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Considerations for producing re-usable and sustainable educational streaming materials

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Abstract

Abstract: Useful lifetime of educational materials should be defined by their continuing ability to help meet defined learning objectives. More often lifetime is compromised by changes in the educational environment that do not specifically relate to the capacity of the material to assist learning. Approaches for integration of materials into the learning environment can be designed to maximise useful lifetime of materials against potential barriers created by, for example, instances of technological change. In this study, the impact of different approaches is demonstrated by examining the development of 163 learning objects, based on several licensed collections of streaming video procured for cross-sector educational use by the UK Lifesign project. Constraints relating to sustainability work within the limitations of a short-term project environment are specifically considered.

Résumé: Le cycle de vie utile du matériel didactique devrait être défini par son habileté continue à répondre aux objectifs d'apprentissage établis. La plupart du temps, le cycle de vie est compromis par des changements apportés à l'environnement éducationnel qui ne s'appliquent pas particulièrement à la capacité du matériel à contribuer à l'apprentissage. On peut concevoir des méthodes d'intégration du matériel dans le milieu d'apprentissage pour profiter au maximum du cycle de vie du matériel en se fondant sur des obstacles possibles créés par des occasions de changement technologique par exemple. Dans cette étude, on démontre les répercussions des différentes méthodes en examinant l'élaboration de 163 objets d'apprentissage en fonction de plusieurs collections autorisées de séquences vidéo acquises aux fins de l'utilisation éducative intersectorielle par le projet UK Lifesign. On tient tout particulièrement compte des contraintes relatives au travail à effectuer pour assurer la viabilité à l'intérieur des limites d'un projet d'environnement à court terme.

Introduction

Interesting and engaging educational resources that are effective for learners require considerable thought and meticulous planning to achieve; good applicable materials become used over and over again. Yet, it is harder than ever to ensure continued access to good materials, especially when these are delivered in electronic form. Short-term projects seeking long-term adoption of their educational materials must address transferability and preservation issues that relate to their educational content, in addition to the technical format of their original production. (Littlejohn, 2003; Phillips, 1997).

It is possible for materials that meet transfer criteria in one of these areas to demonstrate other types of barriers to their transfer between educational or technical contexts. Considering sufficient transfer aspects for successful long term adoption is important, in particular for reaching audiences that are reluctant to adopt transient material, irrespective of quality (Calverley & Shephard, 2003; Warburton, 2000). Without a minimum level of stability, material produced, or made available, quite simply will not be used. It is also more valuable for resources and materials developed for learning to degrade through changes in educational requirements, rather than being driven by technological developments. This approach allows stronger focus on the requirement to support the act of learning itself rather than enhancement of support structures to improve the learning environment. Phillips (1997) remarked on this as early as 1997 in relation to discussion on Interactive Multimedia [IMM] Development:

While it is technically possible to implement almost any idea, not all are suitable for IMM, as other media may be more appropriate. There may well be other valid reasons for seeking to use IMM: reducing lecture load; delivery to remote students; providing alternatives to lectures. However, the bottom line should be that if the proposed project does not improve student learning then it is a waste of effort. (p. 13)

This situation is particularly significant for short-term projects, where the effort required to ensure effective "beyond project" use of their product may constitute a considerable overhead to operating on a tight budget and timescale.

This paper examines the approach taken by one educational streaming media development and evaluation project to ensure continued use of its material beyond the supported project period. Drawing together independently developed data, tools and resources in a way consistent with educational case studies, suggested opportunities to improve transferability and sustainability of its materials by introducing relatively small shifts in production direction. For example, a wider range of access mechanisms, or providing additional supporting materials aimed at wider educational audiences, would help to make the material more available and relevant without a project team being required to be available.

The impact of the constraints described are examined against decisions made within the project environment in respect of the nature of the media itself (England & Finney, 2002; Shephard et. al, 2000-2003), developing its wider use in the classroom (Boyle & Cook, 2004; Conole & Dyke, 2004a, 2000b), and emerging findings characterised by rapid

developments towards a learning object economy (Duncan, 2003a, 2004). This example illustrates how the natural component design of a real project has allowed its materials to be adopted into a more modern delivery structure, while preserving the educational benefit provided by the original context.

Lifesign and Lifesign Material

The developments described in this paper are presented within the context of *Lifesign: Moving Images for the Life Sciences* (Lifesign, 2000-2003; JISC, 2002), carried out in the UK during 2000–2003. The project has been described in general contexts by Mahoney (2001), Garrison (2001) and in the *Times Higher Education Supplement* (Leon, 2002). Lifesign later evolved into an ongoing service for staff and students in UK Higher Education. Figure 1 illustrates the Lifesign interface (primary host delivery site), that supports access to individual streams.

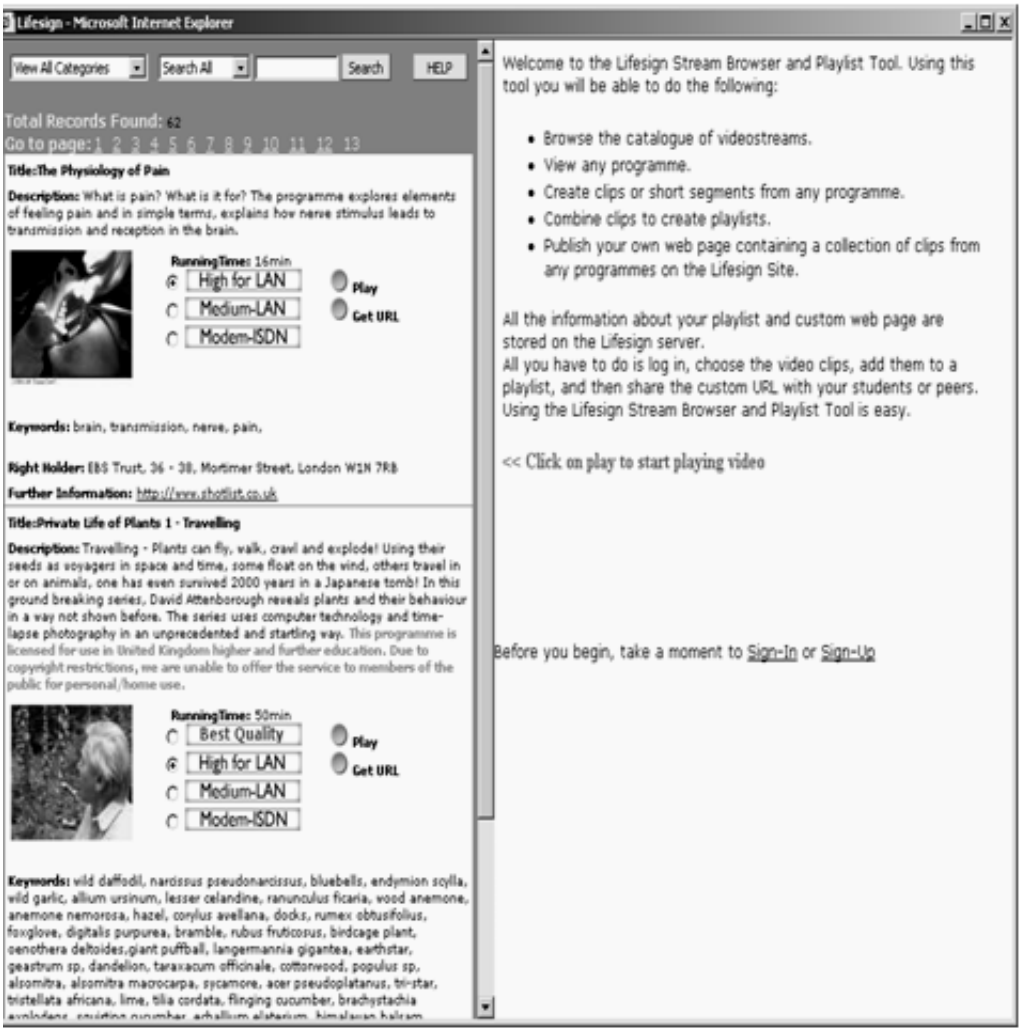

Figure 1: Primary host interface supporting user tools and access to individual streams

As a project, Lifesign was primarily concerned with using streaming technology as a means to develop, catalogue, deliver and evaluate the use of moving images across the internet for learning and teaching in the Life Sciences. Extended reuse and uptake of its resources

were a major consideration, particularly in view of the resource-intensiveness normally associated with these types of activities. However, the primary service environment was initially viewed in terms of a streaming service for staff and students, eventually to include development of user tools. Figure 2 illustrates tool interfaces supporting stream segmentation, playlist creation and 'get URL' functions.

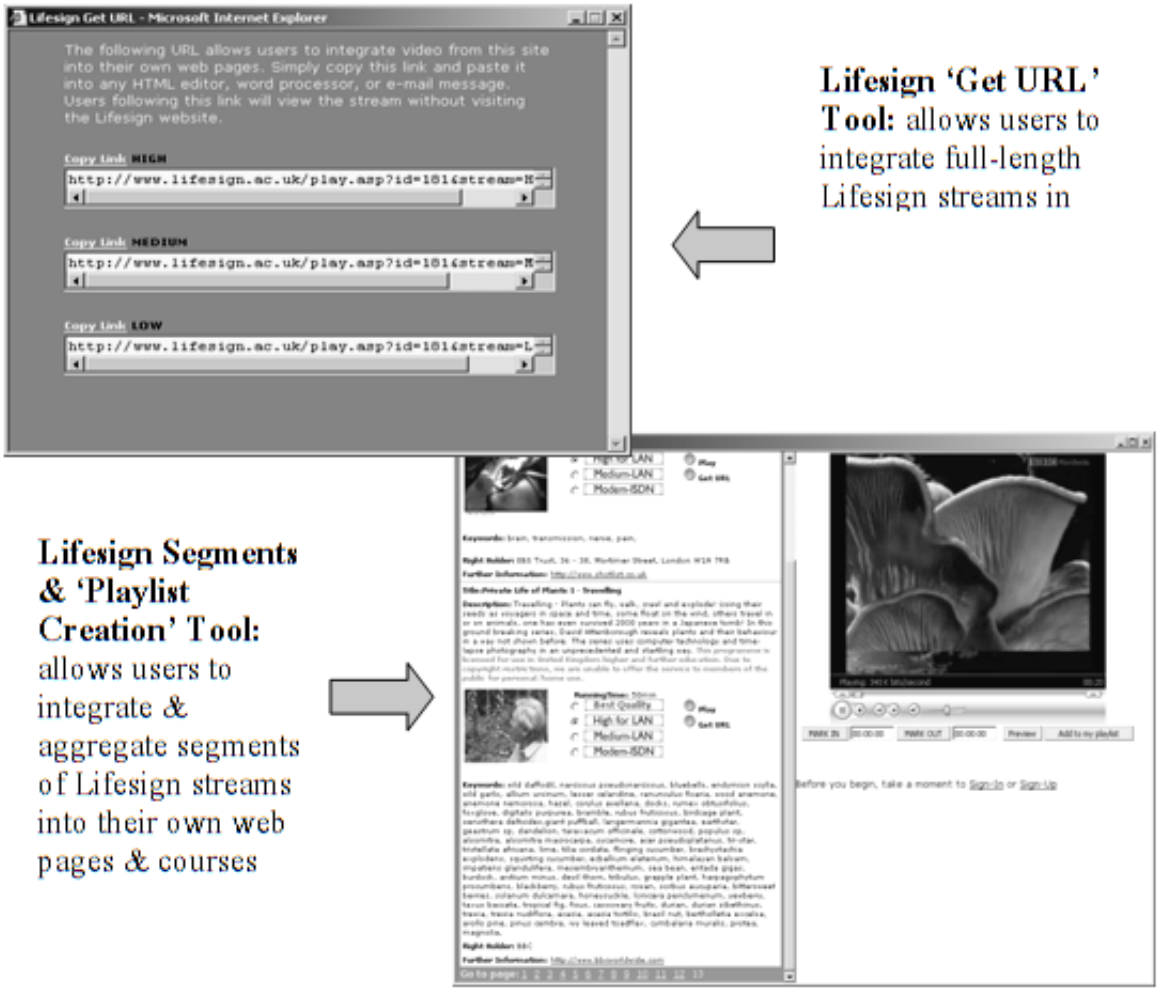

Figure 2: Examples of user tools developed for streaming video customisation

Examining the Potential for Reusing Lifesign Materials

A study evaluating UK project content for reusability as learning objects (Currier & Campbell, 2005) found Lifesign material to be highly reusable due to its self-contained independent nature. Only two projects of 27 content producing projects were cited this way. Lifesign felt the result reflected its efforts to create material of an educational content and media type that lent itself to effective cross-discipline embedding.

Technical Transferability

Currier & Campbell's (2005) positive reuse analysis suggests that Lifesign material should lend itself fairly readily for conversion to Reusable Learning Objects (RLO). Although it is unlikely that the primary service environment would ever be solely offered solely through

RLO technology, this would still offer an effective route for the project to consolidate aspects from a number of disparate areas in:

- production, procurement, delivery and licensing,
- metadata creation and development,
- user uptake and technical embedding of the content in live courses.

Continual development of mechanisms for easy maintenance is very important, given the resource input needed to generate and retain materials of this type. Consolidation would offer a single mechanism for maintaining, in particular, a range of data driven aspects surrounding the resource material.

Expertise Retention and Transferability

Promotion and distribution of the material was initially designed to allow personal evaluative contact to be the initiator of the majority of learning scenarios driven by the project, in order to generate learning case studies based around examples of streaming media in the Life Sciences. The approach was to be supported by the project's own delivery service and tools. However, this is a labour intensive process, and only partially sustainable. Procurement of larger collections was also a significant activity for building up a core of material suitable for browsing users, and to offer as exemplar material. A change in approach to adopt additional external mechanisms to promote reuse, particularly via the RLO and sharable repository format, raised questions as to how the expertise model could be placed within such a significantly alternative delivery model, although it appeared to offer clear promotional benefits from the collection exemplar approach.

For example, in the external repository environment, members of more competitive environments may not adopt or encourage cross-sector sharing of educational material to the same extent. Yet these groups can benefit in cases of academic reuse of material across different courses and student groups. Also production of reusable academic content allows academics and departments to "future-proof" their own material across their own institutions' technology changes. In other words, there is benefit in having the ability to preserve or generate educational material in a form that is able to resist, or has maximum impermeability to, non-educational changes in its environment of use. This is particularly the case where changes are able to render the material prematurely useless or obsolete. These opportunities were not clear to many academic staff until they had the experience of working with project staff on material directly related to their own interests. A strategy was required to demonstrate the ability to capture these types of expertise as the project developed new educational scenarios built around the streams offered.

Concerns of this type suggested that RLO and repository delivery may only be able to service limited aspects of the overall educational drivers being initiated by the project. The emphasis of encouraging academic users to incorporate streaming media more commonly in their classes forces a different set of priorities against a remit of maximising technical opportunity. So, all areas of the project that might be affected or involved by the proposals needed to be investigated.

Contextual Transferability

The academic reuse potential of the educational material with which Lifesign is concerned, is demonstrated by user examples such as:

- Instances of VHS material that needed to be converted as bespoke cases for streaming (Shephard, Ottewill, Phillips, & Collier, 2003) and older educational videos that are still of use in areas such as Backcare in Nursing (Shephard & Jezierski, 2002).
- While the equipment demonstrated in a bespoke blood pressure video, remains in common practice use, it will remain appropriate for training purposes (Shephard et al., 2000–2003).

It is more likely that changes in technological and rights issues will render the material obsolete before its learning value. Therefore, in terms of the Lifesign ethos in supporting the user community, the effort required to sustain the material these resources contain is worthwhile. However, by concentrating on object format, it can be less apparent how indications of technical reusability might guarantee effective content reuse, other than by those mechanisms already introduced by the project as part of its collection-based development work. A major concern with regard to loss of educational expertise surrounding the resources remained, despite creation of educationally sound, technically-independent and potentially reusable video streams. This expertise had so far been crucial in allowing new users to see the opportunities presented by the material and the media.

Impact of New Distribution Opportunities

Although reuse (or transferability) of Lifesign material had been considered in detail throughout the project, there had never been an explicit requirement for producing project material to be delivered in object form. However, near the end of the project lifetime, Lifesign was offered the opportunity to contribute to the establishment of a new central repository service (JISC, 2004) for all further and higher education institutions in the United Kingdom (UK). This opportunity offered an additional route for new users to access and be made aware of the Lifesign materials, considering that participation also required project materials and mechanisms to be looked at in new ways. Increasing demand for project material by this route would also limit preservation mechanisms available for the material. It became important to consider how mechanisms put in place at the primary host delivery site (the source of the service) would operate compatibly with a third party RLO host.

Limitations of Licence Negotiations

Lifesign had recognised from the start that offering short-term availability has never been an ideal situation for encouraging users to adopt a resource for academic purposes, given the lengthy academic timescales, both technical and educational, to put a course in place. However, in procurement, to be able to offer some valuable material to the academic community, the project was required to accept quite limited fixed period negotiations for some stream licences.

Ideally, negotiations via mainstream initiatives would have been able to extend the existing licences to align with whole sector, long-term licensing already in place for specific

collections. However, in practice, need awareness and response timescales on which such mainstream initiatives develop, are often not compatible with short-term materials procurement and development project schedules. Mechanisms had already been put in place at source to handle license termination on behalf of the project in a user friendly way. Continuing to provide access to the streams from the primary host delivery site, eliminates management duplication and alleviates concerns over the limitations in Digital Rights Management (DRM) or licensing processes in place within some repository technologies. This way, honouring individually negotiated licence agreements would not be in conflict with offering objects to or via an external source. However, this may not have been such a straightforward solution if Lifesign objects had required third party material to be directly included in the objects, or did not offer its own material under arrangements compatible with the hosting agreement on offer.

In overall terms, the overhead of producing objects needs to be weighed against the benefit of wider access to the materials. For indefinitely available materials, creating and preserving additional access is worthwhile. For short-term licences, this may not be the case. It is unfortunate that lack of renegotiation by the sector will result in removal of access to the affected materials for long term educational use. It is also unfortunate that this situation may often affect the most popular materials. This makes a case for targeted production and preservation of the existing objects: either to widen availability with a view to push for a new licence or to conserve a resource by not widening the availability of short-term material with a view to its imminent removal.

Added Value

A clear requirement from the start was that, to be of value, objects must not replicate mechanisms, systems or interfaces already in place within the project. The objects should constitute an alternative route or interface to existing services and structures, conceptually providing an adjustable layer or wrapper to extend the functionality of what had already been acquired and made available. Objects should also have the ability to provide alternative representations, to assist with demonstrating less obvious applications of the resources for the target audience.

In one sense this may appear to conflict with the more recent concept of an object as a "container" for custom-built material, capable of standing alone in its own right. But within Lifesign, the streaming media and its accompanying material were produced for use within the environment for which the media was originally designed, and not specifically for object format. There is no advantage to replicating the source media outside of that environment, but there is significant advantage in allowing a greater number of users to access it at source, and to support (in a structured form) those users in ways the original environment does not inherently allow. If, when considering the media for object delivery, it can be demonstrated as sufficiently flexible to reach a new generation of resource user on their own delivery terms, then there is a distinct advantage to combining the technologies.

Being able to treat the object form as a layer or wrapper for existing material is consistent with the ability to allow interchange of components to retain validity of the whole, such as in object-oriented programming languages, and in new approaches to structuring RLOs involving "several layers of reuse" (Boyle & Cook, 2003) or "separation of the deep structure from the surface structure or, the Learning Design from the subject specific content" (Morales, Leeder, & Boyle, 2005, pg. 3).

It is assumed that the format provided for the streaming material, and the case and project information referenced and/or provided for the objects, is sufficiently stable in the long term to underpin delivery through the object and repository technology. Equally, it is assumed that the repository host will retain sufficient interest in providing a working relevant service that appropriate migrations will continue to be performed as far as possible on behalf of the project, in line with improvements in repository delivery technology.

A parallel could be drawn between the relationship of core streaming resource material with its object wrapper and the duration and relationship of a stable video-based "household technology" such as VHS tapes, with the user features that have built up in the players that surround delivery of that format. For example, VHS was first introduced for household use in the late 1970s and is beginning to be phased out in favour of DVD technology in the mid-2000s; a lifetime of around 30 years. Some European electrical companies are responding to the trend by withdrawing supply of VHS recorders and players from the high street market (BBC, 2004). Video + (Plus) technology for easier recording using home video players was introduced much later, but only has a life-time in household terms for as long as it and the associated players are supported.

The concept behind Video + could be transferred to other systems, as could master VHS content, but (rights withstanding) this may not involve the originators of the source material. The Video + concept can be compared to the object wrapper for the stream in terms of providing a mechanism for more people to be able to use features of the core technology easily, but which is built to enhance that technology and does not inherently interfere with pre-produced longer-life core content.

Consolidation

So far, a range of separate considerations have been identified that need to be brought together. Formal recognition of the need cannot be achieved without alignment to educational aspects and project objectives of the original work.

Consolidation Advantages

For any consolidation to offer additional long term value to the existing Lifesign service, the new mechanism would need to harness user and project expertise in an effective way to assist new users. These users have different needs to those approaching the project resources during its lifetime, because post-project users no longer have the benefit of existing project staff and direct support. The mechanism would also have to be fast to put

in place, operable within limited resources, and make a large amount of complex material available in a coherent, linked way.

Creation of a set of Lifesign based learning objects for delivery within a custom repository system would offer the following advantages:

For improving usage	• Pointers to all significant project content contained in one place • Supporting information for individual resources offered in a structured fashion • Provision of accessibility material e.g., transcripts • Targeted searchable cross-referencing of resources and their related materials
For encouraging uptake	• Resource record metadata linked directly with resource location and detailed resource information (not possible within the Lifesign delivery system itself) • Segmentation, timing, and description metadata concurrently presented to allow targeted selection of small sections of lengthy material • Individual record metadata enhanced to better reflect the full information held by the project about its materials
For supporting users remotely	• Segmentation, timing, and description metadata could be provided with direct references to streams to promote cross-discipline use within mixed subject material, or of material predominantly suitable for a single discipline, but with subsets suitable for use in other areas • Provision of available transcripts, programme guides, case studies, project information
For promotion	• Project is represented in a recognised quality resource-location venue • Alternate recognised access to resources, versus ad hoc access to project website
For preservation	• Granular, independent, self-contained object set • Consolidation of material in structured form to allow directed access for reworking • Immediate notification if resource no longer exists (404 error, or missing from repository) • Minimised chasing for revisions staff

Consolidation Practice & Standards

The goal of maximising project mechanisms to assist users beyond the project life-time was strictly time-limited. It had to be incorporated with limited resources towards the end of the project period. Consequently, to be approved, any object development strategy had to be reliant on offering 'instant objects' by the simplest effective route available. It would be possible to manually create sophisticated objects using an object editor, and then to upload the objects to a repository. However, this is time-consuming and involves a two-stage process. It is more straightforward to use the repository directly to upload raw material and import and edit advanced metadata from its original text format instead. This

technique offered a mechanism to create useable visible objects relatively fast that were accessible from the environment either by download or linking. Export from the repository allowed the project to hold an interoperable object record in the form of both XML format metadata files and exported objects compatible with IEEE LOM and IMS specifications.

Compatibility with these specifications reflects their growing cross-service adoption within UK record-sharing and harvesting activities (Powell & Barker, 2004), and development of the UK LOM Core (CETIS, 2003), which is a UK specific application profile of the LOM. In the long term, this allows projects such as Lifesign and its successors to benefit from improved adoption of international standards. In return, projects can provide input to the work of the educational digital repository developers, and to national members of international standards bodies who can raise any significant concern as input through the appropriate channels.

In the short to medium term, many standards-related issues have tended to arise from attempting to match available Lifesign content and data to the Learning Object implementations present within the chosen delivery systems. In turn, much of the development work then relies on determining a best match in rendering the available material and data across the choice of systems and their particular implementations of those standards. With respect to standards and the work of standards bodies, this is somewhat similar to the situation of web developers tackling the way differing standards implementations across different browser types cause their pages to render differently. In this context, the repository user (or object creator) largely continues to remain constrained by the delivery system implementation of standards and specifications, rather than the standards and specifications themselves.

Technical Decisions for Object Production

To proceed with object production requires some key decisions to be made about the nature of the objects to be created. The content structure of the proposed objects in relation to the educational need is important, as well as considering which options are most compatible with the way the streams have been made available from the host delivery site.

Object Granularity

Each video stream is associated with a minimum of its quality-related location and its resource metadata. Many streams are also associated with a file listing their segment or time-based metadata, a transcript, educational case study or other supporting information and materials.

To allow for future developments in repository and metadata technologies, it was decided to build the objects to comprise a reference to the smallest resource component available with its associated resource metadata. For example, future implementation of user preferences during a search could allow a user, initially locating, say, a video object, to be redirected to a more appropriate form of the object, such as a transcript, based on their

accessibility preferences. Composite objects, containing the video and transcript together, would be unlikely to allow automatic redirection in these circumstances.

The small subset of exceptions (e.g., alternate forms of metadata, or additional keywording that might be useful in the future), were merely concatenated for completeness, rather than functionality, and uploaded as compound resource objects.

Although dis-aggregation to the smallest viable resource arrangement (also referred to as the most "granular" level of a resource (Duncan, 2003b) can create issues where users find support or related material before, or instead of, the core resource or stream, careful cross-referencing and description can alleviate this to a large extent.

More formal correlation could be possible with future developments in repository technology, possibly related to the use of object identifiers. This should allow a master identity for the core resource to be provided in subsidiary objects. This could be as simple as using the URL of the core resource within a localised project catalogue reference. In tests, using metadata functionality, automatic display of built in correlations did not exhibit as hoped, and had to be manually displayed by the user. This should be resolved with future upgrades of the repository software. In any event, the objects have been designed to provide sufficient information for the user to return to the primary host delivery site and seek what they need from there.

Multiple Resource Location

Lifesign streams have multiple locations (URLs), according to their quality (defined as "Best Quality", "High for LAN", "Medium-LAN" and "Modem-ISDN"). To the user these are the same educational content resource, although the technical provision is quite different.

It can become confusing to the user to provide what appears to be an identical resource three or four times. It is also more difficult for a user to select a resource accurately when they have multiple options presented to them. One preferred route is auto-detection of the request technology and returning the matching resource. But generally, it is not ideal for the educational user to be presented with a pre-selected technical option by a system. For example, this can affect a student's ability to learn from multiple locations, both on and off-site, at the appropriate quality of resource for their needs. Lifesign also found this technique prevented tutors from being able to test the suitability of lower quality streams that might be delivered to their students, when working from a high quality office-based connection.

Technically, identifying similar resources and their versions from each other is a complex issue, (Campbell, 2003; Kraan, 2003; Powell, 2003). However, choosing an accepted or viable route to handling multiple resource presentation is significant, because potentially an educational requirement is created for multiple resource locations to be presented within individual objects. Several situations were experienced that affected how a requirement of this kind could be handled:

1. Some repositories support listing multiple resource locations. As the URL design for Lifesign resources provided information on the quality and the resource type, which is openly visible to users, this facility provided a viable option for structuring the objects described.
2. In general, for streaming resources presented within objects, the user cannot be guided by technical type. This occurs because the technical information available within the objects is often represented only by the file type of the resource. This is frequently not obvious to the user. Formalising description of resources and the way they are introduced to users within courses may become critical in these circumstances.
3. It is possible in some repository systems that only the first resource location will be automatically listed for the user, despite all locations being available and listed within the object. To support these cases, pre-creation of objects becomes necessary. Although this is effective, it is also the most resource-heavy option. This option allows multiple organisations to be incorporated in the structure of the object, each one representing a different technical version of a resource.
4. If different technical options can reasonably be contained within different objects, and the resource is available to support creation and maintenance of the higher number of objects this approach generates, then the above situations tend not to arise.

Technical and Semantic Issues Arising from a Changing Landscape

The approach described enabled a complete set of streaming material and resources to be functionally and coherently made available through an alternative delivery mechanism, and cross-referenced to related catalogue and project material held on the primary host delivery site. A complete set of 163 independent objects with advanced metadata were created quickly in a straightforward fashion, bringing together a large quantity of raw data, delivery site information and resource and tool references. Figure 3 illustrates a selection of these “Streaming” and “User Support” Objects as displayed in the UK JORUM repository (JISC, 2004). Streaming Objects primarily present the video stream and its metadata, where User Support Objects present material that is associated with particular video streams, or their processing for learning, but not the streams themselves.

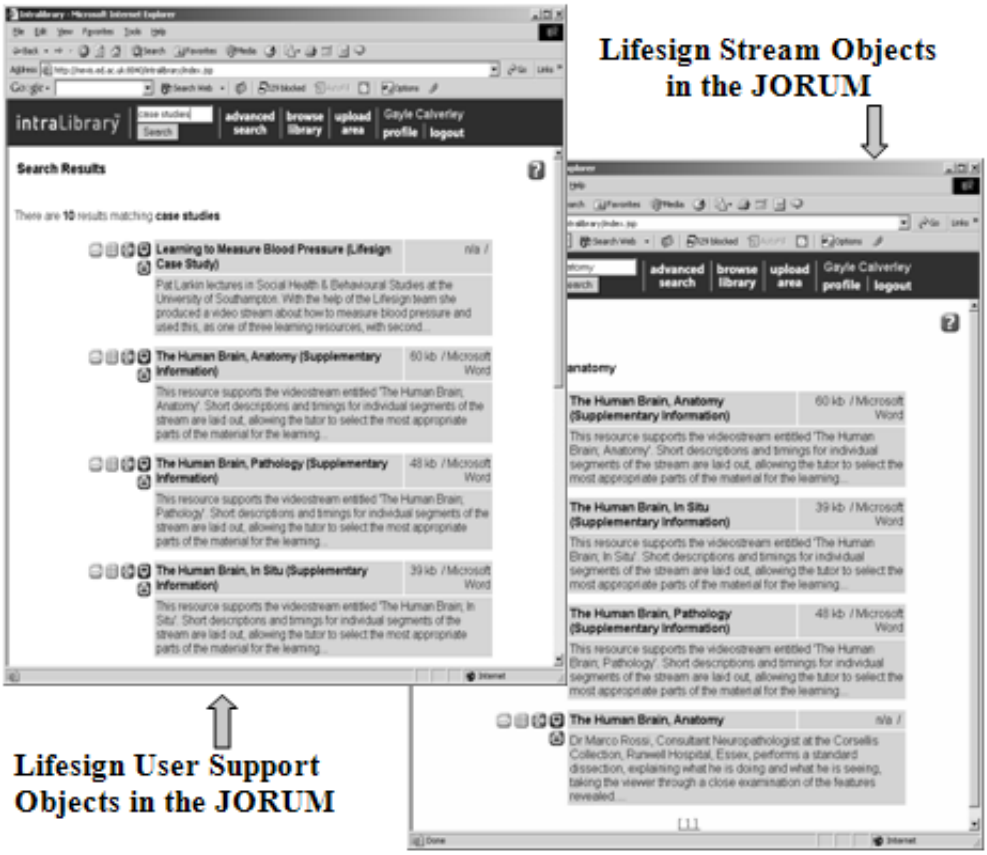

Figure 3: Streaming video and support material objects, based on Lifesign project material, housed within a learning object repository

These objects are based on several licensed collections of streaming video procured for cross-sector educational use. Within the object repository environment, users can either directly access all of the relevant material, or obtain links or redirection to, Lifesign delivered resources and tools drawn from the primary host delivery site. These users may not otherwise be aware of these streaming video resources which they are already licensed to use. In this context, the objects created have been shown to perform their function efficiently and effectively.

Despite efficient and effective performance, issues have already arisen as to the future technical effectiveness of the way these objects are structured. More explicitly, these issues are:

- Repository technology has moved on. Exported objects now have a default organisation in place, that Lifesign exported objects do not, without being upgraded manually or re-exported post-migration from an upgrade of the repository.
- Organisations now offer an alternative mechanism for defining multiple locations of the same resource due to technical variations. This may offer a technique for standardising this information and its display (both in repository representations and object editing tools), while retaining it for user advantage.
- Object and repository technologies are now sufficiently distinct. This means that new needs are more specifically met through pre-creation and upload of objects, rather than adjusting specific repository exports retrospectively.

This suggests that the immediate future for the objects is already coming into question and requires further immediate re-consideration of what actions can be taken to ensure continued sustainability.

Impact on Sustainability of Lifesign Objects

In view of imminent threats to sustainability already occurring, distinctive aspects of the objects and materials begin to exhibit different longevity profiles. Possible immediate futures include:

- The original objects will continue to perform their function in more or less the intended way, until their licensed content is either adopted (independently or for the sector as a whole), or the licences expire.
- The case studies and metadata models for streams should continue to remain useful to educational staff and developers for ideas surrounding use of the media, even when the original streams expire.
- Depending on how existing objects are exported or transferred, location information for alternative sources of the streams may be lost, or remain un-represented. Standardised solutions to fix this now exist, but require reworking of all of the objects to include organisations for consistency. Removal of the error from all video stream objects is also required.
- It is possible to use the default organisation available from the repository upgrade to provide an update to the objects. But this would require all the objects to be re-exported post-migration from the upgrade version of the repository to provide a new master set.
- Using the repository may not provide other customisation required, which may make the job more useful to do manually. In this case, the new creations would not match the objects migrated, and so requires a decision as to whether the existing repository objects should be replaced. Alternatively, these can be left in place, which may negate the need for manual upgrade to an advanced specification. It would be advisable to retain test objects of the various options in this case, should the situation change.
- Use of objects outside of the repository system would favour both manual upgrade, and possible version upgrade to the series that exists in the repository.

Given these possible futures, a range of options emerge, each of which require increasing labour loads to achieve. These are:

- Leave the objects as is. Accept graceful degradation.
- Allow migration to handle changes in export, with loss of potential upgrades to functionality. Accept risk of potential losses to existing functionality.
- As above, allow migration to handle changes in export, with loss of potential upgrades to functionality. In addition, retain example models of future versions that offer solutions to existing problems. Offers scaleable backup plan.
- Produce new master export versions from repository upgrade. Minimal use, but provides consistent record of what users will receive from repository exports. Helpful in case of enquiries.
- Manually correct all objects and reversion. Retain for non-repository use. Up-to-date.
- As above, but replace repository use with new version. Up-to-date.
- Clearly, if a project is past the end of its lifetime, lower labour loads will be preferable or necessary. But if there remains some flexibility in time or financial opportunity, it may be possible to select a more sophisticated exit option.

Conclusions

New models for sharing and integration of educational content and resources call for regular modifications to ensure continued use of individual resources. The modifications may be relatively minor, but are significant because they require ongoing resource to carry

out. Despite best planning to produce highly reusable resources, creative solutions (educational and technical) are still required to maximise chances of sustainability. Each time a minor contextual change is required in use, even for highly transferable learning material, it is likely that fundamental issues regarding the nature of the material and the media selected will be raised. Good planning can alleviate the resource required to accommodate any modification required, but will rarely remove the need for some intervention at the point of new use. Careful planning also offers a better chance for resources and materials developed for learning to degrade through changes in educational requirements, rather than due to technological developments.

Careful design of material with sustainability in mind lends itself to a range of options and labour levels required for continued maintenance at a later date. However, in short-to-medium project arrangements, the best preparation still relies on some provision from the host sector to support adoption and integration of any beneficial outcomes, beyond any initial funded period. The availability of labour beyond the funded period is also critical. In many cases, this can be supplied at a reduced level on a task-oriented basis, or adapted to suit supply by mainstream support services. It is possible that keeping systems simple and straightforward will allow at least their core components to remain useable for longer.

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