virtual helpdesk was set up consisting of five experts from within and outside the project who each have one day per week allotted to deal with questions from users. The involvement of SURFnet staff in the VKS user workshops has also proved very helpful.

Project progress and delays
Development of a collaboratory seems to go in waves. It is not always clear what causes this, but some of the factors involved are:

- teaching obligations having priority
- holiday periods
- budget cuts
- staff transfers
- work carried out by one or a few Ph.D.'s and not sufficiently embedded in the total group, which causes transfer problems
- recruitment of (Ph.D/Masters) students for the project depending on curriculum/time of year
- learning the ins and outs of the system and overcoming barriers related to that
- lack of availability of functionality that is deemed essential (e.g. primary data storage and handling capabilities).

People can start out quite enthusiastically, and can see the time-saving advantages of the system, but if they are not kept involved on a regular basis their engagement dwindles.

Projects such as the SURFshare tender projects, setting up collaboratories within a fairly limited time-frame, are affected in their progress, because of such phenomena.

On the other hand, **special events** such as the workshops organized in Hublab, **have the effect that activity in the collab is heightened** around that time. The Amsterdam constituency in VKS has (face-to-face) research meetings, which are conducive to the use of the online collaboratory.

The Automotive project reports that in the applied research and education environment, the issue of time pressures due to teaching obligations may be even more severe than in the academic environment; there, at least, research and writing are traditionally a significant part of the job. Projects may receive support from the higher levels in the organisation, and may develop good workflows and procedures, but it is not a given that this reaches the people who actually have to do the work.

Working bottom up does establish the contact with the right people, who are willing enough to join in; but even then fitting it into existing tight work schedules is a challenge. This has affected the Automotive project itself, and also the collection of materials in the HBO Knowledge Bank, which was supposed to provide the basic materials for the Automotive project.

Contextual issues
Collaboratories in which **more than one institute or organisation** are involved seem to work better than those based in one institute. Getting such a collaboratory to work, though, may take a lot of time and energy. Alfalab for instance has taken approximately two years to get people aligned and working together in the same direction.

An issue specific to the applied research and education area is the often relatively **short timeframe** for (contract) research projects; this makes it difficult to set up or learn to use a

[32] When people grow more accustomed to a system, their demands on it increase, with respect to use, required functionality and required support.

dedicated collaborative environment. This applies especially if people are not used to working with them – as can be the case with small and medium sized companies (including freelancers or groups of freelancers). It does not mean that there is no need for collaboratories.

Work processes and procedures
The way work is organized within a collaboratory differs substantially. Some are fairly loosely organized, some develop codes of conduct (e.g. file naming conventions to facilitate searching and finding, versioning). In some cases, all community members are responsible for maintaining (a part of) the site; in others the work is assigned to specific people. In cases where work processes and roles are more structured this does influence the demands on the rights and permissions structure within the system.

Contribution to innovation in the institution
Collaboratory development can trigger demand in other areas and can thus function as a **catalyst for innovative developments** in an institute. Examples are:
- storage of materials (theses, publications, data) in repositories may be stimulated because they are needed in the collaboratory
- 'personal library pages' trigger demand for 'group library pages', which call for added functionality in the tool for 'discipline library pages'

To exploit the possibilities to a maximum without duplication of effort, it requires:
- a good overview of current relevant projects,
- willingness to collaborate between projects, and
- resistance to the urge of one project taking over the other.

Participation of the library in collaboratory development means that the library remains involved in new questions about information storage and handling, also those originally outside her domain (e.g. data). Thus, the library more or less automatically changes her role in accordance with the changing research environment.

5.4 Experiences on policy / legal / financial aspects

Political and managerial support
Many interviewees report that there is sufficient to good support at management and board-level of their institution for initiatives such as collaboratories. For instance the Royal Netherlands Academy of Arts and Sciences has made e-research in the Humanities a priority area. The International Institute of Social History has the strategy to be a big player in its field and building large databases has been set as a core task; this generates institutional commitment. University boards and department directors see the strategic importance and opportunities of the new developments. Some university libraries (Utrecht, Amsterdam, Leiden) see the support of collaboratories as a potential new service to research and education.

One interviewee warned that it might be **difficult to retain the present level of commitment** over a longer period of time. The regular pattern seems to be that after a number of years, enthusiasm at the management level for experimenting dies out; incidents influence long term policies; and the recurrent centralisation/decentralisation movement interferes. A complicating factor in the case of online developments is that projects tend to **cross institutional borders**; this poses new questions about the division of responsibilities and funding that cannot be solved from the institutional perspective. Collaboratory development also triggers a need for collaboration between institutions' management.

Support from an institution's central IT department is important, but whether it is crucial depends on the strategic ambitions of the organisation. At the national level, political and managerial support is reflected in the proposed development of the new e-infrastructure indicated in § 4.3.2.

Funding
The prospect of continued funding is an important factor in the uptake of collaboratories. If people are not convinced the project will continue after its project stage, they are not inclined to invest their time and energy in it. This is especially important for institutes or research groups whose parent institution does not offer collaboratories as a (centrally) supported facility, as is done by Utrecht University, Erasmus and KNAW. But this also applies for the funding of large scale data enhancement projects for storage and re-use in collaboratories.

The Collaboratory.nl project shows that the **shared investment and shared risks of collaborative or networked innovation is cheaper** for all parties concerned. This is an influential factor since the project developed ICT-infrastructure which was not the core business of any of the industrial partners. The project also shows that the investment may have **efficiency gains**: once the environment worked properly, project partners started to carry out paid experiments for each other; these turned out to be a factor 2.4 cheaper than before, despite the fact that during the experiment itself, more people were involved[33].

Security and privacy
In some areas, security and privacy issues in relation to data are so important it may not be possible to solve them in a completely open access environment. Examples of medical data and personal data from social research are well-known. But this also holds true for the Dendrochronology project, which covers datasets originally gathered at significant cost by private companies; for them to be willing to cooperate, a fine-grained rights and permissions system is required that enables them to decide for each instance who has access to what information – not necessarily at a fee.

Also, the institutional environment can create difficulties. The **traditional approach to security** of the institutional IT-systems can hinder the implementation of fully integrated collaborative systems that allow for external participants. The latter is essential with a view to the international nature of research, but also in the applied research environment where companies providing contract research or apprenticeships need to be able to join in. Having the collaboratory in a separate place, a 'de-militarized zone'[34] that has more lenient rules than the university network, may work. It does require on the one hand arrangements between the segmented areas to deal with 'compromising actions'; and on the other good synchronization possibilities between files to prevent version problems.

Legal issues
Software-as-a-Service platforms offer **external storage.** This gives rise to questions like: where are the servers located, under which jurisdiction do they fall, and how does that influence the work of the collaboratory? Researchers are not always aware of, nor interested in such issues – it is an important matter for project management and the involved organisations to deal with.

The same holds true for **IPR (Individual Property Rights) issues**. They can concern materials used in the collaboratory, and materials or results produced by the collaboratory. The more participants, the more diverse the participants, and the more international spread among participants, the more complex these issues become. The level of awareness of these issues and the need to deal with them varies considerably, also among funding agencies.

Regarding the issue of **materials used** in the collaboratory, publisher's licences for the (re-)use of their publications are not yet aimed at the 'virtual community' organisational level. If participants' institutes all have the same publications covered by their licences, this may not be a problem in principle (though in practice, authorization and access may prove difficult). If licences differ, an arrangment will have to be made. As long as the number and size of collaboratories is limited, working with 'guests' is possible. But whether this still works when the collaboratory grows is

[33] This information was obtained in the interview with the project leader of the collaboratory.nl project.
[34] This is how the Utrecht Medical Center has solved the problem for its researchers who need more freedom, e.g. for international cooperation, than can be offered in the medical environment.

doubtful. Similar considerations go for licences for software tools used in the collaboratory (e.g. RefWorks).
Obviously, **widespread use of open source, open access and creative commons licences would alleviate these problems considerably**; as was pointed out before, using collaboratories could therefore boost those developments.

Issues with respect to **the ownership of materials, results and products produced** in the collaboratory can complicate matters. Where good, standardized contracts or arrangements are available – as in the case of Collaboratory.nl with Novay, or in LabsOnline with the Digital University – they can be dealt with in an early stage and are of no further serious concern during the project. Other projects start off on the basis of the **'do ut des' principle**[35], or make the IPR/legal arrangements part of the project. Practices and urgency also vary in accordance with the nature of the project: are there commercial parties involved? Is it pure research or pre-competitive research & development?, Are there any direct competitors among participants?

5.5 Experiences on cultural aspects

Differences between users
Distinctions between types of users are reported, e.g. the group that is always online and looks for online solutions, and the group that looks for solutions on their own network drives. This **distinction is not necessarily based on age or discipline**. "If people weren't open to new developments in the past, they will not be now" one interviewee said. It was also pointed out that although young people may already be used to new ways of working, they have more to lose than established researchers and are therefore less inclined to push the experiment; whereas the established ones may be more stuck in their routines. One interviewee noted that the distinctions are too anecdotal to generalize, and that the literature also argues against doing that.

Fit in with work routines
Standard environments are often criticized by researchers and teaching staff for not being sufficiently suited to their normal work practices; therefore, they choose a different environment, go for own development or stick to the existing known systems. However, **standard environments often have far more adaptability** (not just in look and feel, but also in functionality) than people realize. The PARTNER experience shows that proper guidance and assistance in demonstrating, adapting and implementing such a standard environment can make all the difference in how the environmemt is perceived.
Where reluctance to the new system remains, there may be deeper issues at stake, such as unwillingness to let other parties influence the daily research practice.

The use of online collaborative environments changes the way people work. This is a gradual process. Working in such an environment can enable easier presentation and sharing of research results, and handling larger datasets. For many users, it is already a big step to share documents online, in a neatly arranged environment.

There are disciplines in which it is tradition that you keep data to yourself i.e. that you build your own database; when researchers in these areas are **confronted with 'ideals' of collaboration, rather than with something that practically supports their research**, they may have difficulty accepting the changes.

Change affects behaviour
On the other hand, once people start using a collaborative tool, it automatically affects individualism in research and work routines, even where it is not explicitly intended.

[35] do ut des: Latin for "I give, so that you may give"

Examples
Collaboratory.nl aimed at building an environment in which remote operation of instruments was possible, as well as 'looking in' on experiments by others (e.g. clients with specific domain knowledge). The latter was realised first, as it appeared to be the most easily feasible. And it already appeared to have significant added value for the experiments. Remote operation by others took longer because it interfered with the strong vocational pride in the sector: "it's my machine, should I let you touch it, especially if I don't know you?"

In **eLaborate**, larger groups of people work on text editions, e.g. 25 volunteers work on an encyclopaedia. Everyone can claim what they want to do, coordinators check whether it has actually been done. Your contribution becomes very visible. In this sort of environment, it is no longer possible to stake a claim on a text edition without actually carrying it out (or only years later), limiting one's degree of make decisions one one's own. Cooperation is more or less enforced, because otherwise you will quickly be passed by.

Even early adopters run into unexpected difficulties with the use of new technology. A lecturer experimenting with video recording of his lectures found he became less relaxed and informal because everything is stored and retraceable. Another example is that **group hierarchy** – where it already exists – remains; junior researchers or Ph.D. students can find it intimidating to comment on senior researchers' work, or publish their own early drafts for review, in even relatively secluded collaboratories, because they are not sure their work or input is good enough. "There's quite a difference between commenting in a collaboratory, or in a quick face-to-face at an informal meeting" one interviewee remarked.

Barriers to change
Even where people are willing to change their ways, there are barriers:

- Where the normal IT helpdesk has been centralized, it has become distant, anonymous and often waiting times are long – whereas one needs a solution *now.* Even if the project offers a dedicated and quick helpdesk, expectations about 'how it works with helpdesks' are different and this keeps people from contacting the helpdesk.
- If a problem persists, people hesitate to keep phoning (they get annoyed or do not want to look incompetent).
- People hesitate to ask for more than the basic software offers; they have learned to expect that their own wishes will not be realized, based on their experiences with office applications.
- It may not be so clear after all why they should use a new tool – "just because it is there?" Being a means to an end, the technology will not take off if the end cannot be formulated.

Institutional slowness and rigidity is a contributing factor in the slow uptake of new developments. **University IT infrastructural thinking is often contrary to the flexibility needed in collaboratory environments**. Traditional ways of thinking among IT support and library staff hampers experimenting. **It is not always just the researcher who does not want to change his/her habits**.

Example
IT departments offer (limited) support for Microsoft applications; however, what needs support is research, documents, researchers, education. In short, the focus (that drives the standardization of IT) is on software rather than on use.

What does not change

The more general phenomenon seen in discussion fora and mailing lists also shows itself in collaboratories: the division between ‘free riders’ and ‘active participants’ (usually the smaller number).

A group that is already a well-functioning community is likely to work better in a collaborative environment than a group that is not. **The collaborative environment does not make them a collaboratory**.

Face-to-face meetings are necessary in combination with other communication means; it is the **variation in communication means** that is important: phone, email, video, forum, face-to-face.

6 Analysis

No standard answers
The interviews in particular make clear that it is neither possible nor desirable to give researchers a clear-cut advice upfront on which collaborative environment is best for their purposes. Nor is it possible to provide them simply with a standard environment with a lot of functionality. Although the academic environment may have more generalities than the industrial environment, in academia too there are many variables that determine the specific context in which a researcher operates.

At the higher abstraction level, needs and tools may be seen to be generic, but **each specific situation still asks for careful scrutiny of what is really needed**. Each research group will have its must-have dedicated research tool(s) that must be brought into the environment, or around which the environment will have to be built - whatever the software chosen. For example eLaborate, Collaboratory.nl and Dendrochronology all have distinct, specific research tools: text-editing tool, remote lab, sophisticated specialized database.

People may also want to tweak the environment, use only particular functionality (blogs: yes, chat: no) and replace tools offered by the environment by others (publicly available or home grown developments) – examples are Wordpress and Google Calendar instead of Sharepoint's own solutions for these functionalities. Such wishes may fall in the category 'nice-to-have'; if they are important for uptake of the system, they cannot just be ignored and support staff will need to consider the effects of not accommodating sincere needs or wants. **Unlike office software, collaborative environments cannot be enforced.**

Software versus 'soft issues'
Having said this, it can be questioned whether the choice of software for a collaboratory is as decisive as has been claimed. **"It is not the software"** one interviewee said. The focus on technology and its promises tends to draw attention away from all other aspects. Furthermore, the choice may also not be as 'free' as may be assumed. Choices seem rationalized, pragmatic or dictated by institutional policy.

Decision making also depends very much on who initiates the collaboratory: the researchers themselves, or supporting departments in the institution that offer the facility. Lack of acquaintance with what software is available, and what exactly it has to offer also plays a role in decision making.

Whether a collaboratory is successful could well depend more on the **eagerness** of the researchers to work together on a project in this new way than on the software they use – as one interviewee stated: "because we are already a proper collaboration we take the shortcomings of the software for granted; if we hadn't been, people would have withdrawn already".

Willingness to change work habits for the sake of the benefits of collaboration is another factor that may influence the success of a collaboratory more than software. Whatever software is chosen, its use will cause a change in the way one's work is done; that requires adaptation which may be difficult or impossible for people. On the other hand, it is not yet clear either how far and how fast this change has to go.

Example
On the one hand, the wish to have email integrated in the environment can be questioned: if you use the environment to its full potential, email could be dispensed with. The existing email routine drives expectations and demands of the system. On the other hand, mailing lists function well for many people as a means of exchanging ideas, etc. The advantage of the collaboratory with its fora or blogs for this purpose is that the discussion is stored and remains accessible over time. The assumption is that repetitive discussions on the same issue will occur less. However, permanent storage may not be a priority at all for the researcher working in the environment. As the Hublab project management says: "they are historians, not archivists." And it is not a given that storage will prevent discussions from being repeated. Functionalities are fuelled by normative ideas about how things should work, but the starting point for implementing should be: facilitate actual use/needs. "It isn't 'wrong' if some things don't get used" one interviewee said.

Furthermore, it is important to remain aware that who needs to change his/her habits may be a matter of perspective: is it really the researcher in all cases, or also the library or IT support staff? In the joint discovery of how a collaboratory can be made to work, **all parties involved will have to be able to reflect on the aptitude of their present working methods** in the new environment.

Not knowing is part of the game
Collaboratories, though treated as projects, are in actual fact experiments: discovery of new tools, new ways of working, new effects on behaviour, etc.. Not knowing in advance what you need or what the outcome will be is central to this. It is often easier to say what does not work than what does. From what does not work new ways of working develop. This affects all parties concerned. As one interviewee said: with its digital services, the library is entering the (research) space of the researcher, in a more intimate way than before. To make it work, and stick, requires thinking from a researcher's perspective, rather than from a librarian's perspective. The difficulty that such a change in perspective always poses is compounded by the fact that researchers themselves also do not know how their research practice will develop in these new circumstances. So the quest to create and work in a virtual, information-rich, environment becomes a **joint discovery path**. This also requires 'prodding' researchers with tools and facilities they have not expressed a need for – because you do not ask what you do not know. The interesting puzzle here is: how much 'noise' do you accept, how much delay, how much insecurity, openness, how much information overload. The answer will vary per discipline, per collaboratory, per individual. It is a subtle balancing act **how to deal with those diverse preferences, without indulging in idiosyncrasies**.

Development in waves
With a view to this experimental character, development of collaboratories in waves may well be the natural way of things and not necessarily a sign of a lack of success. This was also brought forward in the Science of Collaboratories project (see Appendix C). It *is* important to keep establishing whether an apparent slow-down is indeed a matter of temporary 'lapsing' as a natural part of the learning curve, or something more fundamentally detrimental to continuation.

What we do know about what works
In the VKSC 2008 project, an article[36] is in preparation on preconditions for a successful collaboratory/collaborative environment implementation; in their view what is needed are **incentives** for people to use it, perceived benefits or usefulness. This could be:
- some urgency among the group members
- people have to be visible / recognized, or paid
- it has to be a large project (e.g. a European project)
- it promises to lead to a prestigious achievement
- there is no other way to do your research (e.g. comparative history)

Project funding on its own will not suffice to create more than nominal collaboration.

[36] Success factors and bottlenecks of the VKS Collaboratory: A workflow based analysis , Kanters, T. & Ashkpour, A. (not yet published)

The VKS does state it could well be that this is valid for collaboration in general; and that the online environment does not really make a difference. This has been noted in the Science of Collaboratories context as well.
Another interviewee states as **necessities**:

- vision
- clear demand
- willingness to do and achieve something.

A third interviewee points towards some **concrete benefits** that should be realized:

- less email overload
- fewer versions of documents floating around
- better visualisation of data and information
- easier to find other people working on the same subject.

Realisation of these benefits should be fairly quick, if not immediate, to keep people interested; if it does not they will quickly return to their old systems. This tallies with findings on the introduction of innovative products and services as reported in the study on Networked Innovation by Van Buuren et al.

The **importance of the emotional aspects** is also stressed: is it fun to share something with others? This can mitigate shortcomings on the 'usefulness' side, but it depends on available facilities or software, the way things are presented. For instance videoconferencing can be a good solution to replace face-to-face meetings provided the facilities are of good quality and sufficient technical support is present. In the Collaboratory.nl project, one of the partners set up a complete 'virtual room' to accommodate the work and it appeared that people found they were much more concentrated and productive.

Furthermore, the perceived need for and benefit of collaboration, though not obvious or relevant to everyone yet, does stimulate developments in this area. Nevertheless several other conditions must also be met:

- institutional commitment
- commitment from research leaders – to make it 'safe'
- a clear, straightforward environment, not more complicated than its target group
- personal commitment from everyone involved
- allow 5-10 years for collaboratories to develop into an accepted phenomenon; a timeframe of 0,5 – 1 year will see successful technical and functional implementation, but more time is needed for such a new way of working to become daily practice.

Career points
The willingness of people to adopt a new way of working has individual variations, but it is also related to the way people are assessed. A point that has been stressed in a number of interviews is the fact that **the present academic career assessment system does not provide for recognition of research and collaboration on data as such**. Assessment is on the basis of (traditional journal) publications. In areas like high energy physics, where an entire group of people are authors of the ultimate publication, this does not matter. But in areas where this is not the case – as in arts, humanities and social sciences – it is an incentive against working on data, and against collaborating on them: someone else might be quicker in publishing about them. Putting time into the development of a collaborative environment or development of tools, or other e-science-related efforts (such as collaboration on curating and developing standards for large data collections) is also affected by it; for that too does not provide any career points if it does not lead to publications. Apart from being an incentive against working in collaboratories, it has the additional drawback that attention in such projects may go towards publishing about it rather than implementing and managing it – which is a job in itself.

If collaboration and collaboratories are to be encouraged, additional assessment criteria are required – and more than just the new metrics created in the open access environment - as a **recognition of the value of a different kind of output**.

Collaboratories, Open Access and security

Collaboratories are not – yet – equal to Open Access. Apart from privacy issues in certain areas, traditional habits play an important role in acceptance of Open Access, also of data (e.g. history, dendrochronology). And there are phases in a researcher's work that (s)he does not want to share with others yet, for example because the thinking is still too premature. Security is one of the issues that is mentioned most often.

So here, too, **more than one solution** is to be available, possibilities are role-based access, access on a membership-basis (not necessarily paid, but to ensure the 'right' people are working with the data), and the possibility to change access rights throughout the life of a file.
Having such permission based access possibilities will help to ensure that people **trust the environment**. And it is important that they work properly; as experience in one of the projects shows: if something goes wrong, the whole world watches.

If a project is started as an Open Access Collaboratory (e.g. eLaborate), the issue of public access to research information understandably has less impact than in cases that are faced with transformation from existing commercial exploitation of research output.

If the change to Open Access brings new benefits, such as new money for research or access to data previously not available, the problem of opening up research information (e.g. an article published by a commercial publisher) that would otherwise be commercially exploited also largely disappears.
But in both cases this may well only be valid for the later stages in the research process, once a work is deemed fit to be made more public. While it is still work in progress, a layered permission system may be required – cf. eLaborate which also has this, with distinctions between work and public environments.

The problem of 'free-riders'[37] can be dealt with by applying the 'do ut des' principle. The Dendrochronology project for example requires researchers to deliver their results and developed templates back to the system, in return for use of the data. And eLaborate provides use of the tool for free, provided the Huygens Institute as the developer may publish the edition produced; the edition may also be published on the website of the project's own institution(s), as long as it is made clear that the Huygens Institute has co-developed it.

Standing on the shoulders of giants?

> "There was also general consensus that it was interesting and reassuring to hear that everyone is dealing with the same types of issues with their collaboratories. But also it was discouraging, as some people wanted to go home from the workshop with solutions, only to find that these were common problems that others were also working on."
>
> Science of Collaboratories, Workshop 19-20 July, 2001, Discussion on Community and Knowledge Base

This statement, made eight years ago, could just as well have been made about the projects covered in this report. Many of the experiences and observations concern similar issues across projects. To illustrate this further, Appendix C lists important conclusions drawn by the Science of Collaboratory project and by Novay, on the basis of fourteen networked innovation projects they were involved in (Collaboratory.nl was one of them).

It is not surprising that these issues are seen to be important. What is striking is that best practices from earlier projects do not seem to offer much help to later projects. It looks like every project goes through a similar learning curve. This may well have to do with the fact that it is more about experiential learning than cognitive learning: previous examples may make you aware of issues, but do not necessarily make you better skilled in handling them – that requires hands-on experience. It is very much like learning to swim.

[37] See also chapter 5.5 Experiences on cultural aspects

Management
The apparent lack of absorption of lessons learned may also have to do with the lack of (project) management focus in research environments – where attention is often more devoted to subject matter than to processes.

> An Ithaka Report (May 2008) on Sustainability and Revenue Models for Online Academic Resources pays explicit and extensive attention to this phenomenon because its effect is so crucial for projects' success. In their management summary to the report they state: "….. *There are, however, a variety of processes and procedures that can help to improve the likelihood of entrepreneurial success. These include establishing organisational mechanisms to develop accountability in leaders, setting measurable goals and objectives, reviewing progress on those objectives on a regular basis, and assessing the performance of both the project and its leaders. …. In our experience, we have been surprised by how few not-for-profit initiatives rooted in the academic environment have such procedures in place. Clearly the leaders of these initiatives are competent professionals; why do they not rely on processes that have proven effective in both commercial and not-for-profit contexts? We have concluded that a key reason for this is that academic researchers tend to approach these problems from a different perspective, and with a different mindset, than do commercial entrepreneurs. The reason for this different mindset, we believe, is that these kinds of opportunities are relatively new to the academic environment and culture. …Operating as they did within a grantmaking culture, it has been natural for project leaders to see the challenges in ways consistent with their roles as principal investigators on research project grants. Acting as the principal investigator of a research grant project is a very different responsibility from operating as the organisational leader of a sustainable enterprise*."

Collaboratory projects do have a research component, but also qualify as an – innovative – enterprise. It would be a worthwhile contribution to the success of projects and their speed of implementation if there was:
- more awareness of the importance of management and leadership skills,
- more attention to training of them and
- more appreciation for those skills.

Summing up
This study may ultimately be about the question **'how to deal with differences'**. The availability of standard collaborative environments - and no doubt the perceived ease and efficiency of standardization for support departments and higher management - seems to create the impression that standardization of use is therefore a necessity, or a given. It could be an interesting research project to look at the hidden costs of standardization.

But leaving that aside, even the available standard environments show awareness of the differences in ways people work by their considerable level of adaptability. It may not always be easy to realise the adaptations, but that is not a matter of principle. It is more a matter of ambition, feasibility and ability. Several considerations to take into account are:
- what is the **institution's policy** with regard to (support for) e-research, data management, preservation and Open Access - in short, innovation in research – and what are the implementation efforts
- are the **resources** – time, manpower, money – available to allow for fulfilling a variety of needs
- are the **skills** available to help make (sometimes) latent needs explicit and assess them properly as truly individual, or generic
- will **top-level support** be retained over a sufficiently long period of time (5 – 10 years)
- is there a mechanism in place to **monitor changes** in work routines and (resulting) efficiency gains that can free up resources
- is the **leadership** ability available to collaborate on cross-institutional issues as they arise.

7 Recommendations

The chapters on Experiences and Analysis already contain much that can be read as recommendations. This chapter summarizes them briefly, and expands on a few important ones.

7.1 Recommendations for institutions

- Institutions that actively wish to promote the introduction of collaboratories – as part of an e-research policy – have to provide **dedicated and qualified support staff**. With a view to the difficulties encountered in translating user needs to functionalities required in the highly specialized research environment, a support function like that of the instructional or functional designers in the US and UK may be a good solution. These people have knowledge of ICT *and* the discipline, and are therefore helpful in adapting the environment, and documenting the experience gained in the process. The Library too can have crucial added value, if they can offer a well organized helpdesk connecting technology, information and research & education.

- **Bottom up introduction** works better than top down. This leaves the initiative wish those that really want or need it; there are fewer 'steering' possibilities. Top down projects aimed at the entire organisation take years to materialize and for that reason lack credibility. What works well if a measure of influence is wanted, is a mix of bottom up and top down; in this case, there is initiative from supporting departments to find groups that have a (latent) need for support, without being too missionary.

- Drivers for innovation are **curiosity and urgency**; curiosity can be triggered by providing **working examples** to show the possibilities of standard software and its adaptability. This helps to attract and trigger people and to enable them to envisage possibilities for their own research. Availability of a working environment enables people to try it out, and allows them to experience for themselves what the environment can bring them. Use of the environment in the beginning of the research process, while collaborating to come to a project proposal, makes it easier to continue to work with it in the actual project phase itself.

- One size does not fit all: a proper exchange of ideas and possibilities is required to assess what sort of environment would suit best. It would pay to **have different models to work with**, perhaps even in different software environments. Some groups will really want to use advanced functionalities and are served well with something like Sharepoint or Sakai. For others, a light-weight or SaaS solution may be enough, or necessary, to be able to start quickly. To have a limited portfolio of environments for them to choose from will draw more people in, without encumbering the support organisation too much. And it is important to remember that **not everybody needs a collaboratory**.

- The issue of **access, security and granularity of rights & permissions** is one that requires specific attention in all projects at an early stage, and **does influence choice of software**. For example Google Docs and SURFgroups are very open and 'egalitarian', others offer more possibilities to assign roles with associated permissions (Sharepoint, Sakai, Liferay). When going for a SaaS solution, it is important to check the legal implications of the fact that all data and information is stored on servers that may fall under a completely different legal system.

- **Organisational, policy, and financial support** is another issue that needs tackling. This is required to enable the 'working prototypes' that come out of the first range of projects to grow into a robust (open source) system with sufficient support for increasing groups of users. It requires a longer horizon than a 1 or 2 year project period. Innovations in organisations tend to meet with a lot of scepticism if the tradition in the organisation is to support it for a few years and then drop it without due care for embedding. **Sustainability**

of these innovations requires sustained management support. This becomes even more important and complex in the online environment where the organisation becomes virtual and requires management to match the individual institution's interests with the **larger interests at stake in the virtual organisation**. This asks for leadership, rather than management.

7.2 Summary of recommendations from chapters 5 and 6

Technical aspects

a. The present generation of collaborative systems will require significant programming effort to connect them with discipline-specific tools; and will need provisions to work offline as well as online. IT staff should be made available, or external help hired.

Functional aspects

a. Use of and experience with collaborative systems triggers demand for further functionality and support. A coordinated programme approach enables feasible growth and prioritisation of programming and support efforts.
b. Organisation of work processes and procedures may affect functionality required in an environment. Groups that favour a structured way of working should take this into account in their software selection.
c. It is dangerous to just ignore 'nice-to-have' functionality wishes; the 'fun-factor' can make up for 'usefulness-flaws' in a system.
d. Standard systems should not necessarily lead to standardization of use.
e. Collaborative infrastructure should facilitate plug-in functionality, not dictate it.

Organisational aspects

a. Provide senior, enthusiastic leadership for collaborative projects, and strong and stable project management – especially for large-scale, long-term or important projects. They can and must put effort into building the collaborative community.
b. Proper support for project management, administration, PR and communication is essential for the success of the project.
c. Collaboratories bring together different disciplines. They have to get to know and understand each other, learn to speak a common language, be willing to reflect on their traditional ways of working and thinking, and adapt them to the new environment. Sufficient time and attention should be devoted to this process.
d. Clarifying goals of the collaboratory is essential for its success. The goals reflect the vision, the needs and the willingness of the participants to realise them. In an innovative setting, this clarification process can best be done in an iterative development approach.
e. It is important to make sure that the collaboratory project provides the correct incentives for its participants, and at the right time.
f. The project progress needs to be monitored. Attention needs to be paid to causes of delays to establish whether these are temporary and easily solved or symptoms of more fundamental complications.

Policy/legal/financial aspects

a. Collaborative or networked innovation enables sharing risks and investments, and possibly efficiency gains. It requires looking at these issues from a perspective that surpasses the individual institution's perspective.
b. Traditional institutional security of systems needs revisiting to allow for the construction of a virtual organisation.
c. Project management needs to address IPR-issues for materials used and produced in collaboratories. The 'do ut des' principle may be a good solution for materials produced, whether or not in combination with Open Access and creative commons licences.

Cultural aspects

a. ‘Resistance to change’ is a general concept that masks a variety of difficulties people can experience in new situations. They need time and a safe environment to successfully address these.
b. Face-to-face meetings are conducive to the acceptance of the online environment.
c. Adoption of collaborative environments needs a balanced approach of facilitating expressed needs and actual use, and encouraging experiments with new functionality not expressly asked for.
d. Assessment criteria need to be applied that reflect recognition of the value of a different kind of output than research papers and articles.

7.3 Recommendations for SURF

The phenomenon of collaboratories is in its infant stages in the Netherlands; work on it is still fairly fragmented. The US, where developments started at least a decade earlier, and the UK are more advanced. There is a **need for further experimentation and pilots**, within the framework of a clear vision, from the point of view of research practice. Keeping the vision in sight and alive is important, to prevent the experiments and pilots from turning into projects for their own sake or ways to learn a trick. The experiments should all be steps to realise the vision or in finding out what does not realise the vision.

For SURF, a role is laid out in facilitating experiments and pilot collaboratory projects through funding – of small, but also of longer-term projects (e.g. 2 years). SURF also can take a roke in **making sure that the process continues**; that it builds on the results and prototypes delivered by the present projects to knit them into a flexible and modular range of facilities to support the various needs research may have. An interesting next funding area might be ‘Enhanced Publications in Collaboratories’, to trigger the development of both developments and explore the connections, possibilities and needs.

Apart from providing funding, and a SaaS solution, SURF could play a pivotal role in building and supporting a community – a **‘collaboratory of collaboratories’**. This could facilitate knowledge sharing and dissemination in the Netherlands on new developments on all aspects related to collaboratories. It could provide a ‘starter-kit’ with recommendations and checklists for those who wish to set up collaboratories, provide up-to-date information on developments elsewhere, function as a platform for exchange of experiences and good practices, and perhaps even provide a platform to store specific web-parts that individual projects have developed for re-use by others.

To benefit more from the projects, project administration procedures should be adapted to **allow for ‘negative’ results**, the **experimental nature of projects** which may call for changes during the project, and continued **focus on the project rather than** on fulfilling **project administration** duties. This is especially relevant for smaller projects of up to a year.

Appendix A - Functionality Matrix

Appendix A compares the selected systems on a range of functionalities connected with content management, collaboration, teaching & learning (because of Sakai) and systems and administration; these include the functionalities that were researched in the COIN Technology Scouting.

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
Content management								
file handling & storage	'resources'	document and image library	documents & slides libraries	shared drive interface		online access to/storage of documents	online access/ storage of documents/ spreadsheets/ presentations	online storage/sharing
	drop box	multiple file upload		develop and share content applications	upload files	upload files	im- and export from/to traditional file formats	
	email archive		document workflow support	workflow and content lifecycle management		organize/find all files, independent of format	gmail storage	
		integration with MS Office	integration with MS Office 2007	integration with MS Office				opens/saves files from Word, Excel, Powerpoint
			'business intelligence' (use of internal/external data, reports)	Transformation services: Office to ODF/PDF, PowerPoint to Flash		Online PDF converter		
						print-perfect documents		

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
publishing	web content	workspace publishing	web content publishing & deployment	(staged) webpublishing		embed documents on website, wiki, blog		
		web publishing		publish content created in teamblog to Wordpress and Typepad	content syndication (RDF/RSS)		(internal) webpublishing & -presentations	
		asset publisher			Permanent links			
content creation, editing & contextual info		rich text editor	browser based content authoring	tool of choice for authoring/viewing	collaborative book	collaborative authoring with approved co-authors		collaborate on files
	presentation	live page editing and scheduling	WYSIWYG content editor	check-in/out & version control	version control	version control and track changes	version control/automatic file versioning for no. of traditional file formats	
					threaded comments			
		dynamic tagging		tagging				
	wiki	wiki	wiki					
	glossary		page layouts		taxonomy			
search		multi-tier search	search (incl. cross site, enterprise content, people, federated)	OpenSearch; tag-based search	built-in search		built-in search in all apps	

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
site organization		organization/community/personal pages	standard site/workspace templates	personalized/shared site dashboards	personalization of content and presentation		user-created sites incl display of Google docs, spreadsheets, presentations, YouTube videos, Picasa slideshows	
		integration with other content applications	sites and documents aggregation		templating			
		drag&drop site maps		multilingual management	multi-language support			
		multi-language support						
		search engine optimization						
Collaboration								
asynchronous communication	discussion forum	message boards	email integration (postings via email)	discussion forums	discussion forums			
	blog	blogs	blog	(team)blogs	blog; Blogger API support			
		email	integration with MS Outlook 2007		contact	share by sending links/files to approved recipients	Google Mail	
							sync with MS Outlook email & contacts	
news& announcements	news/rss	rss	rss		built-in news aggregator			
	announcements	announcements & alerts						

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
	messages	activity tracking	issue tracking	site activity feed	tracker (new & updated content)			
synchronous communication	chat	instant messaging	presence icon			platform/browser independent access	instant messaging from gmail inbox	
						chat		
						notes/screen sharing	voice/video chat from gmail inbox	
						audio/video conferencing	secure video sharing (viewing, annotating)	
						whiteboards		
						remote control		
calendar	schedule & calendar summary	shared calendar	calendar	site calendar			Google Calendar (schedule, share)	
			task coordination				embed internal calendar in Google Sites/own website	
							sync with MS calendar	
social networking	site roster (list of site participants & their pictures)		social networking	personal profiles/search people & experts	profile			
			people & groups lists	social tags				
			colleagues & memberships					
other		polls	surveys		polls			
			browser-based forms					

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
Teaching & Learning								
	syllabus							
	lesson builder							
	assignments							
	gradebook							
	tests & quizzes							
	Post 'Em (quick upload of feedback with excel import							
	portfolios							
	reports (portfolio-related)							
	wizards&matrices (document & reflect on learning & development							
	evaluations							
	portfolio templates							
	layouts & styles for portfolios, wizards&matrices							
Systems&admin								
	accounts	secure single sign-on		single sign-on (NTLM, LDAP)	authentication local/via external source/LDAP)		consistent sharing permissions across organization sites	

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
	'realms'	role-based authorizations	user profiles and profile store	security & user management with users, groups and roles	role-based authorizations			
			audience targeting		analysis, tracking, statistics			
	membership		integration with MS Information Rights Management	document-level security	event log		document-level security	password protected files
	My workspace & related tools	dynamic virtual hosting	My Site (incl. privacy & security in My Site public view)	website templating and branching	webbased admin		secure hosting/streaming videos	
	site set-up	SOA framework	site directory	integration with existing enterprise portals			build intranets/project sites	
	site editor		site manager	MS Sharepoint Protocol Support				
	section info		integration with MS Sharepoint Designer 2007					
	super user		ECM: document management and other enterprise site templates					
	users (view/edit user data)		ECM: site variations					
	on-line: track server/system usage		ECM: records management/ compliance support					

Functionalities	SAKAI 2.x	LIFERAY	SHAREPOINT 2007	ALFRESCO	DRUPAL Core	ADOBE SHARE	Google Apps (mail, calendar, docs, sites, video	Microsoft Office Live Workspace
	job selector (create scheduled data integration and data warehouse tasks							
			mobile device support					
	full tools lists for SAKA 2.5 and 2.6				Contributed modules	in Labs: Tables and Presentations		

Appendix B - Interoperability and maturity matrix

Appendix B takes the COIN Technology Scouting functionalities as a starting-point and compares the systems on the standards they support for those functionalities. systems on factors that contribute to the maturity of the system. This matrix also contains a comparison of the systems on factors that contribute to the maturity of the system.

Maturity / Inter-operability aspect	SAKAI	LIFERAY	SHAREPOINT	ALFRESCO	DRUPAL	
Age of the product	ca 4 years (1st release 2005) orginal project started in 2004.	9 years, first release 2000.	> 5 years (could not find info on first release of previous edition on site).	4 years, first release October 2005.	8 years, first release 2001.	
Form of licence	Educational community licence 2.0 (Sakai 2.6+); Sakai 1-2.5: ecl 1.0	Liferay Standard edition offered under MIT License, Enterprise Edition under subscription and service contract.	Commercial licence.	Community edition: for free, no specific licence mentioned; Enterprise edition: included in subscription for support.	GNU GPL v. 2	
Product focus; roadmap available?	Yes; Sakai 3.0 in development.	Yes, for v. 5.3.	Yes, for Sharepoint 2010.	Yes, for 2009 for both editions.	No. "Next release when it is ready". See below for development policy.	
Human hierarchies	Owner: the foundation; organisations (profit & non profit) are the members of the foundation and elect the Board. The board is ultimately responsible, partners have influence on development priorities, staff coordinate development activities, a product council influences what goes into releases; development is community based, the decision structure makes it a fairly formal process.	Owner: Liferay Inc.; they also set the development agenda as far as I can make out from the site; the community is involved for testing, improvements and support (of SE, not of EE), the design seems to be done by Liferay staff. There are conferences where 'direct interaction with the brains behind the product' is advertised as a feature.	Owner: Microsoft Inc.; design/development by them, although they no doubt use input from the developer community and the open source projects (communications) sites Codeplex and Port25.	Owner: Alfresco Inc.; they decide on the roadmap, but work with input, solicited and no doubt unsolicited, from the community; input e.g. through surveys conducted amongst community members with the explicit intention to get guidance for development/development focus, first for the community edition (daily updates). The EE is a branch of any final Community release stabilized and certified.	Owner: the community of contributors to the software. Domainname and trademark rights rest with Dries Buytaert. Buytaert has primary control over the software and makes most decisions on changes, with special weight given to comments from people trusted and respected for past contributions. The Drupal Association provides support for infrastructure, promotion and event planning.	

Maturity / Inter-operability aspect	SAKAI	LIFERAY	SHAREPOINT	ALFRESCO	DRUPAL	
How is development community composed / how does it work?	Joining community via website, seems easy; influence on future of product is controlled by the Board and the menbers of the foundation; there are contributors'tools that are not available in the standard release (yet), but are available via the site and developers can choose to stick to that status to stick to their own development schedule - support in that case no doubt only through the development community. 2009 Kernels (sakai core) are introduced. Kernel 1 for the Sakai 2.x and Kernel 2 for Sakai 3.x	The site claims an active and mature community, but apart from mention of the community's involvement in testing and improvements, it's not so clear what the actual influence on the development programme is. Joining community via the website, it seems easy to join in blogs, forums and the wiki. There's a 'community plugins catalog' for themes, portlets and layout templets developed by community members.	MSDN: developer (support) network for exchange of info/ideas/solutions etc.; Codeplex: open source project hosting website for creation and use of open source applications; Port25: communication platform on interoperability issues between different open and proprietary platforms. Joining these forums via website seems easy; there are extensive licence statements claiming no control by MS, but freedom for them to reuse contributions without compensation.	Joining the community via the website, is easy. To get access to more in-depth info (developer toolbox) for developers, you need to register. They conduct surveys amongst registering (new) members to get input for development. Also other periodical surveys are conducted for the same purpose. There is a 'Forge' for members to develop additional features and capabilities.	Joining seems easy, online. *Core committers* are a team that reviews changes and maintains code. Among them are branch maintainers for specific versions, and maintainers for designated portions of the core. Maintainers (core contributors who have made substantive contributions) are appointed by Buytaert, upon their application or his invitation. *Core contributors* contribute code patches or documentation for the Drupal core. Anyone can do this. Same goes for the *'Contributions' contributors, who* develop and maintain 'contributed' code packages (mainly modules and themes) that are hosted on the Drupal site but not part of the Drupal core (they have been granted write access to the contributions cvs repository by the repository manager).	
How large is the user community (active/passive)	Difficult to answer; what is the community: developers or super users or only code committers …	No info about this on site, apart from mention of 'fortune 500 clients'	User community?	74,000 registered members on the community site; just under 2000 registered users on the Forge.	Claim > 350.000 subscribing members.	

Maturity / Inter-operability aspect	SAKAI	LIFERAY	SHAREPOINT	ALFRESCO	DRUPAL	
How well can the platform/environment be integrated	There quite a number of webservices , api's and other control mechanisms available to integrate a Sakai environment with a larger infrastructure. Support for IMS TI is standard for exposing tools between different platforms.	Seems extensive, it's one of their featured benefits.	Still not high (?)	Extensive, one of their featured benefits; e.g. integration with Web 2.0 tools and services supported, and also MS Office Sharepoint Protocol supported; claim no dependencies on specific hardware/operating systems.	? The core works with a set of API and is useable with a number of databases.	
Support	Online (documentation, wiki, blogs, email lists; issues tracking; helpdesk, newsletters); commercial support listed on site, some are comercial affiliates in the SAKAI programme, 2 dutch firms listed (STOAS and portfolio4u).	Online support and community support for the SE; commercial support for EE; commercial support through partners around the globe, 1 mentioned for Belgium and The Netherlands (Panoptic).	Extensive online and commercial support and training.	Community edition: community support only; there is extensive online documentation available via wiki, forums, blogs, tech tips. Enterprise Edition: community support plus commercial support (subscription based) from Alfresco and service partners (also partners in the Netherlands/Benelux mentioned).	Community support, online: handbooks (written and maintained by the community), forums, email-lists, IRC-discussions, issues tracker; commercial support through individuals and organisations offering professional services and training (listing on site only if they have contributed to DRUPAL. Also hosting services available. Drupal Dojo provides a structured training environment online.	
Documentation	Online: release pages, issues tracking, wiki, blogs; Planet Sakai; hard copy handbook available.	Online: guides for users and developers per release, issues tracking, wiki, blogs, forums.	Extensive online documentation.	Online: wiki, blogs, forum, tech tips, community content.	Online: handbooks, forums, email-lists, issues tracker; Planet Drupal - an aggregated list of feeds about Drupal from all over the web.	

Maturity / Inter-operability aspect	SAKAI	LIFERAY	SHAREPOINT	ALFRESCO	DRUPAL	
Market penetration / installbase	>170 installations (050809), production & pilots, including installations at partner sites (academic and commercial). Sakai is (2009) mostly a Higher Ed tool. Well know Universities are adopting Sakai.	? No clear info on site.	Customers: >17,000 (NYT August 7, 2009).	? No clear info on site, it claims high-level customers among Fortune 500; lists 42 customers as example on site, broad division over business/government/ mnon-profit/education.	? Drupal.org claims 'millions of websites'; Drupalsites.net lists 3400 sites registered with them.	
Part of present services SURFdiensten?	no	no	yes	no	no	Adobe Share and Office Live on request

Appendix C - Lessons learned from Science of Collaboratories and Novay

Appendix C lists important conclusions drawn by the Science of Collaboratory project and by Novay, on the basis of fourteen networked innovation projects they were involved in.

Lessons learned / conclusions / recommendations from Science of Collaboratories

Excerpt from MIT Technology Review, November 23, 2004, 'Rules of the Collaboratory Game'

1. *Make sure your research community is ready*: Is it accustomed to operating this way? Particle physicists have been working in teams for decades, a necessity given the huge cost of their instrumentation. (ATLAS will exploit the Large Hadron Collider, an underground particle accelerator ring 27 kilometers around and costing at least $2 billion.) Earthquake engineers, on the other hand, traditionally work within their own labs. As pricetags soar for state-of-the-art lab equipment, research funders are pushing the collaboratory concept, but "the community is having a lot of trouble embracing this model," Olson says.

2. *Tackle big questions*: Scientists may realize they need to band together to attack truly tough problems such as genome sequencing or HIV/AIDS. But many lead researchers "still have almost a Depression mentality: 'You've got to hoard everything,'" says BIRN's Ellisman. That attitude "doesn't let us get science done as quickly as it might," he adds. "After you've published whatever you've learned about your hypothesis, you ought to publish all your data so that other people can hypothesize about it in different ways."

3. *Get each individual participant on board*: Individual researchers must be assured that their careers won't suffer in such broad-scale efforts. The Alliance for Cellular Signaling, a large scale project studying the extraordinarily complex biochemical pathways in which cells interact, tackles this by treating data contributions as publications. There are similar concerns for the talent you need to get onboard to build the technical infrastructure. "In a computer science department, if what you're doing has practical applications, you've fallen from grace," says Ellisman.

4. *Gear up for major technical challenges*: Megaprojects such as BIRN's may juggle dozens of institutions and petabytes of data over a decade or more. They also face unique challenges. For instance, the scanners gathering that schizophrenia data may each come with their own characteristic idiosyncrasies, so researchers must track which scanner produced a given image, and try to find ways to correlate images taken by all those scanners. Even in less ambitious collaboratories, researchers also must be comfortable with collaboration tools that are highly customized or simply new to them. "Not everyone has the same experience with these technologies, which can be pretty daunting," Olson says. "A lot of the tools are a little clumsy and need a little local support. High-paid scientists just don't have the patience to deal with something that isn't working."

5. *Put enough resources into project management*: Researchers tend to resist spending money that doesn't go directly into science. But these complicated projects can benefit from dedicated managers with suitable training and experience.

6. *Talk the same talk*: The InterMed project, which has standardized clinical guidelines across medical disciplines and settings, required a huge amount of work to establish a common vocabulary Olson says. If participants didn't agree, say, on what 'patient distress' might mean for a heart attack victim, their procedures for dealing with such cases could not be fully spelled out and aligned with each other.

7. *Hold your course*: You need plenty of patience among the players, especially the funders. A project might take four years to hammer out data access issues, and then run a decade or more. You need visionary planning and stable management to stick it out.

"Collaboration is hard in general, whether you're doing it online or not," Olson emphasizes. And it needs the social glue of good relations among participants. No matter how fancy your software, he adds, "the best way to start building a personal relationship with your colleagues is face-to-face."

Findings from Presentation on 'Collaboratories at a Glance', Workshop June 2003

- Coupling: the more partitionable the work, the easier it is to do long distance
  - may not want total independence
  - need interaction to avoid drift
  - some success with standardization
- Common ground: the more shared understanding, the easier it is to work long distance
  - nature of the work
  - vocabulary
  - how and when to communicate
- Technical readiness:
  - infrastructure has to be sophisticated enough to accommodate the new technology
  - the more uniform the infrastructure the better
  - people can't make too big a leap
  - Collaboration readiness: The community has to have a spirit of collaboration. You cannot *make* people collaborate through the technology
- Incentives must be aligned:
  - Incentives must be carefully designed to encourage sustained participation
  - Who has to do the work; who benefits

From presentation on 'Cross cutting themes', workshop June 2003

- Very difficult to manage complex projects without clear objectives
- Crystallized collaboration like common standards and shared data
- Success may look like peaks and then drops
- From a Standish Group Report (2002):
  - Lack of user involvement major cause of project failure, followed by executive support and skilled project manager. User involvement takes a long time but essential for success
- Costs and benefits of diversity of users vs common ground – higher transaction costs, but more potential for new information and connections
- 'managing in chaos':
  - Project team must continually create new decision trees based on incremental learning
  - Managers must repeatedly and completely redefine the project
  - Execution involves repeatedly verifying goals on the basis of learning
  - Detailed planning only go go next verification
  - Rapid prototyping and making ruthless go/no go decisions
  - Necessity of funders to be flexible when dealing with uncertaintly. Changing, evolving model is not necessarily a sign of poor management
  - As we learn, we can move up the scale to unforeseen certainty and then foreseen uncertainty. Projects will get more predictable and can be managed more formally
- Motivation:
  - Extrinsic vs intrinsic – dangers of emphasizing extrinsic awards
  - Bibliometric analysis – recognition of other forms contribution besides articles. Will they be accepted for tenure and promotion?
    - Nature's acceptance of molecule pages
    - Team awards
    - Karma points

- Formal and informal roles:
    - Leaders
    - Project managers
    - Community and technology facilitators
    - Social norm transmitters
- Functions of evaluation:
    - Qualitative evaluation independent of measurable objectives – unanticipated consequences are vital to look at, though not related to project management
    - Ongoing evaluations related to management objectives, but including measures of social engagement to track user involvement, since that's the largest failure point

Best Practices from 'Networked Innovation', Novay 2009

- Projects with clearly defined objectives and a set of questions arising from the market generally have greater impact. The GigaTS project had limited impact in terms of a knowledge push. Real impact was achieved by the projects that were derived from it with market involvement. The ICT-push in CPIM was also counterproductive; success was achieved only when the set of questions was reformulated.
- The differences in the corporate cultures and research competences of the project partners had a great influence on the project. The use of scenarios, the elaboration of case studies and the development of concrete prototypes help to foster mutual understanding as well as to achieve specific, usable results. This functioned extremely well in projects such as Collaboratory.nl, ISI, MESEC, ArchiMate and B-Dossier.
- Projects in which all parties were intensively involved and collaborated in research and development were clearly more successful than projects in which parties simply invested money.
- Subsidies can help to establish a project and to increase the available research efforts. If subsidy is the main reason to collaborate – for instance as in the case of MultiMedian Persis – then the collaboration achieves markedly less synergy.
- Collaboration runs more smoothly if the project includes few direct competitors. Otherwise it is clearly more difficult to achieve agreement on project results and knowledge sharing. For instance, in 4Gplus, the project became fragmented, which required a great degree of extra energy to be put into project relationships between partners.
- Clear agreements on intellectual property are essential and are a highly sensitive subject matter. The aims and interests of the parties may vary widely. In the case of the collaborative structure involved in the ITI project, these factors caused many delays and ultimately placed great restrictions on the ambitions and impact of the programme.
- The commitment of senior management and chairmen of sectoral associations etc is required for projects to be set up and for their results to be successfully spread and adopted by the organizations or associations involved. In projects such as Collaboratory.nl, MESEC, ArchiMate and ISI, strong management involvement stimulated the processes and accelerated adoption.

Appendix D - Checklist questions for setting up a collaboratory

Questions	Has implications for
Orientation phase (General description of the Collab and its context; to be made by the initiators of the project / initial project team)	
Whose initiative is the collab? Is the collab project initiated by researchers or by (Library/ICT) staff? Is it primarily demand-driven or mission-driven?	community building, definition of goals.
Who is involved in the Collab? Is the membership inter/intra-institutional, (inter)national, inter-disciplinary? Is it an existing collaboration or a new one? Are library and/or other support staff included in the membership?	access/authorization, jurisdiction/IPR, communication, support
What are the general goals of the collab? Research-related; other?	demands on software and support
What is the expected size, complexity and timeframe of the collab project? Is it (part of a) programme or infrastructure?	sustainability, management commitment, support, funding
*I*s support needed? From whom?	involvement IT/Library/other staff
What (other) stakeholders does the collab have? What are their interests/challenges?	leadership; PR/communication; funding
What other collabs are you aware of in your environment (own institution, discipline); what do they tell you?	benefitting from lessons learned elsewhere
What's your institution's vision/policy wrt e-infrastructure, data management and collabs? Is it implemented, and how? What are the implications for the level of complexity (of environments) that can be handled? And of variety in demands? Technically, organisationally, financially	freedom of: choice in approach (top-down - bottom-up), choice of environment; managerial support
How does/can your organisation benefit from this Collab?	stakeholder/managerial support
Definition phase (More detailed description of the collab itself and the activities needed to realize it; to be done by projectteam consisting of representatives of all directly involved parties)	
Is the Collab going to be a fixed group, or a fluid one?	community building; support; security/access & authorization; complexity of environment

Questions	Has implications for
Will it exist for a definite or an indefinite period of time? If definite, how long?	community building; support; complexity of environment
Will the Collab be used for a specific research project or for a range of research activities/projects of a research group?	complexity and flexibility/adaptability of environment; availability of long-term support
How can the general goals of the Collab be translated into specific/concrete goals for the first phase/year/project?	prioritization and speed of development/implementation of first version of the environment; building commitment of people involved
What type of research (and/or teaching) will be carried out in the Collab / have to be supported by the Collab?	type of research tools needed -> complexity / adaptability of environment needed; need for additional facilities (e.g. data storage); primary focus of functionality of environment
What specific research/education(-related) activities will be carried out in the Collab / have to be supported by the Collab?	ibidem; type of non-research-specific tools/facilities needed; primary focus of functionality of environment
How will collaboration on this research and these research(-related) activities take shape?	Type of research/non-research-specific tools/facilities needed; project leadership / management (for the non-technical issues)
What is the geographical spread of participants/locations? Is there a need for differences in levels of access/authorisation? Are offline/online options needed?	demands on bandwidth; demands on granularity of access/authorisation; synchronization, date-stamping etc.
Can goals, prospective results, activities and type of collaboration be described precisely/concretely enough in advance? Or are there (many) unknown factors?	method of development/implementation
Is it possible for a requirements analyst to 'sit in' on a regular workday of researchers in the Collab to obtain a picture of workprocesses and routines? Can this detailed information be obtained in other ways?	user involvement in development/community building; fit with work routines and processes
What are the needs for short-term/mid-term/long-term storage and accessibility of data/intermediate results/work-in-progress/final results and publications?	storage and staging facilities; internal /external storage; bandwidth
What (other) internal/external resources are needed in the collab environment?	access rights/limitations; licensing arrangements
Is there a need for integration or linking with other collabs in the field?	interoperability; access rights/limitations; licensing arrangements

Questions	Has implications for
What user requirements may conflict with current institutional policies? Who is in charge of looking for ways to solve those potential conflicts? Do they have to be solved before the development starts, or can finding a solution be part of the project/experiment? What stakeholders need to be involved in this process?	organisational and managerial commitment; trust and commitment from involved collab user group; effectiveness of collab
Realisation phase: development (realisation of the (first version of) the collaborative environment, any development needed, testing, experimenting, adapting, finetuning, adoption in daily work routine; to be done by development team, project members and/or (core) user group)	
How ICT-savvy are the people involved in the Collab? Do they have experience with online collaboration / collaborative software?	support; training; coaching and coaxing; complexity of the environment and tools
Is there freedom of choice for software? If so, who is involved in the choice?	commitment; fit with user group (experience/level) and work routines; funding
Is there a preference for an institution-based solution or a SaaS-solution? For commercial or open source? What is the institution's capacity for development and support?	funding; development and support expertise; security; legal issues; speed of development and support
What are the possibilities for integration with other institutional systems or specific research tools?	ease of integration with existing work routines and systems -> ease of adoption
How much development does the selected environment need? And how quickly, to satisfy the most important needs? What prioritization is possible/necessary?	funding; ease and speed of development; ease and speed of adoption; control of funding
Are core participants in the Collab sufficiently involved in the developing and testing of / experimenting with the environment? How is their (continued) involvement guaranteed?	fit with user requirements and work routines; ease of adoption, also of any required new work routines
Is there scope in the development phase - and/or later phases - for adaptations, tweaking etc.? How is this dealt with/organized?	adjustment to evolving user needs/insights
Realisation phase: project management (project leadership, management and continuity; responsibility of project leader and manager, steering committee/project owner, project team)	
How is Collab leadership and management arranged?	Commitment; community building; involvement of all collab participants; progress and continuity
How stable is Collab leadership and management in relation to its timeframe?	Continued involvement of collab participants; progress and continuity

Questions	Has implications for
How is community building in the Collab organized?	involvement of all participants; effectiveness of the collab
How is support/helpdesk organized? (intersection between technology/information/research and education)	effectiveness and efficiency of collab; ease of adoption; user satisfaction
How is PR/Communication dealt with? And by whom?	continued stakeholder involvement and organisational/managerial support; continued funding; continued involvement of participants; peer recognition; wider adoption of Collabs in the organisation
How is financial stability ensured?	Continued funding
What type of monitoring/evaluation processes with respect to the (development of the) Collab are in place? Quantitative, qualitative? In relation to collabs goals and organisational goals?	Continued effectiveness/efficiency of the collab; continued funding; possibilities for freeing up resources; unexpected 'returns on investment'/spin-off/benefits to research; possibilities for implementation of collabs elsewhere in the organisation/for other purposes
Does the project team have (access to) change management expertise? Are they in a position to make use of it?	facilitating adoption process, changes in work routines/habits/attitudes, continued involvement of participants

Appendix E - List of (re)sources

Interviewees

- F. Benneker, UvA
- R. Brandsma, UvA
- L. Buning, HAN
- R. van Buuren, Novay (v/h Telematica Institute)
- K. van Dalen, Huygens Institute/KNAW
- J. Doove, SURF/Knowledge Exchange
- S. Dormans, IISG/KNAW
- H. Dijkman, UvA
- G. Drenthe, EUR
- G. Goris, EUR
- H. Harmsen, DANS
- D. Jansen, UU
- E. Jansma, Rijksdienst voor het Cultureel Erfgoed & UU
- J. Kok, IISG/KNAW
- J. Loonen, Fontys
- N. Poppelier, UMC
- L. Sesink, DANS
- W. van der Stelt, (Springer)
- F. van Till, JISC
- P. Verhaar, Universiteit Leiden
- de Waard, Elsevier/UU
- P. Wouters, VKS/KNAW

Internet sources / documentation collaborative environments and tools

www.adobe.com/acom (Adobe Share)
www.alfresco.com
http://drupal.org
www.escidoc.org
www.google.com/apps/intl/en-GB/business/index.html (Google Apps)
www.liferay.com
www.mendeley.com
http://research.microsoft.com/en-us/projects/ric (MS RIC)
http://sakaiproject.org and http://sakai-nl.blogspot.com
http://sharepoint.microsoft.com
http://workspace.officelive.com/en-us/Learn-More (MS Office Live Workspace)
www.zotero.org

http://digitalresearchtools.pbworks.com
http://en.wikipedia.org/wiki/List_of_collaborative_software

Project Initiation Document Technologieverkenning Collaboration Infrastructure & Federated Collaboratories (CIFC -> COIN), SURFnet, January 2009

Rapport Collaboration Infrastructure, SURFnet, August 2009

Rapport SURFshare WP2 Collaboratories – Verkenning van (on)mogelijkheden van Sakai en Sharepoint voor samenwerkomgevingen voor academisch onderzoek, Heesakkers, D., SURFfoundation, May 2007 (report on (im)possibilities of Sakai and Sharepoint for collaborative environments in academic research)

Analyse Requirements voor Collaboratories, SURFnet

Internet sources / documentation on projects and programmes

Evaluatierapport Vier Pilots voor Collaboratoria, resultaten van de SURFshare Tender 2007, Ter Meulen, A.G.B., eindred. Van Westrienen, G., SURFfoundation, August 2008 (Evaluation report 4 2007 tender projects)

Rapport Verkenning van de interesse van wetenschappelijke onderzoekers in Verrijkte Publicaties en Collaboratories, van der Poel, K., SURFfoundation, May 2007 (report on interest among academic researchers in Enhanced Publications and Collaboratories)

Tales of the Revolt Collaboratory – Controlling Document (February 2009) and First Report (April 2009)

Testweeklab - Final Report (August 2008)

Virtual Knowledge Studio Collaboratory – Final Report 2007 project (June 2008), Report and Article on Success Factors and Bottlenecks of the VKS Collaboratory, a Workflow-based Approach (February 2009), Controlling Document 2008 project (December 2008)

Evidence-Based Critical Reviews – Evaluation Report (mid 2008)

HubLab – Final Report project 2007 (June 2008), Controlling Document project 2008 (December 2008), Collaboratories: from natural sciences to social sciences and humanities, Literature Review for HubLab2 (Dormans, S., March 2009)

HBO Automotive Kennisbank – Controlling document (December 2008)

http://prezi.com/phvypld_wrqp/ - Presentation John Doove on Collaboratory developments, September 2009

http://alfalablog.huygensinstituut.nl (Alfalab)
http://beta.cell.com
http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.CapacitiesDetailsCallPage&call_id=263#infopack (FP7-INFRASTRUCTURES-2010-2 Call on VRC's)
www.crew.umich.edu
www.dendrochronology.eu/index.html
www.e-laborate.nl/en
www.elsevier.com/wps/find/newsroom.newsroom/bio_anitadewaard
www.jisc.ac.uk/whatwedo/programmes/vre.aspx
www.knowledge-exchange.info/Default.aspx?ID=287
www.labsonline.nl
partner.library.uu.nl/Pages/default.aspx
http://projectbamboo.org
www.scienceofcollaboratories.org (Science of Collaboratories)
www.surffoundation.nl
www.surfnet.nl
www.telin.nl/index.cfm?ID=379&context=380&language=nl (Collaboratory.nl)
www.vl-e.nl
www.vrelandscape.net/

Other literature

From shared databases to communities of practice: A taxonomy of collaboratories. Bos, N., Zimmerman, A., Olson, J., Yew, J., Yerkie, J., Dahl, E., et al. (2007). *Journal of Computer-Mediated Communication*, *12*(2), article 16. http://jcmc.indiana.edu/vol12/issue2/bos.html

Networked Innovation, Van Buuren, R., Haaker, T., Janssen, W., 2009, Novay.

A Virtual Research Environment (VRE) for Bioscience Researchers, Barga, R.S., Andrews, S. and Parastatidis, S., advcomp, pp. 31-38, 2007, International Conference on Advanced Engineering Computing and Applications in Sciences, 2007

Presentation eSciDoc Infrastructure: a Fedora-based e-Research Framework, Hoppe, M., Razum, M., Schwichtenberg, F., Wagner, S., ECDL 2009

Report (in Dutch) on European Conference on Digital Libraries (ECDL) 2009, v.d. Berg, M., October 2009

Ballingschap der Empirici, v. Dalen-Oskam, K., pp. 122-125, Tijdschrift voor Nederlandse Taal & Letterkunde 125, 2009

Presentation e-Infrastructures for e-Science, the EU Policy, Jansen, W., DRIVER II Summit 2, October 2009

Online Textbooks, best practices voor de implementatie van een Sakai omgeving, Brouwer, P., Snijder R., Vogelzang, L., Warmer, C. (project AUP and IMISCOE)

Verrijkte Publicaties, SURFshare study on Enhanced Publications, in preparation, December 2009

Is scientific publishing about to be disrupted? Nielsen, M., June 2009, http://michaelnielsen.org/blog/is-scientific-publishing-about-to-be-disrupted/

Sustainability and Revenue Models for Online Academic Resources, Ithaka, May 2008

Rules of the Collaboratory Game, Bender, E., Technology Review, November 2004

Presentation e-Science and Grid, the VL-e approach, Hertzberger, L.O., University of Amsterdam

Appendix F - Managementsamenvatting

Doel van het rapport

Dit rapport is bedoeld om de onderzoeksgemeenschap, inclusief ondersteunend personeel, te informeren omtrent de wijze waarop online-samenwerkingsomgevingen ('collaboratories') zijn ingericht, in welke mate er gebruik van wordt gemaakt en waarom men voor een bepaalde collaboratory kiest. Het onderzoek is uitgevoerd in gezamenlijke opdracht van SURFfoundation en SURFnet. SURFfoundation had behoefte aan een instrument waarmee zij onderzoekers kan ondersteunen en adviseren bij het selecteren van een online-samenwerkingsomgeving; SURFnet wenste input ten behoeve van het door haar opgezette Collaboration Infrastructure (COIN)-project. Deze tweeledige aanpak heeft in een breed opgezet onderzoek geresulteerd. Er is niet alleen aandacht besteed aan de technische en functionele kant van het opzetten van een collaboratory, maar ook aan de organisatorische, leiderschaps- en culturele aspecten daarvan.

Definitie van 'collaboratory'

Als definitie van de term 'collaboratory' is in het onderzoek teruggegrepen op de omschrijving van 'collaboratory' als vermeld in de Call for Tenders van SURFshare:

> Een collaboratory, of virtuele wetenschappelijke werkplaats, is een webgebaseerde samenwerkingsomgeving voor onderzoekers. Het wordt in de literatuur ook wel omschreven als *'een organisatorische eenheid waarbinnen afstand geen rol speelt, veelvuldige, verrijkende interactie op een gemeenschappelijk onderzoeksgebied wordt gestimuleerd, het contact tussen onderzoekers wordt bevorderd, ongeacht of zij elkaar al kennen, en toegang wordt verleend tot gegevensbronnen, producten en instrumenten die nodig zijn voor de uitvoering van onderzoekstaken.'*[38] Het biedt daarmee een oplossing voor samenwerking tijdens het onderzoeksproces met onderzoekers binnen en buiten de eigen instelling.[39]

Duidelijkheidshalve wordt opgemerkt dat de term 'collaboratories' of 'samenwerkingsprojecten' in dit rapport gehanteerd wordt voor de daadwerkelijke samenwerking (activiteiten) tussen onderzoekers op hun vakgebied; de term 'samenwerkingsomgeving' verwijst naar de software.

Reikwijdte

Op het gebied van samenwerkingsprojecten en samenwerkingsomgevingen is er sprake van grote diversiteit en snelle groei, zowel nationaal als internationaal. Gezien de omvang en de duur van het onderzoek is ervoor gekozen om de algemene stand van zaken in kaart te brengen en geen uitputtend overzicht te geven. In dit rapport worden acht softwaresystemen met elkaar vergeleken. Voorts wordt een beschrijving gegeven van de ervaringen en de evaluaties van twaalf samenwerkingsprojecten in Nederland, worden collaboratories in het licht geplaatst van de online-infrastructuur in het algemeen en wordt kort ingegaan op de internationale ontwikkelingen op het gebied van samenwerkingssystemen en -projecten.[40] Ook wordt enig inzicht gegeven in de sociale en culturele aspecten van collaboratories binnen het wetenschappelijk onderzoek.

[38] Bos et al. 2007. From Shared Databases to Communities of Practice; a Taxonomy of Collaboratories. *Journal of Computer-Mediated Communication* 12(2): 652-672
[39] SURFshare Tender 2008
[40] Begin 2010 komen de resultaten beschikbaar van een door JISC (UK) uitgevoerde Landscape Study on Virtual Research Environments/Collaboratories, een uitgebreider onderzoek dat zich meer richt op de internationale situatie.

In het onderzoek zijn acht softwaresystemen die gebruikt worden ten behoeve van online-samenwerking, naast elkaar gezet:

Producten	Software als Serviceplatform
• Alfresco	• Adobe Share
• Drupal	• Google Apps
• Liferay	• Microsoft Office Live Workspace
• Sakai	
• Sharepoint	

Tabel 1: De acht geselecteerde softwaresystemen

De vergelijking betreft de functionaliteit en de interoperabiliteit van de systemen en de mate waarin de systemen zijn uitontwikkeld; de resultaten zijn verwerkt in de tabellen in bijlagen A, B en C bij dit rapport.

In hoofdstuk 4 wordt ingegaan op de recente ontwikkeling van twee 'tweede generatie' samenwerkingsomgevingen die specifiek bedoeld zijn voor de onderzoeksgemeenschap, en op het COIN-project van SURFnet.

Er zijn twaalf projecten onderzocht om inzicht te verkrijgen in de ervaringen met het ontwerpen, opzetten en implementeren van collaboratories: zes projecten binnen het SURFshare-programma en zes projecten die niet door SURFshare zijn gefinancierd.

SURFshare	Overige
• Collaboratory voor Evidence Based Critical Reviews	• Alfalab
• Hublab	• Collaboratory.nl
• Tales of the Revolt	• Digital collaboratory voor culturele dendrochronology in Nederland
• Testweeklab	• eLaborate
• Virtual Knowledge Studio	• LabsOnline
• HBO Automotive	• PARTNER

Tabel 2: De twaalf onderzochte projecten

HBO Automotive valt binnen het domein van de toegepaste wetenschap en onderwijs. LabsOnline heeft een educatieve focus. Collaboratory.nl ligt op het terrein van industrieel onderzoek en ontwikkeling. Er is welbewust gekozen voor diversiteit om overeenkomsten en verschillen in kaart te kunnen brengen. De ervaring die binnen deze Nederlandse projecten is opgedaan en de evaluaties van deze projecten zijn vervolgens vergeleken en aangevuld met de resultaten van een (Nederlands en internationaal) literatuuronderzoek en met gesprekken met verschillende deskundigen op dit gebied. In hoofdstuk 5 wordt een samenvatting gegeven van de opgetekende ervaringen. Hoofdstuk 6 bevat een analyse, waarna in hoofdstuk 7 aanbevelingen worden gedaan. In bijlage E bij dit rapport is een checklist met vragen opgenomen die gebruikt kan worden bij het opzetten van een collaboratory.

Collaboratories als onderdeel van de online-infrastructuur

Collaboratories maken deel uit van de (inter)nationale infrastructuur voor online wetenschappelijk onderzoek. Via deze infrastructuur worden geïntegreerde ICT- en serviceoplossingen aangeboden voor de verwerking van onderzoeksgegevens en -informatie op verschillende niveaus. Een collaboratory is een virtuele plek waar onderzoekers samen aan gegevens kunnen werken en onderzoeksresultaten kunnen publiceren, dit alles in een voortgaand proces. Het besef dat een goede oplossing moeten worden gevonden voor gegevensverwerking en -gebruik is sterk gegroeid; voor instellingen is dit een stimulans om oplossingen te implementeren en te ondersteunen – collaboratories daaronder begrepen.

Aangezien collaboraties deel uitmaken van de algemene online-infrastructuur moeten zij gekoppeld kunnen worden aan andere systemen en tools, zowel binnen als buiten de eigen instelling(en). Dit stelt bepaalde eisen aan de systemen met betrekking tot de mogelijkheden voor interoperabiliteit en integratie. De huidige generatie software is op dit punt nogal verschillend; naarmate een pakket meer modulair van opzet is wordt de interoperabiliteit ook gemakkelijker. Servicegerichte architectuur en de nieuwere generatie systemen komen aan deze behoefte aan interoperabiliteit en integratie tegemoet, zonder dat er al te veel hoeft te worden geprogrammeerd. Verder zijn er softwarepakketten in ontwikkeling die specifiek bedoeld zijn voor de onderzoeksgemeenschap en rekening houden met de onderzoekscyclus; ook hier is het uitgangspunt dat 'plug-in functionaliteit en tools' geboden moeten worden. Ook het COIN-project van SURFnet is op dat uitgangspunt gebaseerd.

Standaard open source en commerciële software bieden een groot aantal functionaliteiten die verwarrend kunnen werken, wellicht overbodig zijn of zo op het oog niet aansluiten bij hetgeen onderzoekers nodig hebben. Standaardsoftware is echter niet hetzelfde als gestandaardiseerd gebruik. De meeste systemen zijn zeer flexibel en kunnen 'gedowngraded' worden.

Implementatie

Om de wensen in kaart te brengen en het doel en de omvang van de functionaliteit zorgvuldig af te stemmen op de doelstellingen en de complexiteit van een collaboratory, *is gerichte ondersteuning en sturing nodig, zodat de collaboratory op een succesvolle wijze ingericht en geïmplementeerd kan worden*. Uit de praktijk blijkt dat ondersteuning en sturing essentiële voorwaarden zijn voor het verkrijgen van draagvlak voor een nieuw systeem en voor het daadwerkelijke gebruik daarvan. Voor een succesvolle implementatie is het verder van belang dat met verschillende modellen wordt geëxperimenteerd en dat er sprake is van iteratieve ontwikkeling/aanpassing van de vereiste functionaliteit en van een gecombineerde 'bottom-up – top-down' aanpak. Wanneer aan deze randvoorwaarden is voldaan en de eerste experimenten een aantal werkbare modellen hebben opgeleverd en ondersteunend personeel ervaring heeft opgedaan, kan een en ander snel op grotere schaal worden uitgerold.

Ondersteuning

Bij het opstarten van het project, maar ook in latere fases, is het van belang dat de instelling over goed opgeleid ondersteunend personeel beschikt (ICT, bibliotheek, instructionele of functionele ontwerpers). Naarmate van het systeem meer gebruik wordt gemaakt en er meer ervaring mee wordt opgedaan, creëert dit weer meer vraag – naar functionaliteit en ondersteuning. De projectleiders binnen de collaboratory kunnen door het ondersteunend personeel worden geholpen bij het opzetten van de benodigde samenwerkingsgemeenschap en bij andere taken. *De juiste mensen op de juiste plaats is wellicht meer van belang voor een succesvolle implementatie dan het kiezen van de juiste software.* Een enthousiaste leiding, een sterk projectmanagement, een duurzame kwaliteitsondersteuning en tijdige PR en communicatie tijdens het project worden zowel nationaal als internationaal genoemd als de belangrijkste factoren voor succes.

Succesfactoren

Andere 'niet-technische' factoren voor succes die veel genoemd worden, zijn:

- duidelijke **visie en doelstellingen** – en de tijd nemen om deze toe te lichten;
- een **gemeenschappelijke taal** creëren en begrip voor elkaar krijgen binnen de gevarieerde setting van een collaboratory-project;
- structurele **ondersteuning** vanuit het instellingsbestuur en door de onderzoeksleiders, ook op de lange termijn;
- voldoende **tijd** hebben, zodat na een succesvolle technische en functionele implementatie verder kan worden gegaan met het oplossen van de sociologische en culturele problematiek die ontstaat als gevolg van het feit dat een nieuwe systeem tot veranderingen leidt in traditionele gedragspatronen;
- **bereidheid** of besef dat het van groot belang is om aan het experiment mee te doen en ongemakken op de koop toe te nemen, zodat veelbelovende opties kunnen worden uitgeprobeerd, ook al is dit voor de deelnemers onbekend terrein – dit geldt voor *alle* betrokken partijen;

- duidelijke of verklaarbare **noodzaak** om een nieuwe oplossing te implementeren, en concrete voordelen – niet iedereen heeft een collaboratory nodig.

Deze organisatorische, culturele en leiderschapsaspecten spelen natuurlijk een nog grotere rol in situaties waarin gegevensbeheer en het opzetten van collaboratories onderdeel vormen van het beleid van de instelling, bij collaboratories die deel uitmaken van een grotere infrastructuur en bij collaboratories die aan de basis liggen van langlopende onderzoeksprogramma's of een reeks verschillende onderzoeksprogramma's. Wanneer de collaboratory gebruikt wordt voor korter lopende of 'eenmalige' onderzoeksprojecten, is een lichtgewicht systeem en management-/organisatiestructuur wellicht voldoende, omdat duurzaamheid dan minder belangrijk is.

Andere belangrijke aspecten die in het onderzoek naar voren zijn gekomen – en waaraan het projectmanagement, de onderzoeksleiders of het instellingsbestuur aandacht dient te besteden – zijn:

- **juridische aspecten**: privacy en beveiliging van gegevens, intellectuele eigendom van materiaal dat binnen de collaboratory gebruikt of geproduceerd wordt, toepasselijk recht ingeval van externe opslag binnen een SaaS-platform;
- **toegang, rechten en autorisaties:** het is niet de bedoeling dat alles via Open Acces voor iedereen vrij toegankelijk is: de eerste onderzoekswerkzaamheden, bepaalde gegevens, de koppeling tussen interne systemen en de deels externe collaboratory – hiervoor zijn verfijnde toegangsmechanismen nodig;
- er dienen aanvullende functiebeoordelingscriteria te komen, waarmee ook andere zaken dan wetenschappelijke publicaties **erkenning** krijgen – zoals gegevensonderzoek, bijdrage aan de ontwikkeling van een collaboratory, de ontwikkeling van managementvaardigheden.

Voor een uitgebreid overzicht van alle aanbevelingen wordt verwezen naar hoofdstuk 7, Aanbevelingen.

Rol van SURF

Al deze aspecten dienen over de muren van de eigen instelling heen te worden aangepakt; SURF kan daarbij een rol spelen als kenniscentrum en een 'collaboratory of collaboratories' faciliteren waarbinnen ervaringen kunnen worden uitgewisseld en de meer complexe problemen middels een dialoog en praktijkgewijs kunnen worden aangepakt.

Slotconclusie

In dit onderzoek is in ieder geval duidelijk geworden dat de *'software', hoe belangrijk ook, niet van doorslaggevend belang is*. Waar het uiteindelijk omdraait is de vraag 'hoe met verschillen moet worden omgegaan' – verschillen in applicaties, wensen, tools en software. En of men de ambitie en het vermogen heeft om dit op te lossen.