VIRTUAL RESEARCH INTEGRATION AND COLLABORATION

PROCEDURAL REPORT

PROCEDURAL REPORT PREPARED FOR THE JOINT INFORMATION SYSTEMS COMMITTEE (JISC) OF THE UK HIGHER EDUCATION FUNDING COUNCIL

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EXECUTIVE SUMMARY

The introduction of the research governance framework in the beginning of the 21st century heralds reforms in the healthcare research management that are likely to remain. They are designed to ensure scientific integrity in clinical studies and to assure the quality of results. Refining methodology and improving quality, may be achieved at the cost of little 'added value' and the potential loss of lower grade (but still useful) information. The consequence of these reforms is a cost of around £1,000,000 for a randomized controlled trial generating level 1 or level 2 evidence and little opportunity to support other methods of study.

There are as a conservative estimate, around 10^5 concepts in orthopaedics alone, interacting with 10^6 in medicine, so the idea of refining the top down model of targeting a few worthy research questions where opinions are in equipoise may offer benefit in a few discrete areas – such as the *Clinical Trials of Investigational Medicinal Products (CTIMPs)* but the argument for research managed in such a cost prohibitive way to reduce the relatively small perceived bias, when there are over 300 different kinds of joint replacement worldwide (for the knee) means that we need to adapt approaches that apply academic rigour and ensure compliance with regulations whilst also allow for different methodologies such as audit of service, the data mining of large registries and supporting the next generation of researchers and clinician scientists.

The aims of the project were to develop a VRE to enable clinicians creating research projects to collaborate in sharing and reviewing components of internet managed trials. To analyse if the VRE could be robust enough to comply with the evolving regulatory framework we employed the MRC model of trial design as adapted for the RNOHT. The overall approach was that of co-design, between researchers from orthopaedic surgery and computer science. The aims of the project were agreed at the start, but the details were shaped by interaction with the research community. The co-design and co-deployment approach ensured user engagement throughout the development and deployment. A test driven iterative/agile approach to development was undertaken to ensure that regular delivery of a system was achieved.

Over 30 researchers are registered on the VRE in the current Beta testing stage in 10 major projects, ranging from University undergraduate students to senior lecturers and professors. This involves projects that have National and International funding. They are using the tools to manage aspects of their studies.

The greatest impact has been at a deeper level in the clinical community, where research has approximately halved in recent years, partly due to tightening regulations and reduced funding opportunities but also due to the preferred use of clinicians to meet the rising demand for service delivery. We now have a VRE aimed specifically at translational research in the biomedical domain, which will facilitate the discussion and development of this research area providing ready access to the expertise of such clinicians without requiring their regular physical attendance.

Other beneficiaries in an indirect way should be the general population, who will also benefit, as these studies can be performed at greatly reduced cost, so that more effective interventions are researched and developed, having a direct impact on the nation's health. Costs should be reduced as the VRE provides a space where researchers asynchronously and in disparate locations may interact and conduct research collaboratively without incurring in travelling costs, administrative expenses (paper handling, printing) and also reducing response time to complete research tasks.

The benefits of the VRE on the community of students, for instance those undertaking iBSc, MSc and PhDs in the field of musculoskeletal science, will come from having the tools support to peer review their work, seeing and doing good quality research first hand, and receiving help from others more experienced researchers in conducting basic science studies. This VRE could become instrumental in training the future generations of musculoskeletal scientists or other communities of students which would benefit from the advantages of co-learning from peers.

PROJECT REPORT GOALS

This Procedural Report is created to accomplish the following goals:

- Review and validate the procedures employed in achieving effective co-design and success of the project from the perspective of the end users.
- Confirm outstanding issues, risks that have arisen, and recommendations for future work.
- Outline tasks and activities required to close the project and ensure that the progress made is harnessed in future projects and importantly routine practice.
- Identify project highlights and best practices for future projects including developments in learning strategies as well as providing an educational infrastructure.
- The three main areas for development that should be run independently and tested separately are:
  1. System for managing the running of a randomised clinical controlled trial (RCT)
  2. System to managing student projects
  3. System from managing audit of clinical project

THE PROJECT: PURPOSE, SYNOPSIS - AIMS AND OBJECTIVES

This project report is the procedural document prepared in conjunction with the development team at the Learning Societies Lab of the Electronics and Computer Science (ECS) School of the University of Southampton. We have been involved in the co-design and co-deployment of the VRIC project throughout its duration. This report is prepared for the sponsors of the work, the Joint Information Systems Committee (JISC) of the Higher Education Funding Council (HEFC).

JISC are involved in multiple projects developing technology platforms to advance education, and thus this report reflects the learning experiences, and identifies some aspects of best practice which can be forwarded to future projects. It highlights which open issues still remain to be resolved, and as one of the final reports from this project, it represents part of its formal closure.

The majority of the project objectives and deliverables have been met. As a result of some delays outside of the control of the project management team, the timeframe has been stretched, so that the goals may be achieved.
Exploring the management of multicentre multinational research, the aims of the project were to:

- Employ a VRE to enable musculoskeletal scientists working within a variety of disciplines across the university to collaborate in sharing and reviewing components of internet-delivered trial management.
- Analyse and describe how the VRE can be flexibly used to support collaborations within and outside the university infrastructure.
- Develop the technology, and the musculoskeletal science communities.
- Address and where possible resolve integration issues.

The intention is for this work to continue through the form of other projects, reflecting shifts in strategy as one would expect with the rapidly moving field of computer science, and the geographical distribution of the staff involved. This will include the following leads;

- Dynamic workflow modelling with quality assurance error checking
- Exploration of transitioning towards mobile platforms
- Development of interfacing with the “cloud” infrastructure
- Integration of analysis tools to conduct statistical data handling by import and export from the VRE
- Graphical navigation through templating optional paths as filters over static workflows.
- Integration of a module to produce data collection forms per trial characteristics based on user needs – Enhancement of the Template Generation Toolkit (TGT).

PROJECT SUMMARY

- Goals: The main goals of this project were to take the expertise gained from previous projects such as the following;
  - Virtual orthopaedic European University (VOEU) – IST 1999 – 13079
  - Collaborative orthopaedic research environment (C0RE)
  - Orthopaedic research based service (ORBS)
- This project should therefore provide a platform for virtual working, similar that extending beyond the scope of virtual learning environments, to accommodate the necessary tools to manage research projects.
- Objectives:
  - The objectives were to develop a platform, through an evolving co-design strategy which then makes the tools available to a discrete working group that can then thoroughly test the system before rolling this out to other centres, as part of developing a multicentre strategy.
  - The platform should be secure and implementable across a wide range of specialties.
- Success criteria:
  - Indication of success in this project is the uptake of the system, by gaining the support of end-users who preferred this user experience over conventional alternative tools.

The development strategy therefore includes feedback from users which can be used as a benchmark for success.

PROJECT TASKS. - RESOURCE MANAGEMENT

- Resource need to changes throughout the project
  - Originally the intention was to build and test the system using the 2009 to 2010 population of undergraduates and masters students in musculoskeletal science at the Institute of orthopaedics and musculoskeletal science and Stanmore. As a result of the delays this was not possible; this is unfortunate since it represented a cohort of approximately 50 students.
  - Instead a different strategy was adopted, using projects involving multidisciplinary teams. These case studies traversed the translational research pipe, from the domain of basic science such as tissue engineering and by mechanical engineering, to the clinical domain.
- Resources were therefore shifted to allow for the work to be run semi-independently for the latter part of the project with close collaboration between the individual workers. This ensured maintenance of the role for governance was provided by the institutions concerned, but that the project work continue independently also.
- A reflection of the massive reduction in funding opportunities in the UK, has been the potential fragmentation of the team has collaborations are developed in Africa, Canada and on the continent of Europe. As with the traditional “kaizen” this is both a threat and an opportunity. The system itself ensures the protection of intellectual property (IP) for those who are working with it, but in a sense there is a risk of the IP leakage to other groups globally.
- The opportunity here is to use this as a way of disseminating the system and allowing groups to work in ways that had not previously been anticipated. This is one of the main reasons for developing the architecture in the first place, to allow researchers to explore collaborations independent of their restrictions of physical infrastructure, but in a way that allows institutions to protect the IP which is developed in their name.

METHODOLOGY

The overall approach was that of co-design, between researchers from orthopaedic surgery and computer science. We engaged in an iterative cycle where problems typical of the RNOH were firstly acknowledged, followed by an exploration and definition of potential solutions, an implementation of the suggestions and finally an evaluation of the impact of the solutions on the participants work practices improvements

(in line with research by Steen, 2009[1]). Results of the evaluation were then *fed back* onto the system to initiate another co-design iteration, iteratively until the end of the development stage of the project Initial aims of the project were agreed but the details were shaped by interaction with the research community especially with respect to the governance requirements; within the constraints of technological and cost limitations, we provided the researchers with the environment tool to establish the management of projects effectively.

In accordance with the traditional 'V' model of engineering design, build and test, we involved the user community initially in user requirements gathering. This work was undertaken by the researcher from computer science in conjunction with the lead surgeon. This consisted of a traditional literature review, interviews both in computer science and the hospital environment, and running workshops. In parallel the infrastructure was planned and built. The team discussed development issues such as the interfacing with myExperiment that had been planned and reviewed the work of previous VREs including CORE (JISC VRE-1).

This was an iterative process. Progress and results were discussed at weekly meetings with the whole team. These results were generated the set of personas and scenarios and a system design to satisfy the requirements. The critical issue was to get to the level of VRE that could be considered operational rather than simply a proof of concept, in order to confidently engage end-users, rivaling commercial less focused tools, currently being used, such as MS Project, SharePoint and conventional email.

Appendix I indicates the level of competence of the end-user community and the need to adapt to their methods of working in order to support ease of migration.

PROJECT METRICS PERFORMANCE

The project met most of the performance criteria during its lifespan. Due to the loss of critical personnel, vitally the lead programmer for at least six months during the project, there was a necessary delay in the development of technologies. The schedule performance is described below;

- Project Schedule Overview: The intention to complete the project within 18 months was based on the original project schedule. This has been extended to ensure effective deployment, accommodating the delays that occurred when the lead developer fell chronically ill.
- Project Schedule Control Process: This was managed very effectively. Co-design must ensure that the project meets the expectations of the original aims and satisfies the research community in a climate of changing needs. Certain management tools; *e.g.* effective treaded prioritized discussion boards have been employed in the last two years. Flexibility in design balanced with managing 'feature creep' is the biggest challenge. An SVN repository with open source software (tortoise) within the ECS provided a developer workspace.
- Project Schedule Corrective Actions: An extension has been granted that the team has been using to allow for deployment and transfer of various project works from the other sources.
- Project Schedule Integration with Managing Projects: The integration with established systems, both at a human level as well as a machine level is critical to success and it is accepted (following a review by NHS Innovations London) that at least a 6 month 'bedding in' process is required to enable users to learn and accept the developments.

[1] Steen, M. (2009). Co-design and Pragmatism. Paper for the 16th biennial conference of the Society for Philosophy and Technology, 7-10 July 2009, Enschede, The Netherlands (www.utwente.nl/ceptes/spt2009/), 1-16. Retrieved from http://www.marcsteen.nl/docs/Co-design_and_pragmatism.pdf.

At present there is much work on the development of performance metrics for web-based services. Clearly such markers as "number of hits" or number of registered users give a good indication of the exposure and spread of the use of these tools.

The intention here though is to not aim for large numbers of initially enthusiastic and then ultimately disappointed users. Previous experience has shown that the only way to achieve uptake of these tools is to *"win the hearts and minds"* of the key individuals who are leading the field so that it is then rolled out across centres as required.

We therefore placed greater emphasis upon the quality of assessment by the users of the work rather than simply a quantitative assessment of the amount of activity in the early stages. Ultimately this has to lead to broader dissemination having multiple sites being added, there is an exponential increase in the number of users.

THE VRE

The VRE provides end-users with a space where a research study may be followed. The overall structure of VRIC is relatively simple. The diagram below presents the elements of the system available from the main page and the options for each of the elements.

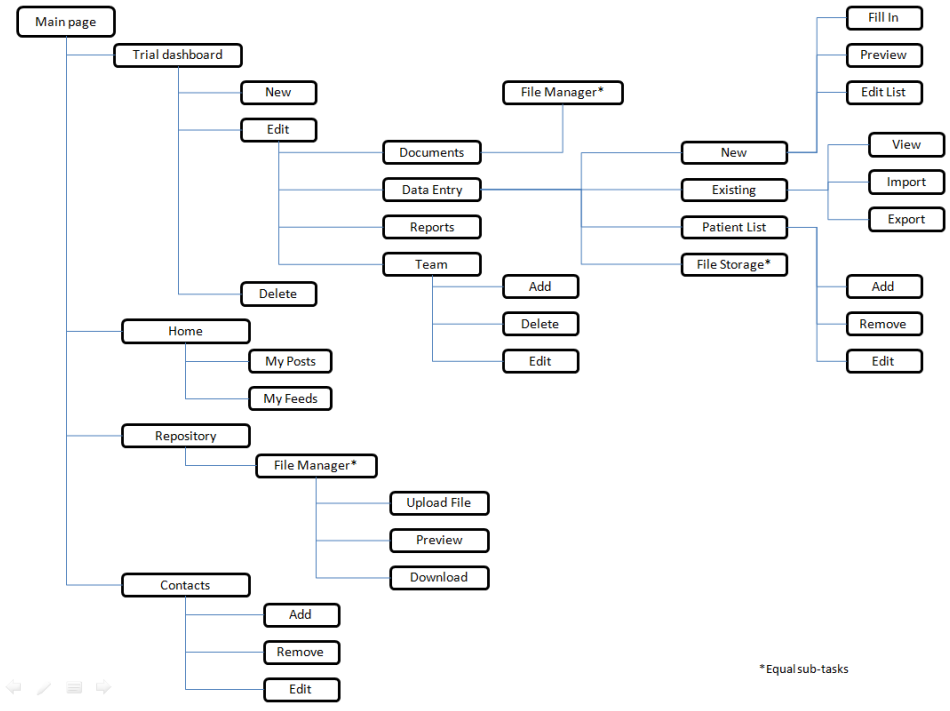

FIGURE 1 ELEMENTS OF THE PROJECT WORK SPACE

The tools within the VRE developed for the project are: a repository for medical-related information (MedShare); Web 2.0 collaboration tools to exchange ideas regarding a trial and subscribe to RSS feeds in order to receive news relevant to the work of the VRIC community; data collection forms which are used to calculate and compile reports for basic statistical analysis and to create the data base structures to store trials in VRIC; a sample list of outcome measure forms relevant to the area of orthopaedics useful to collect data from patients participating in a trial; a data base to store contact data from the VRIC community.

IMPLEMENTATION

The project was led by the School of Electronic and Computer Science (ECS) at Southampton, working closely with musculoskeletal scientists and clinicians in the Royal National Orthopaedic Hospital. The project took a co-design and co-deployment approach, to ensure user engagement throughout the development and deployment. A test driven iterative/agile approach to development was undertaken to ensure that regular delivery of a system was achieved.

The overall technical approach was to integrate the lessons learnt from other VREs such as myExperiment and the CORE; especially their use of communication tools for supporting resource sharing, critical analysis, publishing, and peer review by inter-disciplinary research groups and networks. The framework we built also allowed musculoskeletal scientists to run the interventions within the VRE; allowing them to comment on the content of the study. In house coding standards developed in the department were adopted to ensure readability, testability and sustainability of the code. The project has been linked to other major UK projects to ensure that it is sustainable and the code reusable by other HEI and stakeholders.

The project had weekly meetings, with minutes kept, to disseminate the findings from the community and also to report on progress from the technical development of the VRE. While these were useful and initially long, they did allow issues to be discussed and priorities to be set. In addition to these official meetings, these were supplemented by smaller meetings between the developers and the basic science researchers, to discuss issues in detail and design solutions together. Towards the end of the project, meetings began to be shorter and less frequent. As with any cross-disciplinary work, there is always a time for the teams to understand the language and methods of working, these are often different between the disciplines.

CASE STUDIES OUTLINE

The case studies are written around the trials in the VRE. Participants of the trials were interviewed in order to gather their views on the design and the tools available in the system. In addition, since RNOH staff involved in the case studies have different administrative roles, the case studies have been separated according to the role of the participants in the case studies: Surgeons/Specialists/Supervisors, R&D Managers and Students.

Trial	Role of participant in the case study
Shoulder EMG	Student
Stanmore Paediatric Database	Student
Hamstring Harvesting Techniques	Supervisor/Student
Catch Before a Fall	Supervisor
AMAN2010	Surgeon
Power Wheel	Surgeon

FIGURE 2 EXAMPLE PROJECTS MANAGED BY THE VRIC SYSTEM

The Shoulder EMG trial consisted in a project for an MSc student who was interviewed before introducing her to the VRE and then, after having used it for her final project. During the interview the student was asked about the elements that she would expect to find in a system which would provide her with tools to conduct her research study. Elements that she pointed out as necessary included tools that would help her follow the steps that construct a research study, that would help her to keep track of due dates and checklists of tasks to complete and support tools to conduct statistical data analyses. At present, the VRE allows students to keep track of the steps involved in their studies and the tasks to complete. The module to conduct statistical analyses has been added to the section Future Development, but import and export functions from the repository act as a bridge to using VRIC as a central research node with other

applications running alongside, like for instance, open source statistical analysis tools such as OpenStat4 or PSPP.

The Stanmore Paediatric Database was used as to develop a tool which allows researchers to import data in formats such as CSV, MS Excel or MS Access into VRIC. This migration tool extends the usability of the VRE by permitting researchers to upload data files from diverse sources into a system where they can be used regardless the type. The tool was developed in order to import into VRIC a Paediatric database from a specialist in the RNOH who keeps patient records in paper format and was interested in constructing a repository to study data collected over the years.

The Catch Before a Fall trial resulted from the interest of the lead researcher to use VRIC to conduct a study in Primary Care (GP) clinics using iPads (Apple, US) as data collection tools. A web-based form for data collection was developed along with a tool to import the data collected into VRIC (http://catchbeforeafall.ecs.soton.ac.uk/). The co-design process in this trial was vital as the tool designed had to meet the clinical requirements for the study as well as the technical challenges imposed by the use of a rather new technological device.

The AMAN2010 and Power Wheel trials were conducted with a group of researchers in multiple locations. It was used as a platform to test the ubiquitous aspect of the VRE, which is what would give researchers the ability to work in geographically disperse research centres. The teams involved researchers from within the UK, but also from Canada and progressing toward the continent of Europe.

EVALUATION ARISING FROM THE CASE STUDIES

Following alpha tests of components, the main purpose was to introduce team members to the working environment. The users initially completed a simple usability analysis and this confirmed the functionality was operable. The testing of this was then fed back into the weekly co-design meetings via the coordinator. The diagram below demonstrates the optimum command and control infrastructure the team developed for this kind of work. As a model, the team spirit was driven by the common goals at all levels. By focusing on translational research and life science models it is possible to find a common language, if not a common dialect. The social interactions in the VRE are to an extent mimicked by the development team who have to work across disciplines. Without such a degree of interaction it is harder though to make strategic decisions.

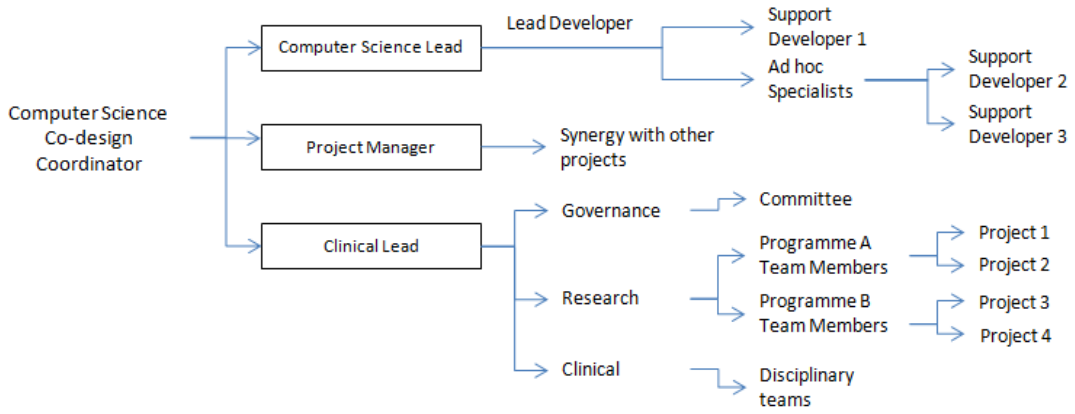

FIGURE 3 PREFERRED PROJECT MANAGEMENT TEAM STRUCTURE

EVALUATION OF HOW THE PROJECT ADDRESSED ISSUES FROM USER/CASE STUDIES EVALUATION RESULTS

Co-design still implies the need to achieve informed interactions and grouped decision making so as to achieve the optimum results. The different processes for alpha and beta testing running simultaneously with the introduction of new users actually can become a confusing matter because although the roll-out of increasing functionality can be beneficial to those who are familiar with the systems, for new users, they are more comfortable with fully tested tools and so can become disproportionately frustrated by 'work in progress'.

Where the early results show promise it is easier to build the user community, even if driven in part by the need to establish this remote way of working by virtue of a distributed research team in many instances. Users are more likely to approve of the tools if the need is unsatisfied by more familiar technologies. This cultural change may be precipitous once a critical mass is achieved.

Initial slow progress in uptake was in part due to the need for users to gain familiarity and bug fixing, along with eh inflexibility that is necessary with such systems as they reflect the actual work required and so the user perception can be somewhat overwhelmed by the reality of the bureaucratic processes when confronted with them directly. Peer consensus is implicit in respect to this.

LESSONS LEARNED: OUTCOMES & RECOMMENDATIONS

Overall the project has been a success, overcoming the adversity of the team fragmentation issues, with two members now working abroad and one withdrawing. In many ways this has exceeded the original aims. These were achieved by supporting the integration of the efforts of basic scientists and clinicians discussing the studies as the translational research paths were developed. These teams also involved researchers from within the UK, but also have teams of researchers from Canada and hopefully before the end of the project, the continent of Europe.

The greatest impact has been on the development of the musculoskeletal science communities, in that there is now a VRE specifically aimed at musculoskeletal scientists, which will facilitate the discussion and development of this research area into specific project support.

The methodology was very successfully applied in this case and lessons learned could be used by similar JISC projects in the future. We would recommend this project for approval from the Project Sponsor, JISC. As co-designers, we are broadly in agreement that the project has fulfilled all of the requirements as documented and that the Project Sponsor can be satisfied that all outstanding items have been satisfactorily addressed, but that the long-term survival of the work, it's true potential and value will only be achieved if there is follow-up work to develop this within the relevant scientific communities.

Project Highlights and Best Practices

- This project provided a unique opportunity for collaboration between different higher educational institutions and NHS facilities. It therefore created suitable working environment for exchange of ideas, and implementation of new technologies in alpha and beta testing environments.
- The key issue here is that of security. It therefore allowed the team the opportunity to explore this in detail, and provide potential solutions to the challenges which are faced by anyone working with healthcare data.
- By changing to a completely new platform, many ideas could be adopted which had previously been explored in purely experimental ways. In a sense this project therefore represents a translational research project, which transfers the technologies to a higher readiness level (TR L) to start implementation and the eventual rollout and dissemination.
- By developing novel management strategies, it has been possible for much of this work to be managed itself in the virtual environment. This has depended heavily upon well coordinated use of tools for conference calls and video conferencing, and for the establishment of repository to track documentation.

- In a traditional sense, there are three key purposes of this kind of work.
    - The most apparent is the need to inform those who currently work in the environment of managing research in healthcare. Many of the healthcare reforms such as the Research Governance Framework (RGF) were established to ensure that users met with legal requirements. Unfortunately there has been a significant lag in providing resources and services to ensure adequate support for the users to adapt to this. The project therefore has helped develop a platform with this purpose in mind.
    - Secondly, there is the issue of "moderation", where the scientific unity often driven by a positive feedback loop by funding tends to head in one direction rather than continue to explore the range of various possibilities which are sadly unfortunately often neglected due to lack of results. The intention therefore for this platform is to provide such a resource that allows researchers to develop themes with the minimum of resources that ensuring that there is adequate governance in place so that standards are maintained.
    - Finally, we are able to develop this work inside a free country, where research and development are positively encouraged. It is our intention to develop this platform in such a way that it is affordable and manageable by any group who wish to collaborate in research.
- Our team has designed and developed the system to support groups in multiple centres working over different time zones, from multiple disciplines. Fundamental to the success of this, is finding common understanding in the research and work processes. We have therefore built this into the training programmes for research at both the bachelor's and master's level is (iBSc and MSc).

The next stage of the work should be considering a platform which is *producible* and can therefore be developed with other partners.

FUTURE DEVELOPMENT

At the end of this project, the following issues remain. There address individually and possible options for resolution are explained.

Increasing recruitment of users:

- This depends upon the success of the underlying research projects which are currently already in the system. If the system demonstrates its effectiveness, then through "viral marketing" with the developing collaborations of other groups, it will be possible to start new projects with the server software being installed in each centre. This will then create a new "satellites" and propagation through propagation of the ideas followed by access to the tools to deliver.
- This will continue to be reported by the project team using the tools embedded within VRIC.

Communications Management: Development of the project communication processes were managed by Mr. Mike Santer, the project manager. These were both efficient and successful, both through his effective management of the face-to-face meetings, but also through the ability to integrate these with the use of appropriate technologies. The most relevant to these were the use of;

"Mind Mapping": – Using tools to provide "mind maps" outlining the details of the work assisted multidisciplinary understanding. These are easily converted to PDF files for archiving and distribution to broader members of the team. This therefore allowed for rapid minutes taking throughout meetings, both real and virtual. It also means that the archive is available to ensure non-repudiation and to track progress. By integrating this was such tools as the fault tracking log and the blog sphere, it was possible to ensure that users who were only transiently involved with a project, could understand the requirements and contribute with minimal overheads.

- This process is so effective, that it released individuals from much of the administrative burden of the work, so they can actually concentrate on research.
- This approach was so successful, that it is now been rolled out as best practice for other national level projects such as the i4i PowerWheel project, an FDP1 project funded by the National Institute for health research (NIHR), which will be employing the VRIC framework for the preparation of the clinical trials.

Information visualisation: These tools are still being integrated into VRIC at the time of writing. These include;

- Graph generation: either through using the python tools or by using the export function for the repository of data to allow for importing into useful third party end-user applications such as SPSS.

End-user Expectation Management: This project is not developing an enterprise ready application. That is what users are familiar with and normally expect. A critical part of the rollout of any such project is user expectation management. This has been managed very well by uncoupling the users directly from the development team in the sense that there is a person who is interfacing both groups.

The problem has been the expectation that was raised due to the original project timetable that unfortunately could not be met. We therefore lost the majority of potential end-users who would have been available within the original timeframe.

In effect the expectations had to be reset by virtue of the project timetable. Fortunately this provided some time to increase the tie-in of a few key individuals, however until the system is fully operational, there is little point in attempting to encourage other users to take the risks of employing such tools since most projects now are managed very tightly and there is not adequately way to withstand delays, and indeed this can lead to a cascading effect.

Asset Management: At the end of the project the assets which remain, in the form of the software developed, remain with electronics and computer science. It is however possible for this to be distributed freely to the collaborating partners. The following strategies therefore would be sensible to employ;

- Maintenance of a central project site for downloads of the core software and upgrades
- Establishment of a forum and user group
- This should be managed through Electronics and computer science in Southampton

CONCLUSIONS

VRIC has offered insights into the novel ways of approaching new knowledge and the learning of effective ways of acquiring new knowledge. The project aims were achieved, and possibly exceeded, with collaborations being managed across national and disciplinary jurisdictions. Co-design and co-deployment was very effective in achieving the project aims. It takes time and effort but the results are worth it.

In conducting this kind of multicentre multidisciplinary work, it is far more brittle than a conventional research project. The system will success or failure can depend on a few key individuals. Efforts must therefore be made in future to ensure some degree of closer integration of projects so that there is more flexibility in staff allocation to accommodate and thus mitigate the risks.

The infrastructure and methods of working have been demonstrated to be very effective when the staff is available. Things unfortunately always take time, and thus building in buffer zones to accommodate likely delays may be sensible, all create greater flexibility in the rollout of the timetabling. These kinds of tools can be integrated as more projects planning it come integrated with the majority of the project workforce being aware.

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APPENDIX I:USER REQUIREMENTS - AN END USER PERSPECTIVE

This appendix is contributed by Raphael Malikian r.malikian@ucl.ac.uk . It emphasizes the level of competence for the end-user community and the need to adapt to their methods of working in order to support ease of migration.

Collaborating within a virtual learning environment (VLE) – such as Moodle, WebCT, Blackboard - is problematic as it makes it very difficult, if not impossible, for collaboration between people from other countries and other institutions who do not have access to the particular course within which you are working. 'Courses' within Moodle are overseen by Tutors and Course Administrators who can – and do – remove users registered on the courses, which can be an issue. Collaborating within the VLE discussion groups & forums is limited as they do not allow for private discussion, only open discussion topics which every user on that course has access to. It is also very difficult to export work from a VLE.

More often than not users revert to sending Microsoft Word documents between one another, either using 'track changes' or amending file names to keep track of changes and edits. This is understandable, as it combines two technologies that many researchers must feel relatively more comfortable with - word processing and email - as opposed to more specific research collaborative tools. In many cases this may be the most appropriate method of transferring files dealing with intellectual property and sensitive information which cannot be transmitted outside of approved institutional email encryption.

Institutional email addresses have limited capacity mailboxes - mine is only 20mb (Figure 1) - clearly limiting the number of emails which can be sent to and from your account. It also makes it difficult to truly collaborate because it means that only one person should amend a document at a time, it is difficult to track changes when multiple people amend one revision of a document simultaneously. Additionally, tracked changes annotations in Microsoft Word can be very messy, drawing a lot away from the original document. Again, to track changes requires purchasing a compatible version of Microsoft Word which can be an issue for some users.

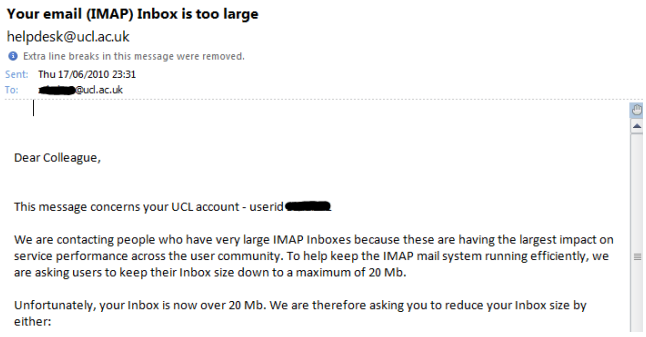

Figure 4 inbox capacity limit

To overcome this recently I suggested for a group project that we worked within Google docs. It was difficult for users to working within Google docs as a collaborative tool because it was not integrated into anything they were already using, for example if it was or could have been integrated into Moodle it may

have been easier for users to work with it. It was a stretch to ask colleagues to register to use Google docs, let alone familiarise themselves with it and use it.

In a research environment where equal teamwork, group work and shared collaboration is key I feel that a major shortcoming of Google docs that the person who 'creates' a document and shares it with other collaborators is then listed as the 'owner' of the document (Figure 2). It is a minor shortcoming, but a concern nonetheless. Google docs looks like Microsoft Office, but does not have all of the features of Office.

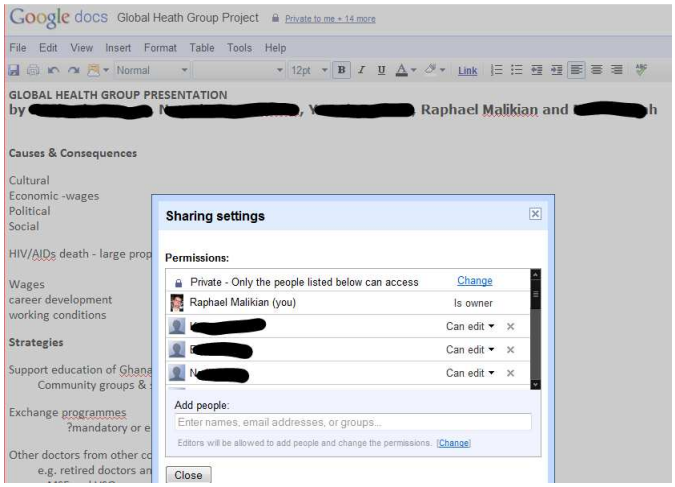

Figure 5 Google docs defining the 'owner' of a collaborative document

Microsoft OneNote allows users to share notebooks and collaborate with colleagues (Figure 3), but this is limited by the requirement for all users to own a OneNote license (which is not free), use a recent version of Windows operating system - there is no Mac or Linux alternative - and have a computer with sufficient hardware specifications to run the software. Microsoft OneNote is also a lot less well known than Microsoft Word and users are less familiar with it.

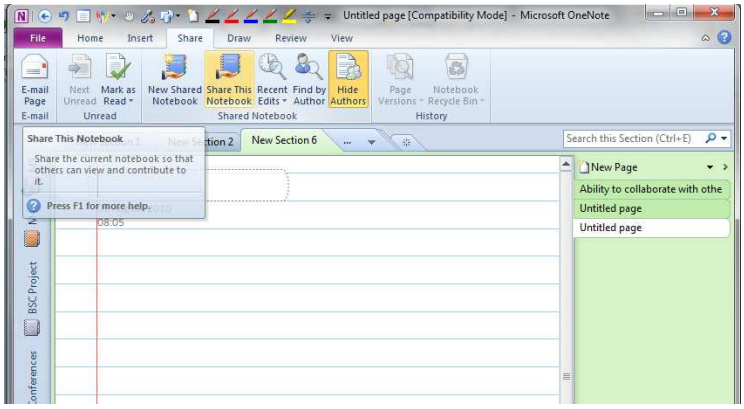

Figure 6 Microsoft OneNote sharing options

GoToMeeting and WebEx are commercial tools available for collaborative meetings online, but require subscriptions which can be expensive over time. An alternative is the use of Skype to chat with colleagues and then share the desktop. Skype 5.0 beta allows screen sharing with up to 4 other people, but I have found it to be extremely CPU demanding, making it difficult to do anything other than using Skype. Skype 5.0 is also Windows only at present. All three of these options require users to have fast enough internet connections to be able to view the hosting person's screen, and sadly these tools are no more collaborative than sitting a group of researchers around a computer and giving a presentation, making them more useful for meetings and discussions than true research collaborations.

Ultimately the virtual research environments that researchers use to collaborate will be determined by what their respective institutions use; a research lab where the head of department only collaborates with his/her researchers by emailing around word documents as opposed to using a centralised 'cloud' virtual research environment (VRE) dictates the way that the rest of that institution will collaborate.

It all comes down to education to keep research groups and institutions informed of what is available to them. To move users and institutions forward to adopt the use of virtual research environments will require top-down education and training about the shortcomings of the methods they may be using already, and the advantages of moving to - or at least considering a VRE.

There is a clear need and demand for something to bridge the gap; a virtual research environment allowing collaboration while not being costly for users to use, being operating system independent, and not requiring a fast, powerful computer or access to an internet connection with a fast upload and download speed would solve a number of these issues and shortcomings of existing options available to researchers.

Project Report

Project Name: Virtual Research Integration and Collaboration (VRIC)

Department: Institute of Orthopaedics and Musculoskeletal Science, Royal National Orthopaedic Hospital, Stanmore UK

Focus Area: End User Co-Design Experience

Product/Process: VRIC Collaborative Research Environment

Project Information			
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Start Date	1 July 2009	**End Date**	31 December 2010
Lead Institution	University of Southampton		
Project Director	Dr Gary Wills		
Project Manager & contact details	Dr Gary Wills, LSL, ECS, University of Southampton, SO17 1BJ		
Partner Institutions	Royal National Orthopaedic Hospital, Stanmore.		
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