On-line Education and Training—Has its Time Come?

The EU 4th Framework Programme has driven a large body of applied research into on-line learning technology. This has covered methodologies for delivering on-line education, content creation and management, pedagogical styles of learning in an on-line context and in the case of the ACTS Programme in particular, how broadband technologies and network management architectures can be exploited to best effect to deliver on-line learning (e.g. RENAISSANCE, PROSPECT).

In the timeframe of the 4th Framework, this area was poorly defined and much experimentation was required in order to better understand what was required of these systems, what was technically feasible and what would actually work to provide a beneficial learning experience for on-line learners. Just as with general education, the term on-line learning (by no means a universally agreed term) encompasses learners from school age right through to postgraduate researchers. Furthermore, this ‘technology’ was expected to support training as distinct from education, including work-based training, self-paced study and remedial education for the disadvantaged. Little wonder then that each project, having identified its key focus, found itself having to work from first principles in designing and implementing a learning system. However, this effort has resulted in an understanding of the diversity of the application of on-line learning and just as important, what areas are common. The experience gained has established the importance of tutor support for on-line learners and the tools which can aid the learning process.

This learning curve has been experienced elsewhere in the world (particularly the USA and Australia) and in recent years there has been a realisation that to speed up the deployment of these systems, open standards are required to permit inter-working between different vendors offerings.

The Standards Effort for On-line Education

A query with your favourite Web search engine on education will quickly reveal the vast extent of material available on-line, including email discussion groups, electronic journals and reports, user groups and on-line conferences. Extend the search to include the libraries domain (an area not insignificant to the management of learning resources, digital or otherwise) and it becomes clear the enormous effort that is being expended globally in making on-line learning a reality. Also apparent is the diversity of system architectures,
favoured infrastructures, pedagogical styles and target audiences for many of these efforts.

Some way along the learning curve, many players come to the realisation that attempting to engineer a complete solution to suit all requirements is just too expensive in terms of financial investment and elapsed time. Indeed, within the lifetime of a lengthy research project, it is all too common for the exciting ideas adopted at the start to have become commonplace or even worse, have been superseded by the time the project is drawing to a close. That is not to say that valuable lessons are not learned, but the opportunity for the short-term exploitation of the results, such as developed tools, can be somewhat curtailed.

It is at this point that people begin to see the advantages of a component-based solution. Here they can focus their effort on the part of the puzzle with which they are principally concerned, whilst integrating their work with tools and content provided by others; ‘others’ increasingly being the prospect of commercial vendors. However, implicit in this approach is the commitment to collaborate with organisations wishing to develop these complementary tools and widespread adherence to a common architecture with well thought out and clearly specified component functions, agreed data schemas and common APIs. This collective thought process has led to the steady emergence and growth of a number of fora concerned with standards for on-line learning. The principal ones covered here include:

- Aviation Industry CBT Committee (AICC)
- Centre for European Normalisation/Information Society Standardisation Service—Learning Technology Working Group (CEN/ISSS LT)
- Dublin Core Education Working Group (DC)
- IEEE Learning Technology Standardisation Committee (IEEE LTSC)
- Instructional Management Systems Project (IMS)

**The Standards Fora for On-line Education**

**AICC**

[http://www.aicc.org](http://www.aicc.org)

The Aviation Industry Computer Based Training (CBT) Committee is a membership-based international forum that develops recommendations on interoperable learning technology, principally for the commercial aviation and related industries. As such its members include both plane and equipment manufacturers, carriers, software and multimedia vendors and a growing number of interested parties not directly engaged in the sector, but nevertheless interested in the work being done there.

Given the costs associated with the aviation sector (the initial purchase of the planes, as well as ongoing operational costs such as maintenance, regulated safety procedures and staffing levels etc.), it is not surprising that cost benefits of on-line training and digital manuals were perceived here at an early stage. Along with some pioneering thinking, this has led to the aviation sector generally being an early adopter of the technology.

One of the key goals of the AICC participants is to extend the usable lifetime of multimedia
training materials to match that of the equipment which they are intended to be used with. A plane is intended to fly many hundreds of thousands of miles over a number of years. The lifespan of a particular version of an authoring or tool or delivery environment on the other hand may be just one to two years before significant change is introduced. Whilst this is inevitable given the rapid state of flux within the IT industry, it creates problems in terms of running and maintaining legacy systems and/or re-engineering content for new platforms. A major thrust of the AICC therefore is to define a mechanism for translating content across operating environments. This effort is directed at creating a CBT Interchange Language intended to be common across platforms.

Given the sector's experience of using CBT for on-line training, the AICC have developed a detailed model for Computer Managed Instruction (CMI) which is extensive in its coverage from LAN based delivery of traditional CBT to current work on Web-based delivery. The specification covers content formats and structure and mechanisms for retrieving data from the content being used by learners. This work has attracted interest from the Advanced Distributed Learning initiative (ADL) being run by the US Department of Defence [http://www.adlnet.org]. ADL is a forum to promote widespread collaboration, exploit Internet technologies, develop next generation learning technologies, create reusable content, and lower costs, with object-based tools in support of distributed learning. It thus shares many of the goals of the AICC.

A subgroup of the AICC have been working with the ADL and other players from the IEEE LTSC and elsewhere to define a subset of the CMI specification that is solely concerned with on-line Web delivery. This work has generated a lot of interest and appears to be gaining widespread support.

CEN/ISSS LT

http://www.cenorm.be/issss/Workshop

- CEN/ISSS, in co-operation with the European Commission's DG III & DG XIII has set up a working group to address European requirements for Educational Technology. This working group aims to achieve a consensus view in this area through the following actions:
  - The establishment of a steering group to guide and monitor progress
  - A requirements gathering stage to discover the precise needs of European developers and users
  - Consensus within a working group established under the TEISS (Telematics European Industry Standardisation Support) framework on the standardisation process for educational technology
  - Coherent developments within metadata under the CEN/ISSS workshop process after this stage
  - Coherent development of standards for interoperability which allow learning resources to work together seamlessly with learning management systems
• Endorsement by project promoters and consultation with all signatories
• Consideration of comments, objections and additions from signatories by the working group
• Publication and transmission of recommendations by the work group to publishers, suppliers of hardware and services, telecommunications operators, industry bodies generally, standardisation bodies, the European Commission and international standards bodies.

The output from this work group will be in the form of:
• Coherent proposals to European and International standardisation bodies on common standards supporting the development, storage and indexing of multimedia digital learning resources and delivery of services
• Specific proposals on interoperability as defined above
• Outputs for public dissemination shall be submitted to consensus of a CEN/ISSS workshop and published in the first instance as CEN workshop agreements.

To its credit (given the scale of standardisation activity ongoing globally for education) this group has decided to follow a course of examining standards emerging from international fora and assessing these for how well they will meeting the multicultural and multilingual requirements within Europe. Only in circumstances where there is a need identified that is not being addressed elsewhere, or an external standard (e.g. US based) needs extension for adoption in Europe, will they embark on creating something afresh. A number of the participants in this group are also active in the various international fora and they thus maintain a liaison with these groups. This working group only held its first working meeting in July 1999 so it is still early days for any outputs.

**DC Education**

*http://purl.oclc.org/metadata/dublin_core/*

The Dublin Core Group have announced their intention to set up an Education working group. The Dublin Core elements were originally defined from the data that was perceived to be widely used or common across metadata communities (e.g. libraries, museums, archives, graphical information systems) and the myriad of metadata schemas in existence (e.g. UKMARC, USMARC, CIMI). These core elements have been widely adopted by various bodies (e.g. European SchoolNet, IEEE/IMS Learning Object Metadata Group, US Gateway to Educational Materials) as the starting point for defining their own metadata to describe online educational resources. Inevitably, as these schemas have evolved, they have diverged somewhat from the original DC concepts and DC itself has changed from its original unqualified, general purpose model to now developing DC qualifiers so that data represented within DC elements can be more accurately interpreted.

This more ambitious role for DC is largely unproved, but given its widespread support and their collaboration with the INDECS project [http://www.indecs.org] working on content IPR
description and handling, it is the direction favoured by many for achieving cross-domain search capability in the future.

The DC Educational working group will hopefully give a steer on how the educational community should support DC, both in its current form and for the future as DC v2.0 emerges.

IEEE LTSC
http://www.manta.ieee.org/p1484/
The IEEE Learning Technology Standardisation Committee is the only body engaged in the educational domain, which has a recognised formal standing. As such, many of the other groups (e.g. AICC, IMS, CEN/ISSS participants and representatives of the US branches of the US military) participate in the IEEE process and aim to progress their working specifications through the IEEE adoption procedures. Given the diversity of the fora represented by the participants in the IEEE, there exist a large number of working groups focused on specific activities, as well as more horizontal activities (such as the Architecture and Reference Model and the Glossary working groups) that attempt to tie the wider ranging work together. The IEEE working groups and study groups (note a study group is formed to do preliminary work to scope any subsequent working group in the particular area) can be broken down as follows:

GENERAL GROUPS
  WG01—Architecture and Reference Model *
  WG03—Glossary *

LEARNER-RELATED GROUPS
  WG02—Learner Model
  WG04—Task Model WG
  WG13—Student Identifier
  WG05—User Interfaces (study group)
  WG19—Guide for Application of ISO-9001 to Self-Managed Learning and Knowledge Management (study group)
  WG20—Competency Definitions (study group)

CONTENT-RELATED GROUPS
  WG10—CBT Interchange Language
  WG06—Course Sequencing
  WG17—Content Packaging

DATA AND METADATA
  WG12—Learning Objects Metadata (LOM)*
  WG09—Localisation (study group)
  WG14—Semantic and Exchange Bindings
  WG15—Data Interchange Protocols
  WG16—HTTP Bindings
NB: Those marked * are the most advanced areas and the Learning Object Metadata and the Computer Managed Instruction will probably enter initial voting stages during 1999.

WG19 study group—Guide for Application of ISO-9001 to Self-Managed Learning and Knowledge Management, is looking to define something akin to a ‘passport to learning’. This will require a new learner not already accredited, to go through a formal induction process to ensure they have the basic personal skills (e.g. time management, report writing, assessment preparation) to take full advantage of their proposed learning programme in an on-line setting. For learners working on-line, possibly remotely and under self-paced study, this is an important consideration in both retaining learners and ensuring that they achieve their full potential. It could be viewed as ‘learning to learn’.

IMS
http://www.imsproject.com
The Instructional Management Systems project is a US initiative, driven by EDUCAUSE and incorporating 600 educational institutions across the USA. The current project will run until December 1999, after which time it is the intention of the members to transform this into a ‘non-profit’ incorporated organisation. The consortium also includes a number of industrial partners, many of whom have made a significant financial contribution to the project as investment members of IMS. Over and above the substance of the work, it is this direct participation by a large number of multinational corporations that has fuelled global interest in the IMS and has led to the setting up of satellite IMS centres in Australia, Canada, Singapore and the UK operated by local agencies.

The IMS started work with the academic community in the US in constructing a detailed requirements specification for on-line learning. This was originally intended to be followed by a pedagogically and platform neutral, functional specification and design leading to a reference implementation which would then be used by others as guidance for their subsequent commercial developments. The original draft specification did not prescribe the distribution environment to be adopted and by way of demonstration, played equally to both CORBA and DCOM. The increasing involvement of the vendor community (each with very strong views on the tools, protocols and technologies to be used for the delivery platform, development environments and management systems) the IMS vision has been broken down into a number of fairly modular areas. Members are able to participate in the specific areas with which they are most concerned.
Key areas include:
• E-Commerce
• Enterprise Systems
• Metadata
• Content & Packaging
• Question & Test
• Security
• Content Management
• Profiles
• Conformance Testing

Of these, the metadata specification, which has been developed in collaboration with the IEEE LOM working Group, is the most advanced and was formally released by IMS in August 1999. In addition to the LOM specification, IMS has made recommendations as to the core elements that should be supported by any developers and issued guidelines on implementation.

The second key focus of IMS at present is the Enterprise Systems group which has taken input from:
• IEEE Learner Model working group (in the form of the draft Public and Private Information specification);
• Schools Interoperability Framework;
• Speede/Express guidelines on constructing and exchanging student records in an EDI.

The group are currently drawing up a schema for representing student data encompassing personal data, groups, group membership and grades.

Other areas which have made progress include the Content & Packaging which has produced a specification for how to package up content for delivery and what files are required to supported installation and usage etc. A demonstration piece of software has also been produced called Packman which incorporates the metadata and package description files with the content in a single file. The Question & Test group have developed an extensive hierarchy for classifying question modes and suggested an XML schema for passing the results back to a Learning Management System. Proposals have also been put forward on Content Management and it is expected that these areas will become a lot more active once the current push to complete the metadata has been completed.

The EU 4th Framework

During the lifetime of the 4th Framework, there have been a number of projects which have attempted to further the cause of on-line education. These have been spread across various programmes (e.g. ACTS, ESPRIT, Telematics). Two examples which are still active are ARIADNE (from the Telematics for Education Programme) and GESTALT (from the Advanced Communications Technologies and Services Programme—ACTS). These two projects have
fundamentally different views of the business case for the development of on-line learning and each has its own system model. Nevertheless, they have been able to co-operate in the formation of international standards and are planning to define a common XML Document Type Definition (DTD) based on the LOM and exchange metadata so as to demonstrate interoperability in this area.

ARIADNE
http://ariadne.unil.ch
The ARIADNE Project has been active both within the IEEE LTSC and in the formation of the Learning Technology Working Group under CEN/ISSS. The project Manager, Eddy Forte, is also the chair of the PROMETHEUS forum. The European Commission (DG III, DG XIII) and CEN have been instrumental in the formation of PROMETHEUS, a forum for exchanging ideas and driving consensus amongst actors in this area within Europe. In the international arena, ARIADNE has been a major contributor to the IEEE LOM work.

The actual project has developed a range of tools for the delivery and support of on-line learning which are made available free-of-charge to the ARIADNE user community. Many both within and external to the project have authored content which is described using metadata and made available to tutors via the ARIADNE Knowledge Pool Sites.

The ARIADNE distribution model seems based on co-operation between, and free access for, the academic community who will develop their own content and tools which will be freely exchanged. As such, the system model is very flexible as tutors simply select the tools they wish to use.

GESTALT (ACTS 367)
http://www.fdgroup.co.uk/gestalt
The GESTALT project has built upon the results from three previous ACTS projects—GAIA, PROSPECT and RENAISSANCE. Respectively, these have addressed:

- A standard architecture for CORBA-based brokerage of on-line services (now published by the IETF as an rfc ftp://src.doc.ic.ac.uk/rfc/rfc2552.txt);
- Management of network services for educational delivery;
- Integration of heterogeneous broadband networks (using IP) for delivery of educational multimedia services.

For RENAISSANCE and subsequently GESTALT, the emphasis is on delivery of learning within a managed process as part of the core business of the educational or training organisation. This entails tight-knit integration between the learning delivery and the central management of the institution, with reliable flow-through of data on student tracking etc. The GESTALT project is then coming at this problem from a systems perspective, the goal being to achieve organisation-wide integration of existing and future systems within the institution and linking the promotion of on-line learning opportunities with the CORBA-based brokerage service. The broker would service queries from potential learners across a wide range of delivering
organisations and a central value-added function of the broker is that it quality assures these offerings and the institutions behind them.

As can be seen from the above descriptions, these two projects have a very different view of the role of on-line learning, but nevertheless they have co-operated (along with IMS and others) on the definition of the IEEE Learning Object Metadata. It is hoped that this will strengthen the LOM specification, enabling it to meet a wide set of requirements across user communities.

Other areas of development within GESTALT have included a European-focused implementation of the IEEE Public & Private Information (PAPI) specification from the Learner Model Working Group and the definition of a Unit Object Model for describing student progress between the Learning Environment and the Administration MIS.

Aligning European R&D activity with the wider standards formation work has had clear benefits in terms of developing a common language for describing systems, components and functionality and generally encouraging the cross-fertilisation of ideas around the globe.

**Challenges for Education in the 5th Framework**

There are still significant areas that need to be addressed within the lifetime of the 5th Framework. Not least in the light of the growing desire to support lifelong learning with learners accessing ‘chunks’ of learning from different institutions at their own pace. This differs significantly from the traditional scenario of enrolling for a full programme of study with a single institution, and has implications for the level of integration required across institutions under this new paradigm of learning. There are also key technical challenges to be addressed for nomadic users of services across variable network infrastructures. Some highlights of what we can expect to see advanced in the 5th Framework include:

**XML Query Language**

The W3C http://www.w3.org have already received a number of proposals on various search mechanisms and protocols for remote querying of metadata repositories. As yet there is no consensus on this topic, but this is clearly an issue which needs to be resolved if there are not to be a plethora of proprietary interfaces spawned. Candidates include Z39.50, DASL and variants of SQL. There is also a growing support (e.g. amongst communities such as Dublin Core) for linking remote searching using RDF/XML Schema with a centralised, third-party Basic Semantic Repository based upon ISO 11179 part 6 being specified as part of the SQL standard by ISO/TC154. This is clearly an issue important to the whole Web community but it is of specific interest to the education sector as a growing proportion of learning assets are digital in nature and the function of the library converges with on-line Web-based content management.

**Credit Framework**

The European Commission have instigated a convergence plan in Europe for the adoption
and harmonisation of credit-based curricula across the HE sector in the member states. There is currently great diversity, with some countries not yet having adopted a credit framework, and the existence of one and two tier HE provision of varying forms, compounded by the growing provision of degree awards from the commercial sector. Lifelong learning across institutions will require recognition of prior learning in a structured, consistent manner if learners are to be able to aggregate their studies to the ultimate award of a qualification. A pan-institutional, Europe-wide infrastructure is required to support this vision and this area is currently wide open for new ideas and exploitation of new technologies.

**Personalisation of Services**
There is a movement to explore how re-usable Internet resources (exploiting e.g. SMTP, HTTP, IP-multicasting) can be personalised for the individual within a scalable architecture for both terrestrial and mobile networks. Also of interest is network caching and dynamic distribution of resources across the network to achieve load balancing. In particular, there are two proposals currently under development within W3C that are pertinent to this issue and worthy of further study and experimentation:

- **Personalised Information Description Language (PIDL)**—personalisation of on-line information by providing enhanced interoperability between personalisation applications;
- **Composite Capability/Preference Profiles (CC/PP)**—is a user side framework based on RDF for negotiating user preferences and device capabilities.

Again, these are generic in nature, but have the potential to impact significantly how on-line learning is accessed and delivered.

**Pedagogically Adaptive Content**
There is a growing community working on ‘intelligent’ content which can offer alternative paths through the material dependent upon the performance of the user as measured by interactive tests. Generally, systems supporting such content rely upon the intelligence being built into the server side and are proprietary in nature. Whilst still an ongoing research topic, there are now standards being developed within the IEEE (e.g. the content API being developed by the CMI Working Group and the Question & Test Group within IMS). Use of the content API along with an XML representation of test results to be returned, will enable this content to be interrogated and the student progress to be tracked by a management system.

**UK University for Industry**
By way of demonstrating the rapid impact that R&D in this area can currently have on large-scale commercial developments, we will examine a new initiative in the UK called the University for Industry. The Ufi has awarded the contract for its nation-wide information and communications technology (ICT) infrastructure for on-line learning to a Logica led consortium which includes Cable & Wireless, David Jennings Associates, Fretwell-Downing Education and Interactive Bureau. The Ufi press release describes this as follows:
“The [Ufi] systems will transform the way millions of people can learn in the coming years whether at home, at work, or in one of the new national network of Ufi Learning Centres. The Ufi learning website which will be developed as part of the contract will give millions of learners and employees instant access to learning advice, packages and support. The consortium will be responsible for linking together the 1000 Ufi Learning Centres with its four regional call centres, so that learners can get the best advice and the centres can share information.”

“This appointment marks a major milestone in the development of Ufi,” comments Dr Anne Wright, Chief Executive, Ufi Ltd. “Our ICT systems are central to our plans to develop a new way of learning which fits the needs and lifestyles of individuals, and the operating realities of our businesses. Our systems will allow us to deliver learning in new and more flexible ways. Ufi learning packages will be available on line, so that learners can mix and match them according to their needs. They will also get support from tutors and be able to interact with other learners via the website. In the future, learners will be able to keep track and record their progress through their own learning log.”

Fretwell-Downing Education will develop the Web-based learning environment to be deployed by the Ufi and the back-of-house management system to support this. The prototype learning environment developed by FDE within the GESTALT project under the ACTS Programme, and their participation and contribution to a number of the standards fora described previously has had a significant impact upon the design and direction of the Ufi system. The GESTALT system has been built to demonstrate how scalable components can be integrated to offer a comprehensive solution for on-line learning using many of the emerging standards discussed here and explored how these can be promoted by third party brokers.

Clearly this is a significant success for FDE, but it also demonstrates dramatically the timeliness of standards formation in this area and the influence they can have on national strategies and commercial developments which need to look to the medium to long term for their investments.