STUDY REPORT

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Frameworks for Virtual Research Communities – A Scoping Study

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Preface

This is the first of a series of reports prepared during research into scoping the creation of a Virtual Research Community (VRC) and use of Virtual Research Environments (VREs) for sections of BRANZ and international fields of research which relate to the building industry, using the area of fire research as an initial case study.

Acknowledgments

This work was funded by the Building Research Levy.

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Note

This report is intended for researchers, research leaders and management in research organisations.

Executive Summary

A Virtual Research Community (VRC) is a group of people with professional orientations who communicate, cooperate and collaborate via the internet. The members are aligned by a common research area or field in which they are experienced and skilled. Stemming from a VRC, a virtual research environment (VRE) is the framework within which a group of researchers collaborate on a project via the internet

In every research field we currently have a large amount of information in a vast array of forms, plus we continually produce lots of information. We need to utilise this resource better.

Improved communication using virtual communities has been identified as fundamental for the future of efficient research in fields as diverse as humanities to the hard sciences and interdisciplinary fields.

This report is a summary of the results of a scoping study to identify key success factors and environmental challenges for small-scale and large-scale test cases, and to provide recommendations for future direction.

The development of a successful VRC or a VRE must include these key concepts:

- Be integrated with current policies and infrastructure
- Reflect its users and be driven by their needs
- Recognise and foster both formal and information communication
- Evolve over time to meeting changing user needs, and
- Actively (for a VRC) or passively (for a VRE) facilitate research processes and collaborative research of project teams.

A recommendation for the development of a successful framework is presented. A summary of the steps that need to be taken to develop a framework for a VRC includes:

1. Identify the intent of the VRC
2. Identify stakeholders
3. Identify the desired membership
4. Identify champions of the VRC
5. Identify developers, initial membership and maintainers of the VRC
6. From the identified desired membership, identify the current/existing culture, policies and infrastructure
7. Form the architectural design of the VRC based on integrating existing culture, policies and infrastructure with available infrastructure and tools
8. Design a prototype VRC
9. Develop and implement the prototype VRC
10. Perform beta testing with evaluation of the feedback
11. Schedule a target deployment date for the public release
12. Specify a maintenance and evolution plan

The development of a successful VRE follows a similar strategy as recommended for a VRC. However the intent of a VRE focuses on the types of research project intended.

A survey of the intended members for the VRC and VRE provides useful insights into the processes currently employed in general and in specific projects, the tools presently used and the needs, desires and expectations of the potential users. This provides information that can be used in the design of an appropriate framework that integrates current culture, policies and infrastructure.

The results of an initial survey within the international fire research field indicated some of the current processes and tools that are used in the initial scoping process of new ideas and concepts for research proposals. A marked difference in the personal networks was clear between early-career researchers and established experts. However overall there was still a need and desire identified for better communication within the field. These self-identified needs included:

- Information availability
    - centralised repositories
    - access to large databases with powerful search engines
    - a way of receiving briefs about on-going research activities in relevant/selected areas
    - information on current research projects
    - information on what has been done or written versus anecdotal information, e.g. why researchers did not go down a certain track or what did not work.
- Frequent interaction with other researchers at various venues
- Lists of expertise worldwide
- Advertising of interesting project ideas or fire research positions
- Everything in one location
- More collaboration with other fire research organizations

Successful VRCs and VREs stemming from the communities add value to research. However a structured and integrated approach must be taken to ensure the level of success of the VRC and VREs.

Frameworks for Virtual Research Communities - A Scoping Study

BRANZ Study Report SR 207

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Abstract

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In every research field we currently have a large amount of information in a vast array of forms, plus we continually produce lots of information. We need to utilise this resource better.

Improved communication using virtual communities has been identified as fundamental for the future of efficient research in fields as diverse as humanities to the hard sciences and interdisciplinary fields. Successful VRCs and VREs stemming from the communities add value to research. However a structured and integrated approach must be taken to ensure the level of success of the VRC and VREs.

This report is a summary of the results of a scoping study to identify key success factors and environmental challenges for small-scale and large-scale test cases for creating a VRC and VREs, and to provide recommendations for future direction in this area.

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Abbreviations

CREW	Collaboratory for Research on Electronic Work
CSI	Cyber Science Infrastructure
DARPA	Defense Advanced Research Project Agency
ELVI	Evaluation of a Large-scale VRE Implementation
IAFSS	International Association of Fire Safety Science
IT	Information technology
KAREN	Kiwi Advanced Research and Education Network
NADE	National Association for Developmental Education
NARCIS	National Academic Research and Collaborations Information System
NHS	(UK) National Health System
SDSS	Sloan Digital Sky Survey
SFPE	Society of Fire Protection Engineers
SPRAC	Space, Physics and Aeronomy Research Collaboratory
UARC	Upper Atmospheric Research Collaboratory
USA	United States of America
VRC	Virtual research community
VRE	Virtual research environment

1. INTRODUCTION

For years, scientists have used the internet to collaborate. The origin of today's internet was developed in the 1960s by researchers at four universities working for the USA Department of Defense. They formed a computer network known as the Defense Advanced Research Project Agency (DARPA) network, which allowed them to communicate and exchange theories. (Kiernan 1997)

The current situation in many research fields is that projects are carried out by individuals, groups or organisations where the communication with the rest of the research field relies heavily on written publications including journal papers (that may take years to be published) or intermittent conference attendance. This fragmented community environment is collectively inefficient, resulting in increasing duplication and limiting of project sizes, scope and impact. There is a lack of collaboration and cooperation and basic communication, and a loss of unidentified opportunities to use research outputs and establish more robust research programs through the communication of ideas. These inefficiencies are recognised problems across many research fields (VRE Oxford 2007; Bos et al 2007; Fraser 2005; Hodgkinson-Williams, Slay and Sieborger 2008; Kiernan 1997; Yu et al 2008).

Currently there is a growing international and New Zealand focus on bringing research communities together. One of the main drivers for this is to increase the overall efficiency and effectiveness of research. Creating Virtual Research Communities (VRCs) is one strategy that is being used. Attempts at creating VRCs cover a wide range of scales from international to local, and from purely technical to purely community based communications.

The benefits of formation of a successful VRC to industry will be:

- more efficient communication
    - of ideas and current and recent research projects between individual researchers and groups, which will lead to
- a better understanding of the current research environment
    - that can be utilised when formulating project proposals, and to identify potential new or wider applications and potential partners for collaboration and/or cooperation
- to provide confidence in the reduction of the potential for duplication
- overall, to ensure a more efficient use of funding
- a stable platform from which collaborative or cooperative research groups can be formed (where the collaborative research would be performed within project specific Virtual Research Environments (VREs))
    - and the VRC can be used as a forum to present and discuss project progress to the wider community and to disseminate final project outputs.

In response to the problem of a lack of communication within research fields or groups, many attempts using different approaches in many diverse fields and in a range of countries have been trialled with varying success. (Albors, Ramos and Hervasa 2008) The scale of these attempted solutions range from large-scale technical data-sharing to smaller-scale community building for connecting researchers and combinations in between. Some examples include:

- Large-scale technical data-sharing:

    - the Space, Physics and Aeronomy Research Collaboratory (SPARC 2006), which is a highly successful USA government-backed data sharing community, and
    - the National Academic Research and Collaborations Information System (NARCIS 2006), which is a Dutch collation of scientific publications and network of experts.
- Smaller-scale community building:
    - the UK National Health System (NHS 2005), which has a smaller-scale nation-wide virtual community, and
    - National Association for Developmental Education (NADE 2007) across the USA and NZ, which is a good demonstration of a small-scale internally organised research-based virtual community without heavy IT involvement.
- e-infrastructure (hardware and related tools) that VRCs and VREs utilise:
    - the Cyber Science Infrastructure (Sakauchi et al 2006), which is a Japanese nation-wide government provided IT infrastructure for data sharing, and
    - the New Zealand-based Kiwi Advanced Research and Education Network (KAREN 2008), which is a government-backed backbone for data sharing with current efforts to grow communities around this network to utilise it.

There is a consistent recognised need for a strong community base to utilise the IT infrastructure of these networks, because without user interest and participation data sharing databases lack current input and therefore usefulness.

At this time there have been many attempts and approaches, of which there have been both successes and failures, and this has not been applied to the fields of research that BRANZ is involved in. This provides BRANZ the opportunity of leading the research and implementation of ways in which to build better communities for our fields of work. This can be achieved on a scale manageable for BRANZ, as heavy IT infrastructure investment is not required, and we can utilise our unique understanding of our research environments in combination with proven collaboration tools.

1.1 Motivation

In any one research field we currently have a large amount of information in a vast array of forms, plus we continually produce lots of information. We need to utilise this better.

Improved communication using virtual communities has been identified as fundamental for the future of efficient research in diverse and interdisciplinary fields.

Communication and community building is fundamental to research, whether it is facilitating:

- Communication between:
    - individual researchers
    - researchers and funders, or
    - researchers and the users of the applications of the research.
- More rapid and efficient dissemination of research results and project outputs

- Promotion of discussion of industry “hot topics” and incidents
- Access to our senior international researchers
- Communication that resembles the flavour of the exchange between excited and optimistic scientists and engineers at conference intervals
- A stable platform for the formation of collaborative and cooperative research groups (and subsequent VREs to support the individual projects), and
- Additional and more effective modes of communication.

1.2 Objectives

1.2.1 Strategic Aim

Increase the efficiency of research through better communication enabled by a stronger research community utilising VRC and VRE frameworks and strategies.

1.2.2 Report Objective

Identify proven key success factors and environmental challenges for the proposed small-scale and large-scale test cases, in order to provide recommendations for future direction.

1.3 Scope

The focus of this report is VRCs, scoping potential frameworks in order to make an informed decision for the next stages in designing and implementing a successful VRC.

Related areas have been briefly included in this report for clarity and to provide context as to the potential breadth and limitations of a VRC.

1.4 Approach

More specifically, *Stage 1: A Scoping Study* investigated the research environments and reviewed the current approaches and the successes of these with the intent of providing substantiated direction and implementation strategies for the following stages of the project. This stage of the project has:

- Carried out a literature review to:
    - learn about previous virtual community attempts to determine key success factors
    - identify the advantages and disadvantages of current virtual community structures
    - identify the advantages and disadvantages of currently available IT tools that maybe utilised;
- Initiated the assessment of the current communication culture and requirements of example small-scale (e.g. an internal BRANZ community) and large-scale (e.g. international fire research field) test-cases; including
    - defining the intent and extent of the proposed test-case virtual communities

- identifying key players (potential users within BRANZ, heads of international research organizations, professional societies, etc) for the success of the communities
- establishing open communication with these key players specifically to enable the implementation of the virtual communities, particularly through establishing potential user requirements and desires, and managing expectations of potential users;

- Provided recommendations for direction and general implementation strategies for the test-cases that are most likely to provide maximum benefits for conservative effort.

This report provides a summary of the results of this approach.

2. BACKGROUND

The two key items of interest are:

1. Virtual Research Communities (VRCs) and
2. Virtual Research Environments (VREs).

A VRC supports wider communication within the group and the formation of VREs for project-specific research groups.

A variety of terms and jargon have been invented and used when describing various forms of communication and collaboration that utilise the internet. For clarification, brief explanations of select terms are included here. More details and discussion are included in relevant sections of the report.

2.1 Virtual Community

A virtual community is a group of people who communicate, cooperate and collaborate via the internet.

A virtual community relies on the interaction of its members for knowledge and experience sharing and provides access to both information and other people. Virtual communities can be sorted into social, professional and business community types, as shown in Figure 1 (Markus 2002).

A virtual community is about enabling better communication. A virtual community combines digital infrastructure and technology with existing infrastructure in a framework that is consistent with the culture and processes of the intended users.

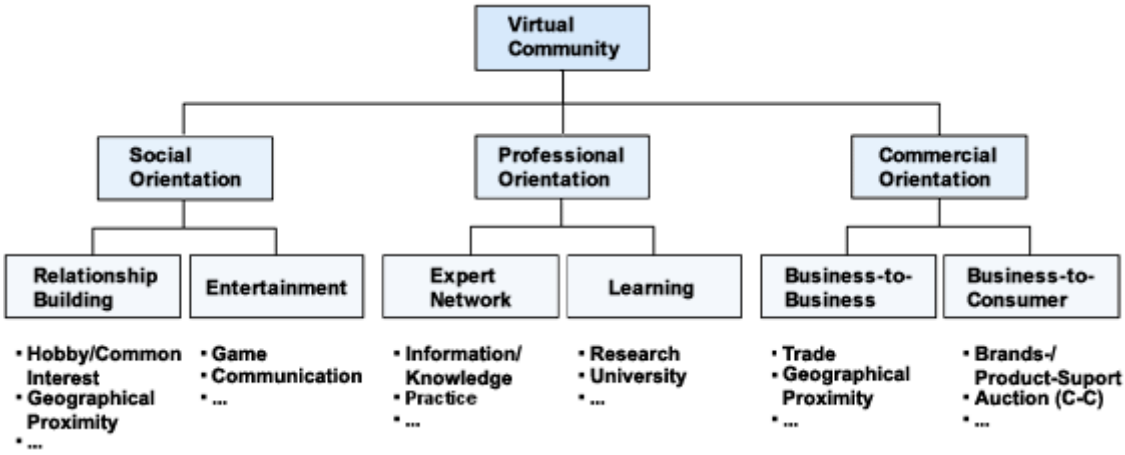

Figure 1: Categories of virtual community types. Extracted from (Markus 2002).

This study is primarily concerned with professional orientated expert networks. Other categories of virtual communities are therefore discussed here for comparison and for demonstration of aspects of approaches or tools that may be useful in this context.

2.1.1 Web 2.0

Web 2.0, also known as Social Computing, is the creation or re-creation of social conventions and social contexts online using software and technology. Web 2.0 refers to the intentional use of the World Wide Web to: facilitate communication; share

information and interoperation between organisations; and collaborate, combining and utilising many existing and newly developed web-based features and functionality.

2.1.2 Virtual Research Community

A Virtual Research Community (VRC) is a virtual community with professional orientation, where the members are aligned by a common research area or field in which they are experienced and skilled and share this experience, skill and results from their work, as visualised in the example schematics of Figure 2 and Figure 3.

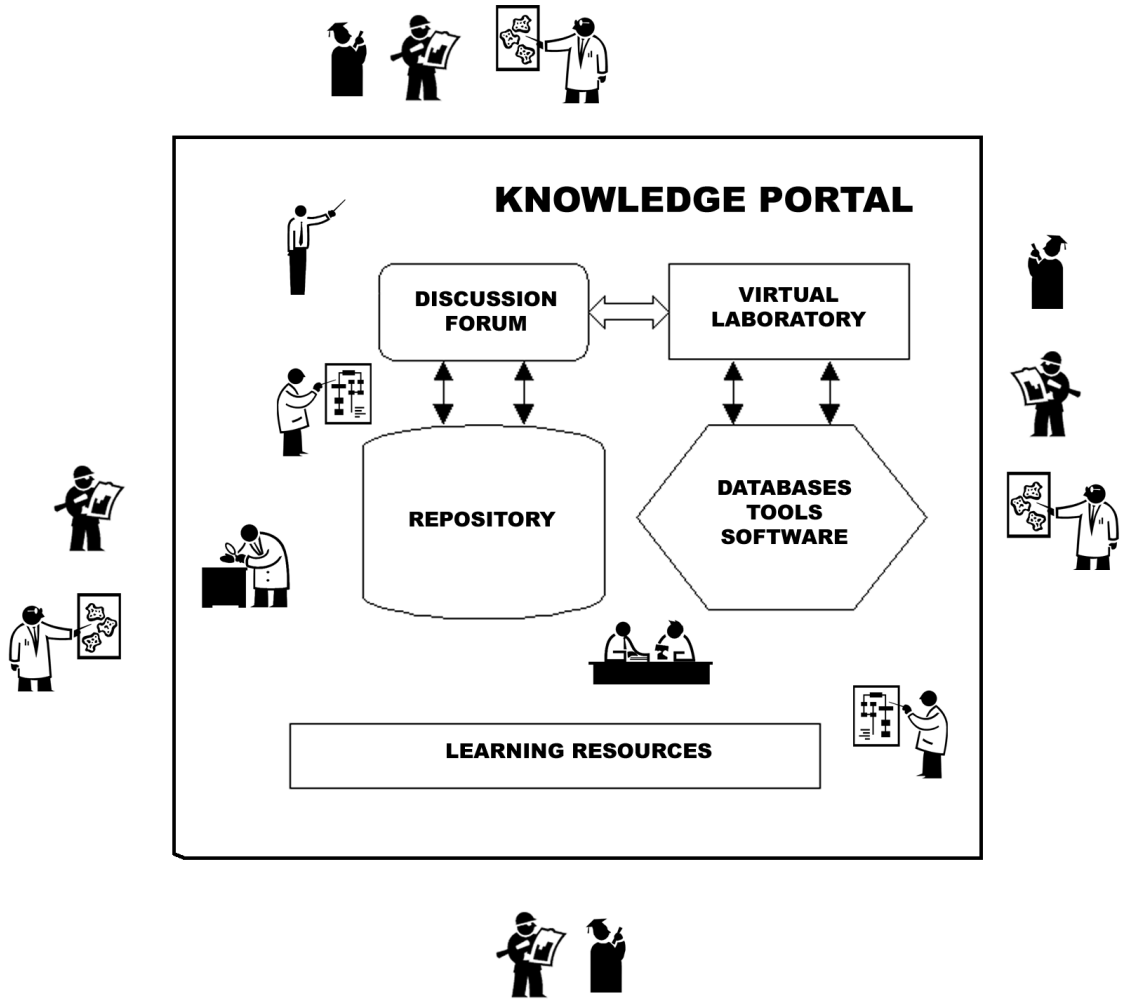

Figure 2: An example of a visualisation of a VRC. Extracted from Kondratova and Goldfarb (2004).

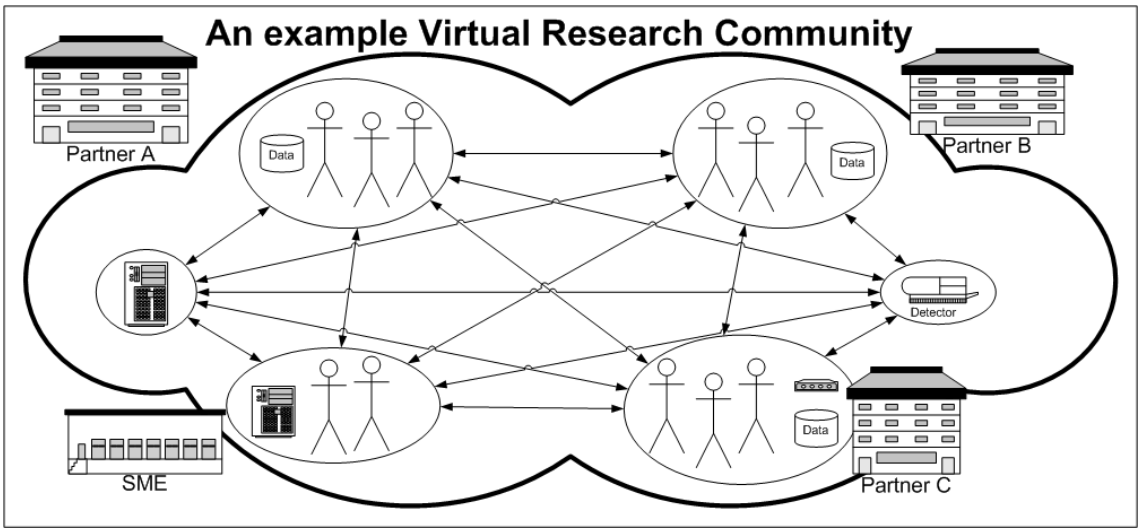

Figure 3: An example of a visualisation of a VRC. Extracted from NeSC (2006).

2.2 Virtual Research Environments

A virtual research environment is the framework within which a group of researchers collaborate on a project via the internet. For example, astronomers sharing telescope data (SDSS 2008), etc.

A VRC provides the context in which a group can form a collaborative project that utilises a VRE. Functionally the VRC provides a forum for the networking and initial discussions of project ideas, the discussion of project progress with an audience outside of the research group, and then the dissemination of project outputs.

VREs combine digital infrastructure and services that can be used to undertake research in combination with existing research infrastructure and polices. These environments include grid-based distributed computing, online tools, content and middleware that can be used to conduct research. (Fraser 2005)

The emphasis is on architecture and standards, not specific applications. A VRE provides the context in which cyberinfrastructure or e-infrastructure is used.

A VRE is about enabling better collaboration.

2.2.1 Science 2.0

Science 2.0 refers to the new and developing practice of scientists openly posting raw experimental results, nascent theories, claims of discovery and draft papers on the internet for others to freely view and comment on. (Kozlowski and Ilgen 2007; OpenWetWare 2007; Schneiderman 2008; Soares 2008; Waldrop 2008b, 2008a)

Concerns have been raised in this area and are under constant discussion. Such concerns include the trade off between potentially having another party use the unpublished results to publish their own work without acknowledging the source of the data or ideas versus the opportunities to brainstorm, form contacts within the direct field, and collectively find better approaches or solutions than the initial one proposed.

This is a very interesting area of current developments regarding open or public collaboration. However this is not the primary focus of this current study, but it is included here for completeness at this stage to serve as a suggestion for ideas for future discussion.

2.2.2 Collaboratory

A collaboratory is an internet-based centre for collaboration on projects over the internet.

A collaboratory is a collaboration of laboratories or a virtual laboratory environment that can be used by remotely located individuals to collaborate on experiments. The form of collaboration may include the online sharing of facilities, equipment, data or documents during creation.

A collaboratory is one example of a VRE or a part of a VRE. A collaboratory typically provides a context for projects to be carried out in a particular area of interest or is based around an e-shared facility or e-shared equipment, whereas a VRE has a broader context.

2.3 Cyber infrastructure/e-infrastructure

Cyber- or e-infrastructure is the core services that a VRC or a VRE works over. These are shared services.

Much of current research has an e-infrastructure component i.e., current research has an amount of digital representation or replacement. For example, even the most basic approaches to an isolated research project have digital components such as electronic copies of reports, electronic data from tests or storage of data. These are all aspects that exist in a digital forum. Full utilisation and integration of these into a larger e-infrastructure framework therefore provides a familiar basis for users to start with and a starting point for developing the e-infrastructure framework for a VRC or VRE.

3. MEASURE OF SUCCESS

With the intent to determine the key components and aspects of successful VRCs and VREs, a way in which to measure the success of each application must be chosen. This section discusses some aspects of determining the success of a virtual community.

Information systems use is a key parameter measuring information systems success. In comparison, virtual communities are typically characterised by anonymity (or some degree of detached identity), addictive behaviour and voluntary behaviour. Therefore it has been suggested that a sense of belonging is crucial for the success of a virtual community, because without it there would be no participation in this community. Therefore this factor has been suggested as an appropriate measure of the success of a virtual community (Lin 2008a).

The following is a summary of some approaches taken to estimate the measure of the success of a virtual community.

DeLone and McLean (1992, 2003) suggested parameters to measure the success of an information system:

- System quality to measure technical success
- Information quality to measure semantic success
- User satisfaction to measure effectiveness
- System use to measure effectiveness
- Individual impact to measure effectiveness
- Organisation impact to measure effectiveness

Preece (2001) suggested some key determinants for measuring the success of a virtual community. The determinants formed two categories: social success factors and useability success factors. Key measureable determinants were identified (Preece 2001):

- For Sociability as:
    - Number of participants
    - Degree of reciprocity
    - Trust
- For useability as:
    - Number of errors
    - Productivity
    - User satisfaction

Data would be collected from a combination of system counts and user surveys.

Lin (2008) examined the success of a virtual community in more detail, expanding on previous information systems approaches. The suggested aspects of a VRC used to determine success can be broken down into (Lin 2008a):

- System Characteristics:
    - Information Quality
    - System Quality

- Social Factors:
    - Trust
    - Social usefulness

Where system characteristics were a measure of member satisfaction and social factors provided a measure of a sense of belonging, when combined this was used to form a measure of member loyalty. A survey was used to collect all the data used for analysis of this success-measurement approach.

Success of a research environment usually manifests, at least, in part, as the production of a body of scientific research that is considered useful and meaningful and may include attracting and retaining a large number of participants. However there are other possible criteria as well, such as other ideas or concepts that were generated that are the basis for other projects or continued work. (Bos et al 2007)

Other research into providing measures of virtual communities, non-virtual communities and other online community-type groups has been performed (Bailey and Pearson 1983; Etezadi-Amolo and Farhoomand 1996). However the approaches are similar, with a range of parameters that are gathered from system data (collected from counters, etc. built into the system e.g. number of members, time spent logged in, number of interactions, etc.) and user experiences and perceptions (collected from surveys). The key for a meaningful measure of success is the choice of balance between system and user data in relation to the intent of the virtual community. Since a virtual community relies on member participation and interaction, the perceptions and satisfaction of the members are key and should be weighted highly compared to other potential success-measurement parameters.

Consistently the issue of having an enthusiastic and active user base is identified as key to a successful virtual community. (Albors, Ramos and Hervasa 2008; Blanchard 2008; Bos et al 2007; Brown et al 1999; Demirkan et al 2008; Griffith and Sawyer 2006; Kondratova and Goldfarb 2004; Lin 2008b, 2008a; McLaughlin 2007) The specific parameter values selected to rate a virtual community provides a comparative level of success. However it is clear that a well financially and technically supported network without compelling applications, supplying new or improved opportunities for research, education and/or societal benefit would prove to be of doubtful value. A successful virtual community needs an enthusiastic membership with champions and the appropriate tools and capability to be able to exploit opportunities as they arise. A framework is needed to ensure that the context of the VRC benefits researchers and society in a powerful, reliable and easy-to-use way. (McLaughlin 2007)

It is also important to note that the framework of VRCs and VREs needs to include opportunities for face-to-face meetings, workshops and conferences to contribute to maintaining a sense of community and belonging and provide opportunities for networking, cooperation and collaboration other than by virtual means. (Griffith and Sawyer 2006; Lin 2008a)

4. GOOD VRCS AND CONTRIBUTION TO RESEARCH

A successful VRC is more than a collection of tools and technologies. It is integrated into business aims, culture and infrastructure, driving performance through better communication.

A VRC must be able to evolve and adapt so that it can be informed by the growth of the members, changes in culture and newly available e-infrastructure.

As a starting point, consider the basic life cycle of a research project to identify the processes and modes of communication that are currently inherent and aspects where these could be incorporated, improved and additional modes be made available via a VRC.

4.1 Communication Aspects of the Lifecycle of a Research Project

Considering the generic intent of a VRC is focused on providing communication supporting aspects of research and information dissemination, then it is firstly important to identify what are the aspects involved currently in executing a research project. Previously, the lifecycle of a generic research project has been suggested as consisting of 10 parts (Wilson 2007):

1. The initial idea and scoping of the research proposal
2. Identifying funding opportunities
3. Finding collaborators and building relationships
4. Creating the research proposal (including contracts, etc.)
5. Costing
6. Submission and approval of the proposal
7. Project administration
8. Undertaking the research
9. Project outcomes (including publication and dissemination, new research proposals, commercialisation)
10. Management of the research portfolio

This 10 part list is discussed in detail in Section 5.1, where each of the aspects of a research project is considered in terms of designing a framework for a VRE.

The aspects of this generic list that would be assisted by the existence of a successful VRC include:

- The initial scoping of the research proposal
    - A virtual library, including integration with existing digital resources
    - Research news feeds, including integration with external information sources
- Finding expertise
    - For scoping of the proposal or for assistance with problems during the research phase.
- Finding collaborators
- Building relationships

- Dissemination of project outcomes

All of these aspects depend on lines of communication and information being available.

4.2 Communication

The general intent of a VRC is to enable communication. The modes of communication utilised by a virtual community include:

- Creation of a non-volatile record of the discussion
    - A record of knowledge sharing for later reference
- Lightweight and searchable content
    - Knowledge stored as text based, with multimedia additions possible
- Support of collaboration of people in different time zones and physical location
- Support of knowledge organisation
    - Use of threading, hyperlinking, etc.

Tools created for one subject-based community have the potential to be plugged into other such communities. A number of generic tools and services have already been developed, especially in the communication and collaboration areas. Some of these tools are already being used in the day-to-day work of some areas or by some researchers. By integrating these tools into a common framework, the network broadens and becomes a more effective and efficient way of communicating. In addition, other potential communication tools can be experimented with within the framework to determine the best tools for which applications within the community.

Some specific tools that could be used to facilitate these include discussion forums, weblogs, wikis, etc. An example selection of specific tools are summarised and discussed in Section 7.2.

4.3 Examples of Virtual Research Communities

A selection of summaries of currently active virtual communities is discussed in the following sections to provide a general overview of how virtual communities have been approached so far.

4.3.1 Examples of Expert Networks

The category of virtual communities based on networks of experts is where a professionally-oriented virtual community focuses on forming a network of experts for particular area(s) of interest. Acquiring and developing knowledge takes place informally and is a result of the personal initiative taken by individuals. An expert network can be formed in-house and across a department or company. (Markus 2002)

4.3.1.1 MyNetResearch

MyNetResearch (Arinze 2009) is an example of an intra-company and intra-field community that is primarily based around a collection of personal portals for international researchers. Experts can be found based on searching personal profiles entered by the individuals. Online organisational tools for collaboration are also available through the website.

This community is a collation of professionals with no specific areas of expertise. However information technology, and computer-related and biological sciences currently prevail as the majority of the profiles.

The functionality of the community consists of:

- Profiles of researchers worldwide
- Project management tools
- Internal site email and chat
- Research News
- Blogs
- Forums
- Wiki
- Job Postings

The combination of ways of finding information and communicating with other experts provides good accessibility. However the broad range of interests and areas of expertise of the membership were found to be dominated by the major fields of interest, as reasonably expected, such that the information on other areas of interest was noticeably very limited when looking at areas outside the major groups of interest. However the range of fields of expertise was impressive and this provided an opportunity for development of multidisciplinary projects. From this experience, it was considered that there is great opportunity for multidisciplinary cooperation and collaboration in a community with a wide range of disciplines. However if this approach is taken then fields of interest must be actively managed to ensure growth, development and adaptation specific to the fields of interest of the community.

This site promotes collaboration by providing opportunities for networking and access to experts and online project management tools. However a framework to facilitate online collaborative projects is not currently available via this site. As the smallest unit this type of network serves is an individual, the framework of this site is based around individuals: their portals to the community and how they interact within the community, etc.

4.3.1.2 Nature Network

The Nature Network (http://network.nature.com) is a USA-based example of a professional networking website for, primarily biologically-oriented scientists around the world. This functionality available for networking of individuals is similar to MyNetResearch, as discussed above, and other professional-based networks for individuals. The Nature Network also has local hubs, which are based on the physical location (e.g. there are local hubs with local events in Boston, London and New York, with others to open as the membership reaches appropriate sizes in other areas).

The network includes:

- A personal profile page that is effectively an online resume for the individual
- Groups for individual laboratories, departments, institutions, a subject of interest, or physical locality
- Discussion forums
- Blogs

- Ability to form a network of online contacts and follow their activity within Nature Network
- Listings of upcoming seminars and conferences
- News feeds and opportunities to post comments, and
- Job listings.

The Nature Network is organised by Nature Publishing Group, which is a publisher of *Nature*, and several other biological, biomedical and clinical journals and online products. The Nature Publishing Group not only uses the internet for disseminating scientific information, but it recognises that it is a powerful medium for "building communities and providing an interactive forum for the exchange of ideas".

The strong linkages with the traditional publishing avenues provide clear usage of and integration with existing modes of communication. The face-to-face meetings of the members integrate traditional networking and information sharing of in person communications to complement the technology-based forms of communication.

4.3.1.3 Linux Community

The Linux community (www.linux.org) is an example of a cross-organization virtual community of software development experts. (Markus 2002) A particularly distinguishing feature of the Linux community is that experts not only exchange their knowledge on software development but develop a collective non-commercial product.

Linux and other similar open source projects are regarded as communities with relatively low commitment, but have strong uniting common values. A particularly strong unifying belief for this community is that software should be developed freely and openly. This community was touted by Markus (2002) as a good example of the statement that "the attractiveness of a virtual community depends on the quantity and quality of the contents generated by its members".

Open source communities can be referred to as a type of "gift economy", where the creations of the collective community are made available to the entire community for free. The community creations may include parts of software, knowledge, or problem solutions. The risk is that members who have not contributed to the project may benefit from the collaborative effort.

4.3.1.4 Aventis Expert Link

Aventis Expert Link (Oldigs-Kerber and Sorensen 2002) is an in-house international network of experts developed for Aventis. The goal of the network was to use existing knowledge more effectively.

The approach taken by Aventis was not only to support people in accessing the right information at the right time, but also in accessing others who have the knowledge. It was found that this was especially valuable in cases where various experts in different areas either work or had worked on similar problems. In addition, redundancy was avoided, productivity improved, and the internal exchange of knowledge meant that Aventis no longer had to invest in external experts.

In the Aventis Expert Link, each individual is the central focus of 'knowledge management' activities. Locating and linking experts (also known as 'expertise location management') plays an important part in the success of this community.

A passive method of identifying the tacit knowledge of each person was used. This particular approach analyses emails and other documents. This builds a picture of the individual's knowledge that is both implicit and explicit based on searches on any number of semantic search options and terms in combination with the job description, as described in the individual's own words. The expert profile is then based on these results where each individual has control over the access others have to view either the whole or parts of their profile.

The advantages of the passive approach taken are that (Oldigs-Kerber and Sorensen 2002):

- Profiles are generated automatically
- Profiles can be updated automatically – immediately and anywhere
- Keywords remain up-to-date
- A search process is used
- Employees are appraised and network building is promoted
- Copyright is not infringed upon
- Data is secure and protected

In comparison an active method would include approaches where a controlled list of keywords are used and maintained by central content administrators explicitly for the purpose of searching and identifying knowledge expertise of individuals, and the profiles of experts would be required to be maintained by each individual.

The locating and linking of individuals, expertise location management or just-in-time availability is growing in meaning and utility compared to "knowledge warehouses" (e.g. document databases such as "lessons learned", expert interviews, debriefing papers, etc.). Quick diffusion of knowledge, or networking of individuals, is the key for meeting the company's high knowledge demand. The individual is the pivotal point of all three aspect of this point – knowledge generation, retention and transfer.

The organisational change was planned as it was acknowledged that the implementation of the locating and linking experts approach to knowledge managements would considerably change some ways in which employees work. The increased direct and indirect contact between employees, and in some cases between individuals who have never met before, prompted the initial requests made of the employees that included:

- Willingness to share existing knowledge
- Willingness to accept the expert knowledge of others (to combat the "not invented here" syndrome)
- Acceptance of saving personal data in a central system
- Connecting with contacts who may belong to different departments, work in different countries, or speak different languages

The approach to the planned organisational change used the model proposed by Porras and Robertson (1992), as shown in Figure 4.

The working environment was divided into four subsystems, in which changes can be initiated and supported:

- organising arrangement (e.g. workers' council, data security officer, management levels, etc.)
- social factors (e.g. announcements, training, internal customer care, etc.)

- physical setting (e.g. work materials, intranet access, work space, etc.)
- technology (e.g. availability of systems for a large number of users, response times for research, required computer configuration, installation processes, etc.).

The goal of using this approach was to influence on-the-job behaviour of employees in a positive way. During the implementation of the Expertise Location Management solution, each of these various perspectives were taken into consideration and specifically designed.

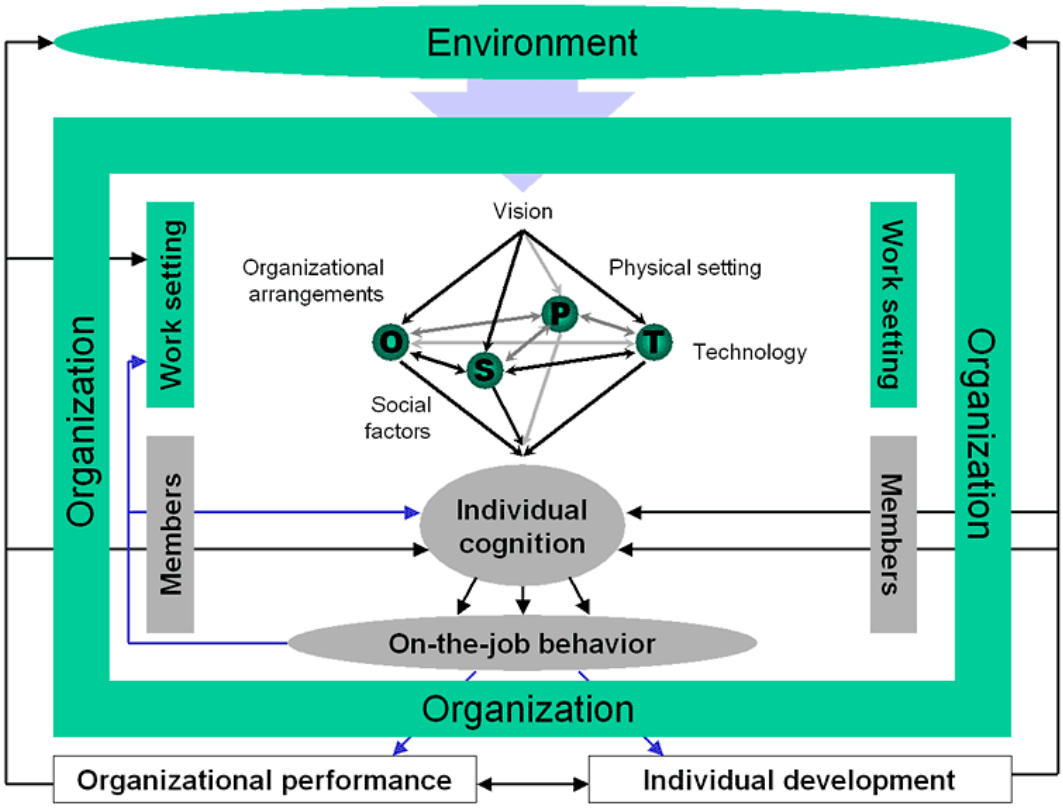

Figure 4: Overview of a model for organisational change. Extracted from Porras and Robertson (1992).

4.3.1.5 NARCIS

National Academic Research and Collaborations Information System (NARCIS) is a project to build a portal for research information which combines structured research information with information from repositories of publication and other scientific results, websites, and news pages of research institutes throughout the Netherlands.

In the Netherlands scientific institutes register current research information and information on research results, like publications, data sets, models, web publications, and patents. NARCIS provides a central facility that allows all these types of information to be searchable at the same time. NARCIS harvests information from the specific information and data repositories of the participating research institutes and gathers other information from websites and new sites via web-crawling. NARCIS is publicly available and it provides an amazing amount of searchable and available information and experimental results.

A directory of the staff of the participating research institutes and a database of researchers in terms of their expertise is also available through NARCIS. However the linkages between individuals listed in the directory is not transparent and the amount of detail available on each of the individuals is limited, typically to contact details and areas of expertise. Linkages between individuals, project groups, and current and past projects may be of use within a virtual community.

4.3.1.6 FDS and Smokeview Discussion Forum

The FDS and Smokeview discussion forum (http://groups.google.com/group/fds-smv) allows interaction between members on the specific topics relating to the use and detail of the software packages. Utilising the functionality of Google Groups (http://groups.google.com/) members can post questions and answers to questions raised by other members, discussions can be viewed by the public, administrators can post files for download, etc. Members have a self-determined level of anonymity, based on the detail supplied during registration. There is not the option for direct linkages with other members within the context of this website, however the small international membership of this area of expertise means that the majority of the members have at least met at real-world events or are known to others via other avenues as well.

This is an example of a very simple approach for the indirect networking of experts for addressing problems and questions in a specific area of interest. This works well for public discussion of ways to use the specific product and problems users encounter. The areas of expertise of individuals are implicit, demonstrated through interactions within the discussions.

4.3.2 Example of Learning Networks

Professionally-oriented virtual communities exist for the areas of education and training where learning is shifted to a virtual environment. The fundamental characteristic of these virtual communities is the common interest in learning or the selected subject matter.

Other than the examples summarised below, other examples of learning-type networks include the in-house training programs (also called 'virtual corporate universities') that are set up as joint ventures between companies and universities. The objective of these in-house virtual training programs is to provide employees with skills and knowledge directly relevant to their work. These programs are often complemented by functions that support the setting up of an in-house expert network (which was discussed in the previous section, Section 4.3.1).

4.3.2.1 Winfoline

Winfoline (winfo.uni-goettingen.de) is an example of a learning network. It is the virtual education network within the German university community for information systems/business informatics. (Markus 2002)

Only students who are registered at one of the four universities are allowed to log onto the system. Each student is registered with a unique user name to preserve online identity.

Winfoline is classified as a 'virtual learning' or as a 'virtual education product'. However a virtual community has to be set up in more and more cases to optimise the complete product. The benefits of studying on the real university campus include:

- forming study groups
- being able to ask the professor questions during the lecture, and
- bumping into other students in the campus café, etc.

These real world benefits can be matched in the virtual campus by:

- discussion forums
- chat rooms, and
- "teletutors" (individual contact with lecturers and tutors for specific questions and problems).

However the discussions within individual knowledge areas are restricted to the semester in which the particular student is taking an exam in Winfoline. Other education-based contents and services can be added, such as establishing contact with companies to find placements or jobs.

The virtual meetings of students are complemented with real meetings that can take place at one of the four founding universities.

In this case, identification of each individual and their interactions is important because of assessment reasons. There are other reasons for requiring stringent identification depending on confidentiality or a need to track contributions explicitly, etc. The combination of virtual experience and face-to-face meetings strengthens the sense of community between individuals and allows for traditional networking and communication modes. As expected for a learning network the framework of the virtual community is based around individual courses rather than individuals. This is consistent with the smallest unit served by this framework being the group of people for each course, where the individual students within each course change each semester.

4.3.2.2 EDUCAUSE Connect

EDUCAUSE Connect (http://connect.educause.edu/) is a USA-based network designed to advance higher education by promoting the intelligent use of information technology. It focuses on helping those who lead, manage, and use information resources to shape strategic decisions at every level. EDUCAUSE Connect is about educating educators, by actively seeking input to the network on the latest international advances, drawing upon the expertise and experience of its members and then disseminating this to the entire membership. It is also an example of an expert network.

In the development of EDUCAUSE Connect it is acknowledged that "the higher education community, as with many other societal segments, is increasingly a set of interdependent relationships that are global in nature, and to achieve its mission, EDUCAUSE must work in collaboration with colleges and universities worldwide" (EDUCAUSE 2008).

A range of resources and activities is available to any interested employees of member organizations. These organisations currently consist of higher education institutions, corporations serving the higher education information technology market, and other related associations and organizations.

The selection of virtual resources available includes:

- Professional development activities

- Applied research
- Strategic policy advocacy
- Teaching and learning initiatives
- Online information services
- Print and electronic publications, including books, monographs, and the magazines *EDUCAUSE Quarterly* and *EDUCAUSE Review*
- Special interest collaborative communities, and
- Awards for leadership and exemplary practices.

The ways in which these are facilitated in the virtual forum includes:

- Constituent discussion groups
- General discussion forums
- Member directories
- Affinity finder for members, topics of discussion and other activities
- Advertisement of professional and volunteer positions
- Collations of discussion archives, publications, and data repositories (e.g. IT benchmarking data, etc.), and
- Information on political and policy issues, and opportunities to participate in discussions.

In addition, emphasis is put on face-to-face meeting experiences. EDUCAUSE Connect organises numerous real-world events throughout each year to gather with members and colleagues. These events range in size from small regional events and specialised topic meetings, to large, comprehensive national conferences.

At the time of writing there were more than 17,000 active members representing more than 2,200 colleges, universities, and educational organisations, including 250 corporations.

Similar to the approach of Winfoline, this community provides courses for its members. However the member base is not as transient, therefore the smallest unit served by EDUCAUSE Connect is the individual. The framework of EDUCAUSE Connect is consistent with this, providing portals and networking opportunities for individuals (in the cut-down version of member directories) as well as group communication forums and courses. Another useful feature is a forum for advertising professional and volunteer positions within the community.

5. SUCCESSFUL VIRTUAL RESEARCH ENVIRONMENTS

Similar to a successful VRC, a VRE must:

- Be integrated with current infrastructure and polices
- Reflect its users and be driven by their needs
- Recognise and foster both formal and information communication, and
- Evolve over time to meet changing user needs.

Specifically for a successful VRE, it must also:

- Facilitate research processes and collaborative research of project teams.

Fraser (2005) stated that a VRE will not be able to facilitate much research if current research infrastructure and polices have not been integrated into it. This is in a similar vein to the infrastructure and policies for a VRC.

In the cases where the VRE belongs to a distributed research group, whether it is distributed over organisations, nationally or internationally, the VRE framework must comprise of an appropriate mixture of the structure (culture, policies and e-infrastructure) of the components that it serves. Furthermore a VRE that is isolated from existing infrastructure and the current research culture will not be a research environment as wished, and will most probably be another under-used internet portal.

The development of a VRE needs to be driven by the requirements of the intended users. The development of a VRE is based on the VRC supporting it, looking inwards to determine the types of research questions undertaken, the approaches taken to address them and the ways of disseminating the findings.

The smallest unit that would be considered within a VRE is a research project team. However limiting a VRE to a specific type of research team with defined roles and structures may neglect more informal teams and potential collaborations which exist in other research contexts. (Fraser 2005)

A VRE must be able to adapt and evolve by learning from the experiences of the projects performed under the VRE.

All of this can be supported by an appropriate selection of generic and specific tools. The University of Nottingham completed the Evaluation of a Large-scale VRE Implementation (ELVI) (Wilson 2007) project that had the initial goals to produce and demonstrate a practical framework for a generic VRE using a userbase of 2000 academic staff and students across five faculties. This project produced useful generic guidelines for the development of VREs. Some of these ideas have been integrated into this report in conjunction with information from other sources and new approaches to these concepts.

5.1 Lifecycle of a Research Project

In order to develop a useful and successful VRE, it is necessary to identify the types of project that are intended to be performed utilising the environment. With specific types of projects in mind, working through the generic list of a research project (as discussed in Section 4.1) will help in identifying what is required and/or desired for each step of a research project performed online. Using specific examples of current or recent projects that are of types intended to be performed using the VRE may prove to provide more specific feedback.

For example, when considering each aspect of the suggested generic lifecycle of a research project, functionality that might be desired by researchers may include (Wilson 2007):

1. The initial idea and scoping of the research proposal
    a. Digital libraries and repositories of reports and access to bibliographies
    b. Lists of available equipment and resources
    c. Brainstorming sessions
2. Identifying funding opportunities
    a. Prior warning of opportunities
    b. Information about eligibility and targeted opportunities
3. Finding collaborators and building relationships
    a. Knowledge and expertise database
    b. Facilitation and support
    c. Networks
    d. Conferences and other events
4. Creating the research proposal (including contracts, etc.)
    a. Examples of proposal templates
    b. Information on IPR, copyright and dissemination implications
    c. Peers to review proposals
5. Costing
    a. Software to do the task – training, manual, etc
6. Submission and approval of the proposal
    a. Track submissions
7. Project administration
    a. Software to do the task – training, manual, etc.
8. Undertaking the research
    a. File and data sharing
    b. Ability to conference and edit and analyse data in real time
9. Project outcomes (including publication and dissemination, new research proposals, commercialisation)
    a. Conferences
    b. Other events
    c. Repository of research reports, conference and journal articles – and compliance with publishing IPR issues
10. Management of the research portfolio of current and future research
    a. Brainstorming sessions
    b. Leadership and direction from within community

The specific requirements for a VRE must be identified by the intended membership for the most appropriate direction to be taken. The desires indicated during this process will influence the direction and functionality of the intended VRE. The desires may be directly supported by a software application or in indirect ways through the research environment or the base VRC.

5.2 Collaboration

Since the intent of developing a framework for a VRE is to facilitate collaborative research, the types of research must drive the development of the framework. That is, by identifying what approaches to research are taken and how researchers work within a team will determine what types of tools are required.

Tools created for one subject-based community have the potential to be plugged into other such communities. A number of generic tools and services have already been developed, especially in the communication and collaboration areas. Some of these tools are already being used in the day-to-day work of some areas or by some researchers. By integrating these tools into a common framework, the network broadens and becomes a more effective and efficient way of collaborating. In addition, other potential collaboration tools can be experimented with within the framework to determine the best tools for which applications within the research environment.

5.3 Dissemination of Findings

The dissemination of findings may be integrated as an aspect of a VRC, which would allow for research outputs prior to the creation of the VRE or projects completed outside the framework to be available to the public.

Research outputs that may be integrated into either a VRC or environment framework could include:

- Research reports
- Raw test data for individual studies
- Collation of data in databases over multiple studies

The specific framework and the way in which the dissemination of research results is integrated depends on the culture and intent of the community which is served and the ways in which current and previous results are available.

Current databases and repositories of reports and data need to be integrated into the new framework in order to retain the current digitally-stored knowledge and then to build on it.

5.4 Collaboratories

A collaboratory is an internet-based way of carrying out scientific research, controlling instruments and/or interacting with colleagues all over the world in an environment that represents a virtual laboratory. Collaboratories are frameworks that are examples of VREs.

Experiments can already be carried out in real time over a network by investigators around the world. Collaboratories enable groups separated by thousands of kilometres to pool their knowledge and work with a global view at the same virtual lab bench. (Kiernan 1997).

It has been suggested that there are seven types of collaboratories (Bos et al 2007):

- Shared instrument:
    - based around the control of specific equipment
- Community data systems:
    - collections of data
- Open community contribution systems:
    - for solution of a common research problem
- Virtual community of practice:
    - network of individuals for communication about a common research area of interest
- Virtual learning community:
    - increasing the knowledge of participants
- Distributed research centre:
    - for conducting joint projects in an area of common interest
- Community infrastructure project:
    - to develop technology resources that facilitate research in a particular area

Collaboratories have been touted as facilitating (Kiernan 1997):

- Changes in the way that science is done
- Breaking down the walls that have confined much cutting-edge research to scientists from elite institutions, by enfranchising scientists at smaller institutes that cannot afford expensive research facilities
- Allowing students to participate in proper scientific research at a much earlier stage in their careers, inspiring and motivating them in a way not possible before.

5.5 Examples of Virtual Research Environments

5.5.1 UARC

Upper Atmospheric Research Collaboratory (UARC) facilitated upper atmospheric physicists from six American universities to make observations of the interactions between the solar wind and the atmosphere over Greenland. The collaboratory was based at the University of Michigan. The system linked the researchers with radar located in Greenland. The radar continuously monitored the upper atmosphere and the data was broadcast in real-time on the UARC website. Real-time computer models were also available through the website. This allowed collaborators to post a 'space weather forecast' (Kiernan 1997).

UARC was established in 1992 and was one of the first and most successful distributed collaborative groups intentionally designed using a VRE framework (CREW 2007).

Instant access to instruments, data and other researchers distributed over the world was the key of the UARC, reducing the time to see collected data from months to being able to view the data while it is being monitored. The UARC interface used a text-based chat window to discuss data with other researchers and to send instructions to technicians. Video was used to provide participants a sense of 'telepresence' (Kiernan 1997).

The large amounts of data transferred within UARC meant that sufficient bandwidth and data transmission capacity was required for the collaboratory to work.

UARC utilises a specialist team to regularly redesign the human-computer interface based on member feedback. It was assessed that the collaboratory had an effect on the science being produced by (CREW 2007):

- Reducing the cost of the accessing complementary expertise through the use of asynchronous collaboration, by relieving scheduling difficulties and reducing travel of participants, and
- Creating more opportunities for students to be involved, with exposure to the community and high-level research earlier in their carrier.

UARC was superseded by the Space, Physics and Aeronomy Research Collaboratory (SPARC 2006).

5.5.2 SPARC

Space Physics and Aeronomy Research Collaboratory (SPARC 2006) (http://www.windows.ucar.edu/sparc/), formerly known as the Upper Atmospheric Research Collaboratory (UARC), is a highly successful USA-government backed data sharing community. SPARC links an international community of space, computer and behavioural scientists with distributed instruments and data.

The collaboratory incorporates satellite and ground-based observational instruments. Supercomputer models are also integrated into the collaboratory.

SPARC not only consists of a framework for the connection of researchers, instruments and data, but has a virtual community that has fostered a sense of team spirit with publically available components for educational use. The publically available portions of the collaboratory includes updates on research projects, general interest information related to space and the high atmosphere, and it also encourages interaction with games and opportunities to 'ask a scientist'. This broadens the virtual community base from the hub of researchers and postgraduate students to include participants from schools and the public.

6. EXISTING E-INFRASTRUCTURE

The e-infrastructure that is selected to support a VRC must integrate existing e-infrastructure. Existing e-infrastructure is discussed briefly in this section to provide a context in which to examine current e-infrastructure of an intended membership.

6.1 Examples of Existing Member E-Infrastructure

Examples of potential current e-infrastructure used by intended members of a VRC that would be valuable to consider during the planning of a framework for a VRC may include but are not limited to:

- An organisation's
    - electronic submission system for forms, proposals, etc.
    - digital collections, such as digital libraries and research repositories, etc.
    - grid and super-computing facilities
    - access management services
    - internet portal
    - virtual learning environment
    - supported communication technologies
    - technology-transfer frameworks
    - digital preservation and curation strategies and storage
- Related industry societies' internet portals

For an international and inter-organisational community, it may not be possible to integrate every one of these aspects of every organisation. It is important to, at the very minimum, include consideration of these aspects during the initial planning of a VRC and to utilise as much of the current e-infrastructure available as practicable in the VRC e-infrastructure.

6.2 Advanced Research Education and Innovation Networks

Large predominantly government-funded high-speed high-capacity e-backbones are present throughout most of the world, in at least 40 countries (*KAREN* 2008). These backbones are implemented to provide state-of-the-art electronic access between hubs on the backbone. The hubs primarily consist of research providers, such as universities and research organisations. These backbones are referred to as Advanced Research Education and Innovation Networks. A summary of some of these current backbones is presented in Table 1.

These backbones provide hardware and electronic access, but do not inherently facilitate communication or collaboration. Virtual communities enable communication and VREs enable collaboration, and these both enable utilisation of the potential of these international e-backbones.

Table 1: Summary of Advanced Research Education and Innovation Networks

Country	Advanced Research Education and Innovation Network	Reference
USA	National LambdaRail	http://www.karen.net.nz/assets/Uploads/pdfmoulambada.PDF
	Abilene	http://www.karen.net.nz/assets/Uploads/pdfabilene.PDF
European Union	GÉANT2	http://www.beliefproject.org/about-e-infrastructures/what-are-e-infrastructures
New Zealand	KAREN	http://www.karen.net.nz
Taiwan	TWAREN	http://www.karen.net.nz/assets/Uploads/Documents/MoUKARENTWAREN.pdf
Singapore	SingAREN	http://www.karen.net.nz/assets/Uploads/Documents/MOU-SingAREN-REANNZ.pdf
Japan	SINET3	Lambda-based Academic Networking Backbone http://www.sinet.ad.jp/login_form/view?set_language=en

6.2.1 New Zealand Example: KAREN

Kiwi Advanced Research Education and Innovation Networks (KAREN) (*KAREN* 2008) is a next generation telecommunications link for New Zealand educators, researchers and innovators. This backbone provides leading edge infrastructure, with high capacity, ultra high-speed (up to 10 GB/s) connectivity to the rest of the world and between New Zealand's tertiary institutions, research organisations, libraries, schools and museums.

Any member of KAREN can connect through it to any other member or to collaborators on other advanced networks internationally. KAREN has an initial 18 members comprising Crown Research Institutes, universities and the National Library. This membership is intended to be extended to include all New Zealand schools, libraries, polytechnics and private sector research organisations. KAREN connects with similar high-speed national research and education networks in Australia and the United States, and through them to networks in Asia and Europe. A schematic of the current topology of KAREN is shown in Figure 5.

KAREN allows:

- The exchange of large volumes of data quickly
- Access to large scale national and international infrastructure, and
- The potential to collaborate better on research and education projects with distributed teams.

The objectives of KAREN revolve around research, education and innovation. The stated objectives of KAREN are to:

- "Enable leading edge e-research

- Facilitate universal connectivity throughout the New Zealand and international research and education community
- Encourage broad participation by the research and education sector in New Zealand through accessible technology and reasonable pricing
- Connect the research and education sector to the broader innovation community for pre-commercial, research and development based collaboration
- Facilitate participation by multiple telecommunications sector partners to ensure the greatest possible flexibility for ongoing evolution" (KAREN 2008)

KAREN has enabled some innovative projects. For example:

- New Zealand geologists and geophysicists access sensor data from fault lines around the world
- Scientists participate in three-dimensional topographical international mapping projects, and
- Students in New Zealand lecture theatres participate in interactive video lectures with experts throughout in the world.

It is intended that KAREN will be continually evolved, emphasising flexibility in functionality, supply, scalability and reach. It is acknowledged that the future development of KAREN will be influenced by the needs of its members.

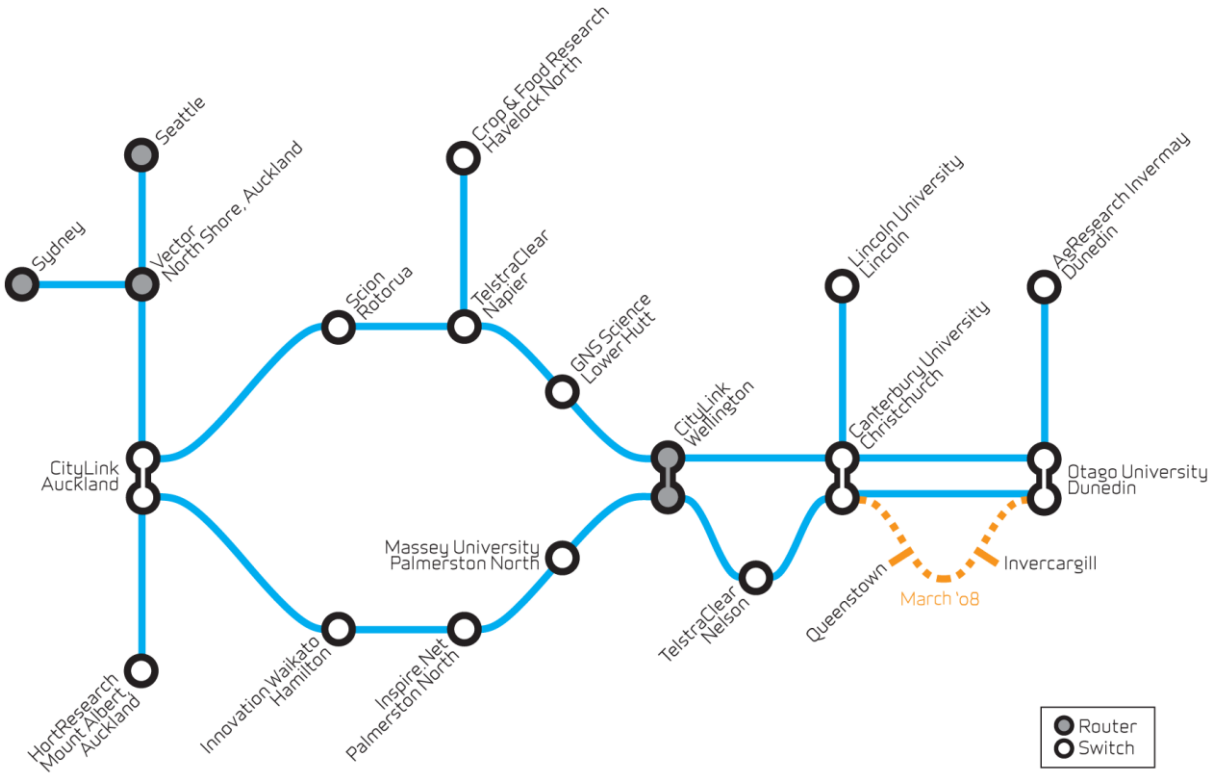

Figure 5: A schematic of the backbone and hubs for KAREN. Extracted from KAREN (2008).

7. OPTIONS AND TOOLS FOR BUILDING A VRC/VRE FRAMEWORK

As a simple overview of how these concepts fit together, the members of any virtual community are the core. The intended members of a VRC determine the culture, policies and current e-infrastructure from which the culture, policies and e-infrastructure of the VRC are developed. A consistency between the current culture, policies and e-infrastructure of the members and those of the VRC must exist in order to provide an initial core connection with the members. Starting from the base determined by the intended membership, a VRC can be developed with appropriate additional complementary policies and e-infrastructure to facilitate communication, information sharing and networking between the members of the community. The framework of the VRC must be developed to be flexible so that it can be adapted as the membership grows and matures and the intent of the group changes as more is learnt through the usage of the e-community.

Building on the base provided by a VRC, a VRE can be developed with additional policies that are specific to the way in which the research environment is intended for uses that are complementary to the policies of the VRC and the members. The framework of a VRE also requires additional e-infrastructure to provide research tools to facilitate research for defined types of projects and/or usage of internet-accessible facilities and/or equipment.

A simple graphical representation of the way these concepts fit together is presented in Figure 6.

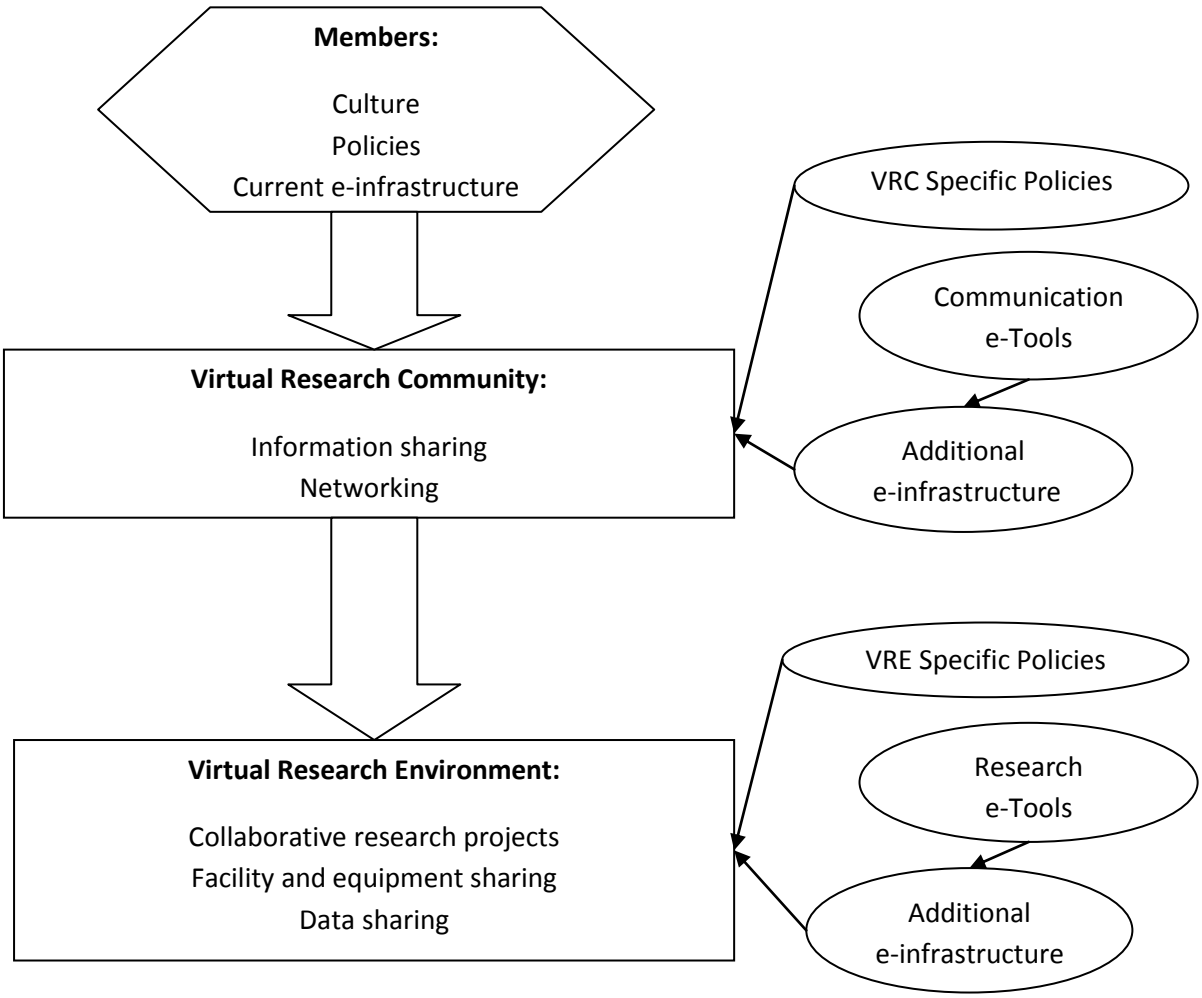

Figure 6: A schematic of an overview of a virtual research community and virtual research environment.

7.1 Selection of Framework Options

A summary of potential basic framework options for the design of a VRC is presented in Table 2. Selection of a combination of these basic framework options can be used to form the architecture for a VRC to align with the defined intent and culture of the community.

Table 2: Summary of framework options for virtual research communities

Framework Type	Brief Description
Individual based	An expert linkage system. Typical style of individual-oriented communities, e.g. Facebook, MyNetResearch, etc.
Thread based	Centred around topics of discussion in a question and answer style, e.g. FDS and Smokeview Discussion Forum, etc.
Information gathering	Collation of information or experiences on specific topics, e.g. specialised wikis, technical databases, virtual libraries, etc.
Data gathering	Collation and repositories of data, reports, etc. When isolated, databases typically fail without integration of tools for user interaction to build a sense of community for users and a framework within which the data is useful.
Presentation based	Lesson/seminar based, integrated with question and answer opportunities, e.g. educational purposes, online seminars, etc.
Work-centre based	Group-based organisation of members and/or data using area of primary interest or types of work. Useful for sharing of online facilities or equipment, or for individual collaborative projects. This may be particularly useful for a VRE, depending on the intent and approach of the specific projects and the research style of the researchers involved.

7.2 Selection of Communication e-Tools

A summary of selected current tools that can be used for internet-based community communication or technology transfer is presented in Table 3. The examples included here are by no means exhaustive nor is their inclusion in this report an endorsement. However these are a selection to provide an overview of the types of tools currently available.

It is reminded that these tools alone do not make a community. It is only when a framework is designed based on the culture and policies of the intended membership and the intent of the community that appropriate e-tools become obvious and when integrated form the e-infrastructure of the virtual community.

Table 3: Summary of a selection of types of communication e-tools

Type of e-Tool	Brief Description
Discussion Forums or Boards	Users participate in a question and answer process, where both the questions and answers are generated any member of the community.
Weblog (Blog)	Encourage first-person storytelling and commenting. This style can be setup to stimulate community discussion (group blogging) using the commenting function.
Wiki	An encyclopaedia-style collation of information contributed to by users in an incremental, version based style
Community Calendar	User accessible calendar to organise and publicise upcoming events
Personal Portals	Personalised websites for the publication of personal information
Voice and Video over IP	The equivalent of phone calls using a computer interface instead that has the option to include video, e.g. Google Talk, Skype, etc.
Instant Messaging	Real-time text-based communication between two or more participants, e.g. Google Talk, Skype, MSN Web Messenger, etc.
Ambient Communications	Micro-interactions of online micro-blogging between friends or colleagues, individuals or groups that can be viewed synchronously or asynchronously. The short updates and communications allow brevity, spontaneity and familiarity. E.g. Twitter, plurk, jaiku.
Image Sharing	Image and visual sharing with integrated Web 2.0 functionality for tagging, notes and discussion of images, e.g. Flickr, Photobucket, etc.
Document Construction	Co-writing shared documents in real time, e.g. Google Docs, etc.
Physical Location	Interactive maps for locating places or identifying regions, e.g. Google Maps, Google Earth, etc.

In general, aspects to consider when making a successful and easy-to-use discussion forum or group blog (Galore 2007) are:

- Create meaningful categories:
    - this assists both automated and manual searching for associated information and keeping track of what topics are generating interest or re-occurring.
- Assign a overseer to monitor posts, encourage comments and, where needed, cajole others into contributing:
    - for a group blog this may be assigned to the individual who created the blog. However for discussion forums this may be more complicated and may require a range of topics to be assigned to individuals or small groups (depending on the size of the tasks, the number of users involved and the range of subject specialities, etc.).

- Record blog site statistics for the numbers of people reading and using the site:
    - this provides useful general information in terms of the assessment of the performance and usefulness of particular information and communication modes in the context of the overall site.
- Make contributing to the site simple for people:
    - use formats that people are familiar with e.g. being able to copy and paste from MS Word, direct emails to the site, other authoring/blogging tools, etc.
- Allow the site to be easily accessed:
    - in addition to internet access, other modes may be used, such as RSS to allow interested readers to be updated without having to check the blog

7.2.1 Summary

To create a cohesive community that uses a blogging approach to communication, issues to address must include (Silva, Goel and Mousavidin 2009):

- Explicit rules for membership
- Presence of moderators
- Available profile information of contributing members
- Explicit definition of site etiquette
- Ways of identifying pertinent posts, and
- Specified techniques for deploying discipline.

These lists of consideration relate to ‘what the tool can be used for’ and ‘how the members use the tool’. The selection of a tool must be appropriate to the desired functionality of the virtual community and the way in which a tool is to be used within the framework must also be consistent with the intended culture of that community.

7.3 Selection of Research and Collaboration e-Tools

A summary of selected current tools that can be used for internet-based collaborative research or technology transfer is presented in Table 4 and discussed in more detail in this section. Similarly to the previous section, the examples included here are by no means representative of the totality of the tools available nor is their inclusion in this report an endorsement. However these are a selection to provide an overview of the types of tools currently available. A selection of example e-tools is also discussed in more detail to provide a snapshot of some current functionality.

Table 4: Summary of a selection of example research and collaboration e-tools

Types of Tools for Collaboration or Research	Example e-Tool
Synchronised File Sharing (remote)	Dropbox, Google Docs
Synchronised File Sharing (maintaining IT control)	MS Office Share Point
Real Time Editing	Google Docs
Real Time Viewing of Presentations/Broadcasts	Google Docs
Project Management	
Resource Scheduling	
Grid-based Computation	Including distributed data sharing, data management and data processing applications (Corcho et al 2006; Venugopal, Buyya and Ramamohanarao 2006)
Data Mining	

Dropbox (https://www.getdropbox.com/) allows the sharing and synchronising of working files between users and computer (including Windows, Mac and Linux platforms) that are stored at a remote site. This tool can be accessed via a internet-based application or can be synchronised within the file structure of your personal computer. Changes made to any shared folder are instantly synchronised with all members of that folder. Dropbox has the ability to share selected files publicly, where files can be accessed without the need to be a Dropbox member. At the time of the collation of this report, the Dropbox was at a beta testing phase and was freeware.

Google Docs (http://docs.google.com/) also allows sharing and editing of files in real time. Google Docs is freely accessible through a Google Account. Files are stored on a remote site. Documents can be created within the Google Docs environment or files can be uploaded (most common word processing, spreadsheet and presentation files are accepted). Multiple people can view and edit a file at the same time, and a chat window provides information on who changed what. Presentations can be followed in real time, with anyone joining a presentation as a viewer able to automatically follow along with the presenter.

MS Office Share Point (http://www.microsoft.com/Sharepoint/default.mspx) integrates a number of e-tools into one commercial package. Such e-tools include collaboration and publication of documents, view and analyse data, task lists, wikis, blogs, local search function, personal MySite portals, targeting of content to specific audiences, workflows and electronic forms. Office Share Point can be integrated with other collaborative products that may form the e-infrastructure of a VRC and/or environment. IT control

can be maintained in-house. This package is intended as enterprise-scale and may not be appropriate for a decentralised approach to the management of a virtual community or research environment, depending on the implementation requirements.

AGORA (http://agora.lancs.ac.uk/) (Fish and Gonzales-Losa 2007) is an online open-source meeting tool. It can be used to video conference multiple people in virtual meeting rooms, share a desktop in realtime, share a virtual whiteboard, instant message another user of AGORA, broadcast movies and record any of these sessions for later broadcast and/or analysis. AGORA needs to be integrated with Saki (http://www.sakaiproject.org/portal) before it can be utilised. Saki is open-source software developed for the support of the education environment, including teaching, research and general project management. Saki provides the basis for a portal-orientated network.

7.3.1 Summary

When selecting a collaboration tool, a good tool can be generally evaluated in terms of whether it (Lomas, Burke and Page 2008):

- Promotes communication,
- Has the ability to facilitate expected collaboration (defined by what is required to be shared and to what extent),
- Allows natural interactions, and
- Is easy to use and learn.

However consideration would need to be made of the functionality of the individual tool or a set of tools in terms of the intended type of collaboration and overall research environment. Some aspects for consideration that may be useful would include (Lomas, Burke and Page 2008):

- Number of collaborators:
    - the limit of how many that can use the tool
    - the limit of where the tool is effective
- Synchronous versus asynchronous collaboration:
    - real-time versus turn based
    - time zone differences
- Public versus private sharing of information:
    - some stages or components may be shared with a wider audience
- Discoverable collaborators:
    - are collaborators pre-arranged or invited or is wider access available?
    - does exclusivity provide robustness or security?
- Ownership of contributions and products:
    - identify this at an early stage of the collaboration
- Level of engagement:
    - the intended tone of engagement may be playful to serious.
- Social:

- allowing serendipitous discovery of peers, friends and topic of interest based on an individual's profile
- what level of personal interaction is desired?
- can individuals connect with and work with others in a compatible way?

Similarly, it is restated that tools alone do not make a research environment. It is only when a framework is designed based on the culture and policies of the intended membership and the intent of the research environment that appropriate e-tools become obvious and, when integrated, form the e-infrastructure of the VRE.

8. STRATEGIC FRAMEWORK DEVELOPMENT

We speak of collaboration between the organisations in our fields and the valuable potential benefits to research. Research is fundamentally about achieving meaningful outputs. Therefore the concept of VREs is tempting. However VREs created for individual projects or research programs will be limited to those intended projects. To create a framework within which research environments can be formed as required a coherent basis is required. This basis would facilitate both the initial phases of conceptualising the project and the final phases of distribution of the results outputs. A VRC can provide a coherent basis for a range of VREs for specific projects. Therefore it is recommended to implement a VRC before venturing onto developing VREs.

8.1 Virtual Research Community

The following is a suggestion for one strategy for the development of a framework for a VRC. This strategy needs to be implemented by a core group of leaders in consultation with the intended membership, developers and maintainers of the VRC. The issues, decisions, development and technical background are to be documented throughout the stages of the development of the VRC. This documentation would form the formal framework description and operation manual for the VRC.

Development of a framework for a Virtual Research Community:

1. Identify the intent of the VRC
    a. The objective or mission statement that provides a context for the framework of the VRC.
2. Identify stakeholders.
3. Identify the desired membership, including:
    a. The intended size of the membership.
    b. The type of membership that will be included, e.g. researcher (industrial or academic), students (undergraduate or postgraduate), users of research, funders of research, general public, and at what stages of development of the VRC would these groups be integrated.
    c. This provides the context in which to start to determine the culture and policies of the VRC.
4. Identify champions of the VRC
    a. These people need to be self-selecting
    b. The champions need to be from a range of aspects of the desired membership
    c. The champions will form the heart of the core team for the development of the framework
    d. The champions provide a line of two-way communication to the desired membership during the development of the framework
    e. The champions provide a leadership within the implementation of the VRC
5. Identify:
    a. Developers of the VRC
    b. Initial test membership for the prototype VRC
    c. Maintainers of the VRC

6. Select high-level champions
    a. The high-level champions do not need to be involved directly in the development of the framework or the day to day running of the Community
    b. The high-level champions perform the function of high-level advertisers and monitors i.e., they may passively support the Community and be asked to intervene from time to time when needed on difficult issues that may arise within the Community.
    c. The people selected for these positions must be well-known and highly respected within the membership intended for the Community.
7. Revaluate the intent and scope of the VRC
    a. As the potential membership is determined more accurately and feedback is obtained, the intent and scope of the VRC must be reassessed.
8. From the identified desired membership, identify the current
    a. general culture
    b. policies
    c. digital processes used
    d. problems and items of concern or frustration in the current processes of research, and
    e. expectations and desires of a VRC.
9. Based on the feedback of the intended membership:
    a. Identify the appropriate culture and policies for the VRC
    b. Develop user scenarios
    c. Identify the functional requirements of the VRC. Include a rating of the priority of each of these requirements
    d. Identify the non-functional requirements of the Community (i.e. *how* the Community and interface should function instead of what it should *do* or *include*)
    e. Identify the incomplete (or future) requirements. Keep a record of items under development and ideas for future developments.
10. Form the architectural design of the VRC:
    a. Based on the assessment of the feedback of the intended membership, identify the appropriate modes and types of communication styles that are in alignment with the intended membership and the intent, culture and policies of the VRC.
11. Design a prototype VRC:
    a. Collate a list of specific e-tools that can be used to achieve for the communication modes and styles identified in Point 10. Identify which e-tools are already used by the intended membership and the extent of use. Identify advantages and disadvantages of each in terms of the member useability, the VRC intent, culture and policies
    b. Select the suite of e-tools appropriate for the VRC
    c. Identify the hardware, software, development and training required

    d. Assign leaders and development teams to each aspect of the proposed VRC
    e. Schedule a development timetable for the aspects of the proposed prototype

12. Develop the prototype VRC.
13. Specify the testing plan for the beta VRC:
    a. Identify a testing strategy, listing tests (automated tests, functional tests, useability tests, compatibility tests, load tests, etc) to be performed and evaluation to be completed and returned to developers
    b. Specify acceptance criteria
    c. Identify stages for implementation of the aspects of the beta VRC. The implementation includes a prototype of each aspect and a series of cycles of changes based on interactions between users and developers
    d. Prioritise the implementation stages of the VRC
    e. Assign leaders to each of the implementation stages, or aspects of each of these stages if appropriate
    f. Schedule the implementation stages.
14. Perform beta testing.
15. Evaluate beta testing feedback:
    a. Development team to assess required changes.
    b. Implement changes to the beta Community, returning to Point 13 if required.
16. Schedule a target deployment date for the public release.
17. Specify a maintenance plan:
    a. Schedule a revision and adaptation assessment for the overall and aspect performance of the VRC as a formal evaluation of the progress, usefulness and effectiveness of the Community. This forms an opportunity for the planning of required changes and future direction of the VRC based on practice. This is expected to be an ongoing periodic assessment that can be adapted according to the growth and performance of the VRC.

8.2 Virtual Research Environment

Building on the foundation of the development of a prototype VRC, the following is a description for one strategy for the development of a framework for a VRE. A similar approach as suggested for the development of a VRC is that this strategy needs to be implemented by a core group of leaders in consultation with the intended membership, developers and maintainers of the VRE. The issues, decisions, development and technical background are to be documented throughout the stages of the development of the VRE within the context of the VRC, forming a manual containing the formal framework and operational procedures for the VRE.

Development of a framework for a Virtual Research Environment:

1. Identify the type(s) of projects that will be performed within the VRE
    a. Identify the scope of the types of projects that would utilise this environment.
2. Identify the intent of the VRE
    a. The objective or mission statement that provides a context for the framework of the VRE.
3. Identify stakeholders.
4. Identify the desired membership, including:
    a. The intended size of the membership
    b. The type of membership that will be included, e.g. researcher (industrial or academic), students (undergraduate or postgraduate) etc
    c. In conjunction with the culture and policies developed for the VRC, this provides the context in which to refine the culture and policies of the VRE
5. Identify champions of the VRE:
    a. These people need to be self-selecting
    b. The champions need to be from a range of aspects of the desired membership
    c. The champions will form the heart of the core team for the development of the framework
    d. The champions provide a line of two-way communication to the desired membership during the development of the framework
    e. The champions provide a leadership within the implementation of the VRE.
6. Identify:
    a. Developers of the VRE
    b. Initial test membership for the prototype VRE
    c. Maintainers of the VRE.
7. Revaluate the intent and scope of the VRE:
    a. As the potential membership and types of project to be conducted is determined more accurately and feedback is obtained, the intent and scope of the VRE must be reassessed.

8. From the identified desired membership of the VRE in conjunction with the established VRC, identify the current:
    a. general culture
    b. policies
    c. digital processes used
    d. problems and items of concern or frustration in the current processes of research, and
    e. expectations and desires of a VRE.
9. Based on the feedback of the intended membership:
    a. Identify the appropriate culture and policies for the VRE
    b. Develop user scenarios
    c. Identify the functional requirements of the VRE. Include a rating of the priority of each of these requirements
    d. Identify the non-functional requirements of the VRE (i.e. *how* the environment and interface should function instead of what it should *do* or *include*)
    e. Identify the incomplete (or future) requirements. Keep a record of items under development and ideas for future developments.
10. Form the architectural design of the VRE:
    a. Based on the assessment of the feedback of the intended membership of the research group(s), identify the appropriate modes and types of research styles that are in alignment with the intended membership and the intent, culture and policies of the VRE.
11. Design a prototype VRE:
    a. Collate a list of specific e-tools that can be used to achieve for the communication modes and styles identified in Point 10. Identify which e-tools are already used by the intended membership and the extent of use. Identify advantages and disadvantages of each in terms of the member useability, the VRE intent, culture and policies
    b. Select the suite of e-tools appropriate for the VRE
    c. Identify the hardware, software, development and training required
    d. Assign leaders and development teams to each aspect of the proposed VRE
    e. Schedule a development timetable for the aspects of the proposed prototype.
12. Develop the prototype VRE.
13. Specify the testing plan for the beta VRE:
    a. Identify a testing strategy, listing tests (automated tests, functional tests, useability tests, compatibility tests, load tests, etc) to be performed and evaluation to be completed and returned to developers
    b. Specify acceptance criteria

c. Identify stages for implementation of the aspects of the beta VRE. The implementation includes a prototype of each aspect and a series of cycles of changes based on interactions between users and developers

d. Prioritise the implementation stages of the VRE

e. Assign leaders to each of the implementation stages, or aspects of each of these stages if appropriate

f. Schedule the implementation stages.

14. Perform beta testing.

15. Evaluate beta testing feedback:

    a. Development team to assess required changes

    b. Implement changes to the beta Environment, returning to Point 13 if required.

16. Schedule a target deployment date for the public release.

17. Specify a maintenance plan:

    a. Schedule a revision and adaptation assessment for the overall and aspect performance of the VRE as a formal evaluation of the progress, usefulness and effectiveness of the Environment. This forms an opportunity for the planning of required changes and future direction of the VRE based on practice. This is expected to be an ongoing periodic assessment that can be adapted according to the growth and performance of the VRE.

9. ASSESSING POTENTIAL MEMBER CURRENT STATES

Before initiating the planning stage of a VRC, it is useful to have an understanding of the current culture and specifically the current communication pathways and modes of communication of the group of people that are the intended membership of the VRC. The following describes the initial approach to collating this information.

9.1 Survey/Email Interview

The intent of the survey was to identify the current state of the research environment, current practices and needs or desires to improve the current state or practices or facilitate new opportunities for these.

A loosely structured survey was designed to identify the steps used in the initial stages of a potential project and the final stages of disseminating the outputs. The loose structure was intentionally chosen to provide the interviewee with a broad spectrum of possible answers, instead of a more traditional approach to an interview where the questions are designed to lead the answers in a predefined direction. The breadth of answers were welcomed as this provided further insight and discussion points that led to other ideas and concepts for potential solutions.

The initial interview questions consisted of:

- What is the typical output of your research projects?
    - how is this disseminated? where? when?
- When starting from the initial idea for a potential research project:
    - what are the processes you use?
    - where do you look?
    - who do you talk to?
    - how do you avoid duplication?
        - are there any examples where this did or did not work?
- In terms of needs:
    - how could these processes be easier for you or more efficient?
    - what would make these processes easier for you?
    - what would you like to see?
    - are there any tools that you would like available?

An example of the email interview used is included in Appendix A.1.1. A brief summary of preliminary results collated for the international fire research field are presented in Section 9.2.

9.1.1 Communication Matrix

In order to assess the modes and paths of communication currently in use, a communication matrix was used. The paths of communication of interest are between:

- An individual and:
    - other individuals within the individual's organisation
    - groups within the individual's organisation
    - other individuals outside the individual's organisation

    - groups outside the individual's organisation
    - other organisations.
- The research group the individual belongs to and:
    - individuals within the individual's organisation
    - groups within the individual's organisation
    - individuals outside the individual's organisation
    - groups outside the individual's organisation
    - other organisations.
- The organisation the individual belongs to and:
    - individuals within the individual's organisation
    - groups within the individual's organisation
    - individuals outside the individual's organisation
    - groups outside the individual's organisation
    - other organisations.

The types of information of interest that are communicated via these pathways were selected as:

- General information, consisting of informal and formal contact modes
- Dissemination and/or access to existing research
- Awareness of current and/or future research, and
- Funding.

An example of the communication matrix is shown in Appendix A.2. An example of the email interview used to fill this matrix is included in Appendix A.1.2.

The modes of communication are what are inserted in the elements of the matrix. Modes of communication may include discussions at lunch in a common cafeteria, email, phone calls, visiting offices, newsletters, blogs, magazines, project meetings, staff meetings, conferences, other technical meetings, etc.

A communication matrix may not have pathways for all of the elements. These voids indicate lack of communication pathways in the current framework. They may be associated with the specific position of the individual or may indicate opportunities to improve the current communication pathways.

It is possible that one mode of communication covers multiple elements of the communication matrix. For example, an organisation's newsletter or magazine that is distributed internally and externally may provide communication pathways between individuals (if there are summaries of current work of groups, selected profiles of individuals, etc.) or groups or organisations depending on the content.

Analysis of completed matrices by a range of levels (both technical and managerial) of people in one group or an organisation or an international field of research provides a overall picture of how people are gaining their information, what modes of communication people utilise and where there are potential gaps in the intended communications. This provides a useful basis for planning changes or the introduction of new ways of communicating. It also provides a good starting point for discussion of what people want in terms of gaining information and having access to others.

9.2 Example Results using International Fire Research

The results from a relatively small number of respondents from a range of international fire research groups were initially surveyed.

9.2.1 Processes of Initial Scoping

As expected, the general processes used for the initial scoping of concept or idea for a potential research was similar, with the differences stemming from the specific tools available for each group. The tools used ranged from personal databases, in-house databases, combined university-based databases, and general search engines.

From the responses, it was also clear that early-career researchers relied on the support of colleagues for guidance as to where to look and who to contact regarding certain fields or questions. On the other hand established researchers were confident that they had a sufficient knowledge of the field and strong personal contact with group-, organisational- and international -colleagues to assess who they specifically needed to contact for information, if required.

9.2.2 Self-Identified Needs

In terms of indicated needs to facilitate more efficient research, items were raised including:

- Information availability:
    - when looking for what other people have done in an area that the researcher is not an expert in, the outcomes are currently hit and miss. Therefore a way is needed to increase the confidence in the identification of relevant work
    - access to large powerful databases
    - an informal discussion forum within the fire community to facilitate exchange of information concerning on-going research that has not yet been published.
- Language barriers:
    - initial searching of potential papers/documents in a range of languages
    - enough detail available to make a decision on whether to get the document translated.
- Research exchange barriers between countries where there is typically little technology transfer
- Frequent interaction with other researchers at various venues such as conferences
- A way of receiving briefs about on-going research activities in relevant/selected areas
- Everything in one location:
    - centralised repositories
    - current research projects
    - lists of expertise worldwide

- what has been done or written versus anecdotal information e.g. why researchers did not go down a certain track?, or what did not work? and why it did not work?
- advertising interesting project ideas or fire research positions.

- More collaboration with other fire research organizations.

9.2.3 Other Items to Consider

Some pertinent results from comments that were not expected included:

- Avoiding duplication is not necessarily the penultimate, as sometimes there is a need to duplicate previous work to develop a thorough understanding. However this needs to be performed in the context of having an understanding of what has previously been done.

Other items to take account of during the planning include other similar initiatives that may be being developed in the area, so that a holistic outcome can be achieved. For example, items for inclusion within the international fire field such as:

- CIB W014 Commission on Fire.

9.2.4 General

These results, in combination with the results with more respondents, would be useful in the further development of a VRC and VRE for international fire research.

10. SUMMARY

Successful VRCs and VREs stemming from the communities add value to research.

The development of a successful VRC or a VRE must:

- Be integrated with current policies and infrastructure
- Reflect its users and be driven by their needs
- Recognise and foster both formal and information communication
- Evolve over time to meeting changing user needs, and
- Actively (for a VRC) or passively (for a VRE) facilitate research processes and collaborative research of project teams.

A summary of the steps that need to be taken to develop a framework for a VRC includes:

1. Identify the intent of the VRC
2. Identify stakeholders
3. Identify the desired membership
4. Identify champions of the VRC
5. Identify developers, initial membership, and maintainers of the VRC
6. Select high-level champions
7. Revaluate the intent and scope of the VRC
8. From the identified desired membership, identify the current/existing culture, policies and infrastructure
9. Form the architectural design of the VRC based on integrating existing culture, policies and infrastructure with available infrastructure and tools
10. Form the architectural design of the VRC
11. Design a prototype VRC
12. Develop the prototype VRC
13. Specify the testing plan for the beta VRC
14. Perform beta testing
15. Evaluate beta testing feedback
16. Schedule a target deployment date for the public release
17. Specify a maintenance plan.

A similar summary for the steps that need to be taken to develop a framework for a VRE is included in Section 8.2. The recommended strategy for development is similar to that proposed for a VRC. However the focus for the environment is strongly dependent on the types of research intended.

A survey of the intended member for the VRC and VRE provides useful insights into the processes currently employed in general and in specific projects, the tools currently used and the needs, desires and expectations of the potential users. This provides

information that can be used in the design of an appropriate framework that integrates current culture, policies and infrastructure.

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APPENDIX A SURVEY MATERIALS

A.1 Email Interview/Survey

The email versions of the survey and communication matrix are presented in Appendix A.1.1 and A.1.2 respectively.

A.1.1 Email Survey of Research Methods and Processes

These questions are intentionally vague, because your opinions and comments are the goal of this survey. Therefore if any question is too vague, please ask for clarification.

Please type your answers and comments in the box following each set of questions. If something doesn't apply to you or you don't have a comment, leave the box blank. All comments and even questions are appreciated.

Part 1:

As an experienced researcher, when forming an idea into a research proposal…

or as a relatively new researcher, when performing a literature review on a new project…

List the general processes you use.

(Some prompts that may assist:

- Where do you start looking for information?
- Who do you talk to, and why (close by, have more or different knowledge from me, etc)?
- What databases do you search and why (availability, what is good/advantageous about them)?
- Where else do you look?
- If you don't know who works in the specific area, how do you find out?)

…

How do you avoid duplication of what has previously or recently been done or is currently being done?

…

Do you have any examples where this strategy didn't work? Please describe what went right and wrong in this case.

…

How could these processes be easier for you or more efficient?

…

Assuming an ideal world and that you could have what you wished for, what would make this/these process(es) easier for you?

…

What would you like to see?

…

Are there any tools that you would like available that would make it more useful to know what is going on in the fire research world?

…

Once the research project has been done, how do you disseminate the information? Where do you publish it? What other ways do you let people know what brilliant work you have been doing?

…

What are the designed audiences for each of these?

How could these processes be easier or more for you to communicate your good work to others in the fire field or funding bodies or end users?

…

What would you like to see?

…

A.1.2 Email Survey of Communication Methods and Processes

These questions are again intentionally vague, because your opinions and comments are the goal of this survey. Therefore if any question is too vague, please ask for clarification.

Please type your answers and comments in the box following each set of questions. If you aren't involved in some of these types of communication paths, then state this. All comments and questions are appreciated.

Part 2:

Within your organisation, what are the **informal** (e.g. over morning tea, at after work drinks, walking down the hall to the next office, etc.) ways that you find out about:

What other individuals in your organisation are working on?

…

What work/research your group is doing?

…

What work/research is going on in your organisation?

…

What are **informal** ways that you find out what other individuals in other organisations are working on?

…

What are **informal** ways that you find out what work/research other fire research groups are doing in other organisations?

…

Within your organisation, what are the **formal** (e.g. meetings, publications, email, phone calls, etc.) ways that you find out about:

What other individuals in your organisation are working on?

…

What work/research your group is doing?

…

What work/research is going on in your organisation?

…

What are **formal** ways that you find out what other individuals in other organisation are working on?

…

What are **formal** ways that you find out what work/research other fire research groups are doing in other organisations?

…

Within your organisation, what are the ways that you:

disseminate your work to other individuals/ access existing work of others?

…

disseminate your work to your research group/ access existing work of your research group?

…

disseminate your work to your organisation/ access existing work of your organisation?

…

What are the ways that you:

disseminate your work to other individuals in other organisations/ access existing work of others in other organisations?

…

disseminate your work to research groups outside your organisation/ access existing work of research groups outside your organisation?

…

What are the ways that you gain awareness of current and future research of others and describe your current and future ideas for research:

between you and other individuals?

…

between you and your research group?

…

between you and your organisation?

…

between you and individuals in other organisations?

…

between you and research groups in other organisations?

…

between your research group and research groups in other organisations?

…

A.2 Communication Matrix

		Informal contact			Formal Contact			Propagation/Access to Existing Research			Awareness of Current/Future Research			Funding		
		Individual	Group	Organization	Individual	Group	Organization	Individual	Group	Organization	Individual	Group	Organization	Individual	Group	Organization
Intra-Organisational	Indiv.															
Inter-Organisational	Indiv.															
	Group															
	Organiz.															

APPENDIX B SUMMARY OF OTHER ITEMS FOR CONSIDERATION

B.1 Potential Barriers to a Virtual Community or Research Environment

Issues identified as potential barriers to a virtual community or research environment by the research team working on the Evaluation of Large-scale VRE Implementation project were (extracted from (ELVI 2008)):

1. Engagement
2. Culture
3. Baggage
4. Resistance
5. Politics
6. Cost and resources

B.2 Personal and Privacy Issues

A summary of additional issues for consideration during the development of a framework for a VRC and a VRE may include:

- Security of information
    - Security by obscurity for important instruments, etc.
- Anonymous versus non-anonymous access
    - Parts of the framework may be publically available and other only accessible by registered members
- Personal privacy
- Policy and operational details for dealing with inappropriate material from users