TECHNICAL ARCHITECTURE OF THE RDN VIRTUAL TRAINING SUITE: A NATIONAL E-LEARNING RESOURCE FOR THE UK

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Abstract

This paper describes the development of the technology and architecture behind the RDN Virtual Training Suite - a national e-learning resource in the UK, comprising over 50 Web based interactive tutorials designed to support learning and teaching. It describes the phases of development undertaken; the issues arising; the role of user feedback and the challenges met and tackled during the development of this popular resource. This paper concludes by discussing the future of the RDN Virtual Training Suite as it continues to develop to meet the needs of UK education.

Keywords
Internet training, Web-based learning, technical architecture, virtual training suite, collaborative publication, content management

What is the RDN Virtual Training Suite?

The Resource Discovery Network (RDN) Virtual Training Suite is an UK national eLearning resource, comprising over 50 "teach yourself" tutorials on the Web, each teaching *Internet skills* to support learning and teaching in a different subject. It was built in recognition that the potential of the Internet to support education can only be met if people have the skills and inspiration to use it. However, while many people know how to make use of a traditional university or college library they may not yet have got to grips with how to make good use of the "virtual library" of the Internet. Likewise, while many students may have become familiar with using the Internet to support recreation or schoolwork, when arriving at university, they may not be able to use it to support educational activities at this level. As the Internet becomes increasingly important as a resource for learning and teaching, students and lecturers will benefit from developing the skills required to use it to support their work.

Information literacy is widely recognised as an essential skill for academic work in all subject disciplines. It enables people to recognise when they need information and to locate, evaluate and use relevant information for the their work (ALA, 1989). It has long been taught in library user education and courses in study and research skills. These tutorials aim to teach *eLiteracy,* the ability to use the Internet to meet information needs, alongside more traditional information resources also required.

The subject-approach and the skills covered comply with recommendations of the Quality Assurance Agency for Higher Education, which has included "Information Retrieval Skills" and "Information Technology Skills" as key transferable skills in their benchmark standards for the content of degree courses (QAA, 1999). The tutorials covering subject taught in UK further education have been carefully developed to map onto the relevant parts of the Key Skills Specifications for Information Technology (IT), as defined by the Qualifications Curriculum Authority (QCA, 2001).

The RDN Virtual Training Suite is a free, national, public Internet service funded by the UK Further and Higher Education Funding Councils, through the Joint Information Systems Committee: JISC (JISC, 2002). The Virtual Training Suite has been embedded into one of JISC's larger national services; the Resource Discovery Network: RDN (RDN, 2002), an Internet search service designed to provide access

to high quality Internet resources that can support learning, teaching and research. The tutorials in the Virtual Training Suite offer a taster of the many thousands of high quality Internet sites that can be found by using the RDN. The RDN hubs have played a major role in creating and updating the tutorials:

> **BIOME:** the **health and life sciences** tutorials
> **EEVL**: the **engineering** tutorials
> **HUMBUL**: the **humanities** tutorials
> **PSIGate**: the **physical science** tutorials
> **RDNC**: the **generic Internet skills** tutorial
> **SOSIG**: the **social science** tutorials

Each of the tutorials was authored by an acknowledged subject specialist commissioned from the UK academic lecturing or library community, with an editor also appointed to ensure peer-review and quality control of the educational content. So, for example the "Internet for Nature" tutorial was written by the librarians at the UK's National History Museum in London; "Internet for Modern Languages" by a lecturer at the University of Cambridge and so on.

Educational/Instructional Design

A detailed discussion of the nature and pedagogy of this resource was presented at the ASCILITE 2000 conference (Place at al, 2000), and so in this technical paper, is only briefly outlined here for reference. All the tutorials have the same aim: to enable the user to practice and develop Internet information skills that can support learning, teaching and research in their subject. With this common aim, all the tutorials have the same basic structure and design, with four main sections (or chapters) that map directly onto the four main learning objectives. Each tutorial enables the user to:

TOUR key Internet resources for the subject

- Distinguish the different types of resources available on the Internet
- Identify important resources for the subject
- Compile a personal list of links to Internet sites relevant to their work

DISCOVER how to search the Internet

- Explain the differences between Internet search tools (gateways, directories and search engines)
- Identify Internet search tools relevant to the subject
- Develop effective techniques for Internet searching

REVIEW and JUDGE Web sites

- State why *quality* of information is an issue on the Internet
- Critically evaluate information found on the Internet
- Avoid common pitfalls of Internet use

REFLECT and PLAN to use the Internet effectively for work

- Summarise key Internet information skills
- Decide how to use the Internet to support personal study, teaching or research

To work through all the sections takes around 1-2 hours, though users can choose to do one chunk at a time over more than one sitting, or focus on the sections of most relevance to their work.

Tutorial features:

- Simple step-by-step instruction on the Web
- Interactive quizzes and exercises
- Links Basket – to collect a personal list of useful Web links
- Glossary of Internet terms

- A guide to citing Web sites
- Print options (for notes or handouts)
- Teaching Resources

Recognition of the value of this approach was given recently, when the UK Minister for Education and Skills, Estelle Morris, selected the RDN Virtual Training Suite as one of her top three favourite educational Web sites <http://www.ngfl.gov.uk/features.jsp?sectionId=15&resourceId=1015>.

Initial phases of development

Since Autumn 1999 there have been five funding phases for development of the RDN Virtual Training Suite as it appears today. The technical development has therefore been incremental, and to some extent pragmatic.

The initial Virtual Training Suite was launched in July 2000 and was funded to produce 11 tutorials. The project had a relatively small budget and the majority of the funding went towards procuring the high-quality content required for these tutorials. With this in mind, the project team chose to use the free CALnet tutorial building software package (CALNET, 2000) - with which the technical staff already possessed expertise - to provide the technical development platform. CALnet is designed for building Web based tutorials quickly and simply, and also enables the production of multiple tutorials - all of which can use the same basic layout, design and technical architecture.

CALnet works by defining a series of components that are the essential building blocks of the tutorial. For example, components exist for images, a type of quiz question, a page type, or a block of text. The tutorial is built by defining a list of these components and assigning content to each one. CALnet then processes these components and exports the final tutorial as a series of HTML pages. See Figure 1 for an example of the CALnet editing interface.
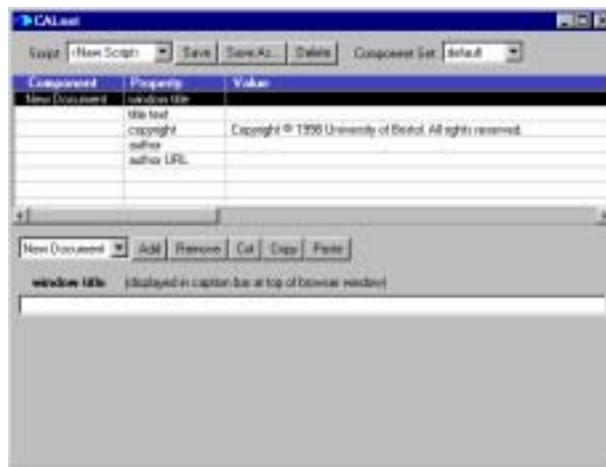

The CALnet editing interface

The use of CALnet allowed the project team to separate the tasks of authoring from that of building the Web version of the tutorial. Tutorial authors were provided with a document template and guidelines to follow in the development of their content. These templates could then be easily transferred to HTML format by the project technical team. Completed tutorials were presented to the authors for checking before final publication. They were also able to suggest edits at this time, which were implemented by the technical staff. The tutorials were then distributed to the various participating hubs - specialist service providers within the UK, such as the Social Science Information Gateway: SOSIG (SOSIG, 2002) - within the RDN for hosting.

The success of the first phase of the project led to the commissioning of a further 28 tutorials to extend the scope of the training suite. The decision was made to reuse the CALnet software, mainly because the

increase in the number of tutorials being created in this second phase meant that there was no time or apparent requirement for significant software developments. Feedback on the use of the tutorials is invited from the Web site, and a major issue reported from the first phase related to the implementation of the Links Basket feature, the use of which was hampered by the use of older versions of Web browser software. Some development time was used to address this feature, although only limited changes could be made.

Due to the volatile nature of the Web, with sites appearing and vanishing with little notice, reasonable attempts were made to future-proof the tutorials. By choosing what were considered to be links to stable Web sites and using materials from known sources it was hoped that the shelf-life of the tutorials could be extended for as long as possible. It should be noted that the initial phase of the Virtual Training Suite was funded as a one-off project, with no contingency for updating or editing the tutorials once the project was ended.

Throughout the first two phases of the Virtual Training Suite, completed tutorials were sited on Web servers at the various RDN hubs located at Universities around the UK. Despite implementing a central index site linking to all the tutorials, no money was available to centrally host the tutorials, so hosting by the participating RDN hubs was the only option. In many cases the tutorials were added to hub portals as value added resources, both to the hub and the RDN. The ability to organise this disparate hosting arrangement was a critical benefit of using the CALnet software, which produces self-contained tutorials, which require no server configuration or advanced technical knowledge to install.
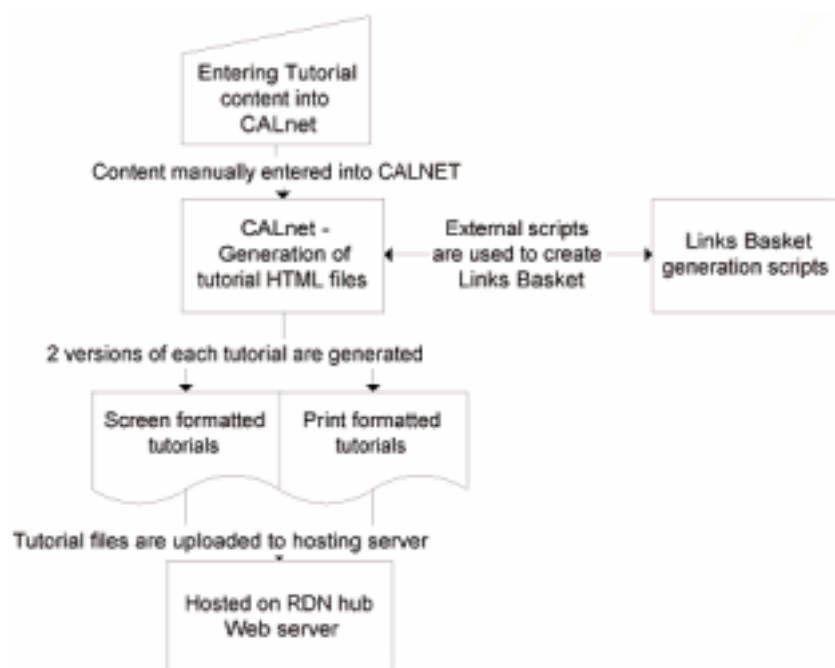
Technical architecture of the first phases of the RDN Virtual Training Suite

The need to make changes

The tutorials proved to be highly popular both within the target UK Higher Education sector, and also within other learning environments, both in the UK and abroad. However three issues arose from the initial phases of development and implementation that required further technical development: tutorial editing, Web accessibility, and a call for improved functionality.

Some editing required
With many of the tutorials having now been available for over a year, some of the links used as examples within the site were either outdated, or simply no longer available. It was clear that some sort of editing

system was required; the CALnet software was made available to the hubs so that they could maintain their tutorials easily. Initially editing involved a complicated process, requiring some programming expertise due to additional work required to build and implement the Links Basket feature, which was developed outside of the standard CALnet functionality. Many of the hubs were uncomfortable with its use, and so tutorials were not being updated as regularly as they might have been.

Access denied

It was also realised that the tutorials' dependence on Javascript was a major accessibility issue, and was preventing some users from gaining the full benefit from the tutorials. In order to implement the Links Basket a Javascript based navigation system was used to maintain the list of selected links within each tutorial. If Javascript was unavailable on the user's computer, then the tutorial would not function correctly.

A bigger basket

User feedback via the tutorial Web site also suggested that features such as the Links Basket and the Print Friendly option could be expanded and improved, to offer more options for users to exploit the tutorials within their learning environments.

Extending the RDN Virtual Training Suite

In September 2001, funding was provided by the RDN for the development of 11 new tutorials for the UK Further Education (FE) sector. There seemed to be considerable interest from practitioners in developing tutorials for FE, and the RDN was looking at "discrete" services it could fund/develop for FE users - and given these factors, the Virtual Training Suite tutorials were an obvious choice. It was decided that a new tutorial design and structure was required for this different user base, which could integrate the different learning objectives in line with the FE curriculum.

A major change in this phase of development was that the tutorials would be centrally hosted. This was a departure that meant there was scope to develop and implement a central content management system for the Virtual Training Suite that would allow direct online editing of the tutorials. Another project led by the Institute for Learning and Research Technology (ILRT), the Contract Research Online Survey (CROS, 2002) had been recently developed, and it was recognised that there were elements of this system which could be transferable to the Virtual Training Suite model. It was therefore decided to develop a system based on the CROS architecture to host and manage the 11 new tutorials.

Towards a new content management system

The new content management system would address the issues of editing, accessibility and functionality described earlier. The pre-requisites for this new system were as follows:

- Minimal use of proprietary technologies (eg. JavaScript), yet maintaining the interactive elements which had proved so popular within the tutorials
- Tutorials should adhere to the W3C guidelines on Accessibility (W3C, 2002)
- Multiple levels of access to editing tools to be provided
- Enable tutorial content to be easily editable
- Utilise the existing 'component based' structure of the tutorials

The solution was to produce an online, Web based version of CALnet, with both the tutorial structure definitions and tutorial content held within a relational database. In addition, rather than producing a series of static Web pages, which would have to be distributed to the hosting servers, the tutorial pages would be generated dynamically on request and available immediately. All administration is carried out through a series of simple Web forms, and so no additional software is required to enable a registered user to make changes to their tutorial. Technical knowledge requirements for editors would be limited to understanding simple HTML markup.

Example of the editing interface to the new Web based system

The system breaks down into 3 areas, each providing specific improvements on earlier revisions of the tutorial system architecture:

1. User administration
2. Tutorial component administration
3. Tutorial content administration
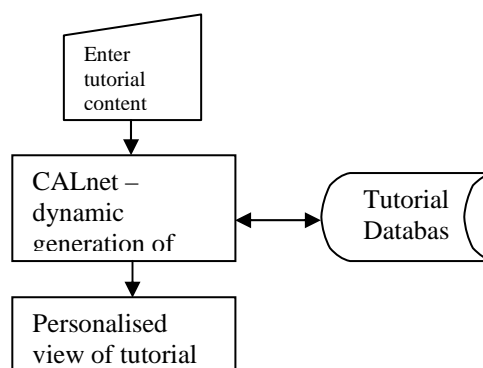
Safeguarding the content

The potential user base of the tutorial management system is quite large and distributed (staff from 6 RDN hubs across the UK), and it was important to implement safeguards to prevent users making alterations to sections of the site that are standard across the whole suite, eg. the learning objectives and section titles, and other authors tutorials. The user administration area allows top level administrators to define groups of users, and assign permissions accordingly.

The majority of users are allowed only to edit existing tutorial content for those tutorials for which they are registered authors. Top level administrators are able to edit tutorial content, create, insert and delete new components and add new tutorials. They also have full access to the component editing system, which allows them to add, edit and restructure the tutorial components, which can result in global changes to the whole suite of tutorials.

In addition to this, safeguards were put in place to prevent simultaneous editing of tutorials, allowing authors to lock their tutorials for editing by other users while they make changes to the content.

Streamlining the build process

The tutorial component administration area of the site provides tools to create and maintain the components of the tutorials. Each tutorial shares a common set of components, each of which is used one or more times. This means that any changes to a component immediately affect all tutorials that use that component, which cuts down on maintenance time considerably. Using the previous system, each tutorial would have to be recompiled individually, and then redistributed for hosting – a process which could take days from start to finish. With the new online system, the whole process could be completed in a few minutes, and the updated tutorials would be immediately available.

```
   ┌──────────┐
   │ Enter    │
   │ tutorial │
   │ content  │
   └──────────┘
        │
        ▼
   ┌──────────┐        ┌──────────┐
   │ CALnet – │        │ Tutorial │
   │ dynamic  │◄──────►│ Databas  │
   │ generation of│    │          │
   └──────────┘        └──────────┘
        │
        ▼
   ┌──────────┐
   │Personalised│
   │view of tutorial│
   └──────────┘
```

Technical architecture of the Content Management System for the tutorials

Editing made simple

The tutorial content area of the administration system allows registered users to gain access to the content of their tutorial for editing purposes. Tutorial editing takes the form of navigating a separate rendered version of the tutorial, to locate the section to be edited. This means that locating the area to be edited is never more than five mouse-clicks away, as this is the maximum depth of linking used within the tutorials.

The majority of editing procedures involve editing simple HTML, and this again is a slight departure from the previous CALnet system implementation. The most complicated feature of the first two phases of the Virtual Training Suite was the implementation of the Links Basket – a tool allowing users to record Web links in a shopping cart style basket for viewing later, rather than interrupting the flow of the tutorial. Whilst being one of the most popular features, it was also the most technically difficult to implement. With the new centralised structure utilising a database, the problem of storing the selected links was easily solved, and the previously cumbersome Links Basket annotations were replaced by simply inserting the required link, and using server parsing of the tutorial content to determine which links were to be included. These features are discussed in the next section.

New Features

Feedback received from the first two phases of the Virtual Training Suite identified several areas that went on to an internal technical 'wish list', which due to budget constraints or technical limitations had not been implemented. With the new system developed for the Virtual Training Suite for FE tutorials, the technical team were able to look at this list and implement many of the suggestions.

Opening up the Links Basket

Previous incarnations of the Links Basket had a few technical limitations:

- Heavy reliance on Javascript
- Per-session only – once the browser had been closed, your Links Basket collection was lost
- Unable to bookmark it
- Use of standard browser functions (eg. Back button) could empty your basket without warning

The Links Basket developed for the new system solved all these issues, and provided additional features. By using a database to store not only the selected links, but also a session identifier for the person using the tutorial, users could simply bookmark the tutorial at any point, and return later and retrieve their Links Basket. In addition, a feature was added so that the user could email their Links Basket contents to themselves, or anyone else.

A frequent criticism of the Links Basket was that by hiding links to URLs within the site, the tutorials were not using familiar Web technology – links mentioned on Web pages usually are accompanied by a direct hyperlink to the resource mentioned. To accommodate this, a feature was added to the tutorials

which allowed the Links Basket feature to be disabled, instead displaying URLs within the tutorial pages, rather than the usual Links Basket icons. This feature was only possible due to the dynamic nature of the page generation – multiple users can make simultaneous use of the Links Basket in a personalised way without affecting each other.

A feature added as a requirement for the Further Education tutorials, was the ability to annotate Links Basket contents. Again, this feature is switchable, so if not required, it does not interrupt users' normal use of the Links Basket. By allowing users to type short comments in to Web form text boxes, which were then stored along with their Links Basket selection, a simple yet valuable addition was made to the system.

Example of Links Basket entry

Going to print

The ability to view pages or sections of the tutorials in a format more suited to printing rather than screen was available in the first implementations of the Virtual Training Suite (see Fig.2), but involved viewing a pre-rendered static version of the page. This caused additional problems with maintaining multiple versions of the tutorials. In the new system, as the pages are dynamically served to the user, it is possible to produce a 'print friendly' rendering of the same page on request, rather than maintain a separate copy. This version removes the navigation bar from the left of the page, and renders the content to extend to the full width of the page to make full use of whichever print medium is used. Links are provided to link to a print friendly version of the parent section, chapter, or complete tutorial.

Developing an architecture for the future

A key point which has been part of the continued success of the Virtual Training Suite has been the willingness to act on feedback gathered during the project lifetime to improve the tutorials, both for existing users, and when considering future functionality of the suite. In each phase of development, features and functionality have been added and improved where possible to create a valuable and useful resource.

Chunking for Virtual Learning Environments

A surprisingly popular feature of the first phases of the tutorials, was that the tutorials could be packaged up and distributed easily for use on systems which either have no online facilities, or for use on standalone systems for users to access in their own time. These packaged tutorials were also being widely integrated in to commercial Virtual Learning Environments (VLE) such as Blackboard (Blackboard, 2002).

With the move to a centralised system, this feature was lost, as the tutorials were no longer stored as static pages that could be easily packaged. However, the desire to continue to more closely integrate the tutorials in learning environments such as Blackboard led to the VTS project team submitting a successful proposal to the JISC in April 2002, under a call for bids for their Exchange for Learning programme. At the time of writing, technical work on this project has not yet started, but two of the deliverables from this project will be to:

- Investigate "chunking" and re-packaging of existing Virtual Training Suite tutorials to create new VLE compliant learning objects (in line with existing and emerging standards such as IMS / SCORM) (IMS, 2002)
- Investigate the best way to "plug-in" Virtual Training Suite tutorials into different VLE software packages

The plan is to build on the database-driven architecture developed for the FE tutorials, and extend this by gradually implementing an eXtensible Markup Language (XML) framework to describe the content of

each component of the tutorial. This framework will enable "chunking" or contextual selection of tutorial components into individual learning objects so that tutorials can be selectively implemented within a VLE environment, with the option of only using required tutorial content rather than the tutorial in its entirety.

This use of XML to separate tutorial content from structure also lends itself to possible future tutorial developments, where the requirements for new designs or formats can be easily addressed by using different tutorial 'skins' without interfering with the content.

Conclusion

The Virtual Training Suite has developed from a small development project into a widely used national resource and an integral part of the RDN. Feedback continues to be positive and encouraging, and recently the suite has been nominated as a favourite site of the UK Secretary of State for Education and Skills (NgFL, 2002). It is being gradually integrated into curricula within the UK Higher and Further Education sectors, as well as being recommended to learners world wide, both within education and in the commercial sector. The continual development of the technical architecture has been an integral part of this growth, both in supporting the pedagogic framework of the tutorials, and ensuring they remain accessible, useable and relevant.

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