The Use of SMIL in an Educational Extranet

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Abstract Electronic publishing, and in particular Web-based publishing, has assumed an increasing importance in higher education. The possibility of delivering learning material to students over an extranet, thus bypassing the need for investment in usual university infrastructure, is clearly an attractive option for many institutions. Teaching staff, even those who are not particularly technically competent, often possess sufficient skills to publish text-based learning material on an extranet. However, this approach to the electronic delivery of courses in essence treats the Web as little more than a "fax-broadcast" medium. Furthermore, recent research suggests that students do not learn effectively from text-only Web-based courses.

The development of plug-in technologies such as Shockwave has enhanced the capabilities of browsers, so it is now possible to deliver highly interactive media-rich learning material over an extranet. This approach has recently been applied successfully in several higher education institutions. However, the authoring of such material requires advanced scripting skills. Furthermore, many of the more successful multimedia-supporting technologies, like Shockwave and Neuron, are proprietary formats.

The promise of Synchronised Multimedia Integration Language (SMIL), a W3C standard, is that it will have the same effect upon the publishing of synchronised multimedia as HTML had upon the publishing of text and static multimedia. This paper describes a pilot project to deliver multimedia learning materials over an extranet using SMIL; this approach is compared with the delivery of similar materials using proprietary plug-in technologies.

Keywords SMIL; synchronised multimedia; distance learning; Web-based learning

1. Introduction

It has been argued by many new-media analysts that the early popularity of the World Wide Web owed less to the fact that individuals could suddenly access a plethora of information, and more to the fact that those same individuals suddenly had the chance to be publishers. An HTML document could be created with a simple text editor, and the remarkably straightforward nature of HTML itself allowed for ease of authorship of hypertext documents; once placed on a server, a document was published to the world. The development of HTML editors, which removed the need for hand-coding the mark-up, made Web publishing even more widespread.

Mosaic's support in 1993 for a new HTML element (the `<IMG>` tag) ensured that graphical images became common in Web pages; the use of audio in Web pages came soon after. Thus, for several years, HTML has allowed static multimedia content on the Web. However, relatively few authors of HTML documents have attempted to synchronise the multimedia content on their pages. The reluctance of authors to use synchronised multimedia for Web delivery is perhaps unsurprising: until recently, an author had either to employ a proprietary authoring package (e.g. Macromedia *Director*), and rely on the intended audience possessing an appropriate plug-in, or else learn a complex programming language (e.g. Java). SMIL

(Synchronised Multimedia Integration Language) was developed in order to improve upon this situation.

The release, on 15 June 1998, of SMIL 1.0 as a W3C recommendation (W3C 1998), promised to bring synchronised multimedia to the masses. Upon its release Hoschka, who is Chair of the W3C Synchronised Multimedia (SYMM) Working Group, predicted that "SMIL will have the same effect for synchronised multimedia as HTML had for hypertext". After a difficult birth (Kennedy 1999), SMIL has finally begun to gain a measure of industry acceptance. For instance, RealNetworks has continued to integrate SMIL tightly into their player; Apple's QuickTime 4.1 now supports SMIL 1.0; and Microsoft has rejoined the SMIL development process. Furthermore, W3C have announced a third Working Draft of the next version of SMIL (known as SMIL Boston; see W3C (2000)). Nevertheless, Hoschka's prediction has yet to be fulfilled. Compared to the myriad of HTML documents that exist on the Web, relatively few SMIL presentations exist. To the present author's knowledge, no studies have been published regarding the use of SMIL in an educational setting. It is the purpose of this paper to describe a pilot study that was undertaken to examine the feasibility of using SMIL presentations as an aid for students at the University of Northumbria at Newcastle.

The paper is structured as follows. Section 2 discusses some of the relevant current issues surrounding electronic publishing for Internet- and Web-based learning. Section 3 discusses some of the history and the technical background to SMIL. Some brief examples of SMIL coding are presented in order to illustrate the simplicity of this language. Section 4 describes some preliminary results of a pilot study undertaken to assess the feasibility of using SMIL to support a particular group of students at the University of Northumbria at Newcastle. To conclude, Section 5 discusses the possible directions of future work in this area.

2. Web-based learning in higher education

2.1 Electronic publishing in higher education

Academics in many fields of study have been quick to embrace electronic publishing and alert to the possibilities it offers to support research. Advances in electronic publishing are having a profound effect upon scholarly communication. For instance, the Santa Fe convention of the Open Archive Project (Van de Sompel and Lagoze 2000) promises to bring the benefits of the new modes of communication made available by systems such as the LANL e-print archive (see e.g. Ginsparg 1996) and Cogprints (see e.g. Harnad 1998) to research fields beyond the narrow confines of theoretical physics, mathematics, computer science and cognitive psychology. And recent developments such as PubMed Central in the USA (see e.g. Varmus 1999) and E-Biosci in Europe (see e.g. Pettenati and Le Meur 2000) are ensuring that the life sciences research community is now at the forefront of using electronic publishing technologies to disseminate research results.

Academics have perhaps demonstrated even greater innovation in utilising advances in electronic publishing to support their teaching (see Brown *et al*. (2000), Goldberg and Salari (1997) and Wise (1999) for a very small but representative selection of papers, and for pointers to further reading). In part, this innovation seems to be driven by the changing role of higher education (HE) institutions in today's knowledge-driven economy. Employers need to update the skills and knowledge of their workforce, as indeed does the nation state, if they wish to remain competitive. Many publications have advocated the replacement of traditional patterns of education with the more flexible concept of lifelong learning (see e.g. HMSO 1998). If lifelong learning is to become a reality it is clear that educational institutions must adapt in order to provide access to learning opportunities for individuals who may be able to study only for irregular periods, and who have to fit study around domestic and employment commitments. The traditional operating mode of an HE institution (for example limited opening hours for buildings and libraries, fixed attendance at lectures, communication via notice boards, face-to-face seminars and tutorials) all create barriers to the lifelong learner. It is not surprising that several institutions have looked to the Internet, and the variety of traffic that it carries (WWW, e-mail, newsgroups etc), as a possible method of rising to the challenges posed by lifelong learning. (In this regard, it is

worth looking to Western Governor's University (**http://www.wgu.edu/wgu/index.html**) and Colorado University's CU Online (**http://www.cuonline.edu**); in addition, commercial organisations such as ZD University (**http://www.elementk.com/**) and Phoenix University (**http://online.uophx.edu/**) have a role to play here.)

Lifelong learning under the guise of distance learning is, of course, not a new instructional phenomenon. First-generation distance learning (correspondence courses, in which communication took place through the medium of print and the postal system) is over one century old. Second-generation distance learning started in the late 1960s, with the granting of degree-level status of open universities delivering instruction through television, radio, recorded audio tapes and printed workbooks. Third-generation distance learning, which started in the 1980s, used the emergence of telecommunication networks to deliver digital content to desktop computers; multimedia CD-ROMs; and audio or videoconferencing (Moore and Kearsley 1996). Passerini and Granger (2000) argue that the Internet has opened up a new, fourth generation of distance education.

2.2 Learning intranets and extranets in higher education

In the light of the points made above, it is not surprising that many HE institutions have developed intranets that are used solely or in part for the dissemination of teaching and learning materials (see e.g. Brown *et al* 2000). (Differences in terminology often bedevil discussions regarding intranets. The term intranet in this paper simply refers to a wide area network that implements Internet technologies inside a firewall and that spans a whole organisation without regard to geographical boundaries. The major users of intranets have typically been businesses, who use them to reduce duplication of work activities by providing access to shared information. Increasingly, however, educational institutions are using intranets to provide students with access to learning materials as well as providing academic, support and administrative staff with access to shared organisational information. Note that learning materials of this type are classed as intellectual property; since intellectual property is increasingly being recognised as an asset by all organisations, including universities, such learning materials will increasingly appear on an intranet rather than on the World Wide Web. The term extranet in this paper simply refers to a part of an organisation that is extended to specified users outside the organisation. In the present context, an extranet thus refers to a university's learning intranet that can be accessed by a student, perhaps from within a different intranet, as long as that student is in possession of appropriate authorisation to use the extranet.)

As noted above, educational intranets have the potential to provide more than mere one-way delivery of instructional materials: discussion groups, chat rooms, mailing lists and CAA are just a few of the possibilities (see e.g. Khenak (1999) or Chellappa *et al.* (1997)). Nevertheless, a prime function of such intranets must be the distribution of pedagogical materials. There is conflicting evidence regarding the effectiveness of static multimedia as a teaching tool; see e.g. Brown *et al* (2000) and Herson, Sosabowski and Lloyd (1999). However, there is the possibility of creating highly interactive, media-rich material for delivery over an intranet/extranet. Croft *et al.* (2000), for instance, used Macromedia *Authorware* to develop a cross-platform interactive hypermedia package featuring text, animated graphics, audio, video and both formative and summative computer-based assessment. Such a package would until recently have required distribution via CD-ROM. The use of Macromedia's *Shockwave* streaming technology, however, enables the delivery of this material over the Web or over an intranet/extranet for viewing by a browser, with all the benefits that this implies. (The browser, of course, must have the appropriate plug-in, which in this case is the *Authorware* Web reader). This approach has proven to be extremely popular with students (Ward and Croft 2000) but there are clear disadvantages to this approach from the organisation's point of view. First, in terms of authoring, it uses a proprietary format. Furthermore, it requires a level of expertise in programming (*Authorware* uses a simple flowline metaphor to aid rapid development, but in order to go beyond basic functionality use must be made of a fairly sophisticated scripting language). Second, in terms of viewing, it requires a plug-in. This may not be a problem within an intranet, where the organisation's central computing service may be in a position to ensure that every user of the intranet has access to an appropriately enabled browser. The student

attempting to view the material from outwith the intranet, however, is required to download and install a large plug-in. This assumes a level of technical competence on the part of the student that may not be warranted. Even if the student has the technical competence to download and install the plug-in, they may not be in a position to do so. For instance, if they wish to view the material from their place of work, they may be accessing the material from an intranet that is protected by a firewall. In such cases it can prove to be a non-trivial task to enhance the student's browser appropriately. Third, there is a large cost in both time, money and effort associated with the authoring, development and maintenance of such Web-based interactive multimedia materials. This is perhaps the most important point: without clear institutional backing, and the existence of funding and resources for projects of this type, it is unlikely that academics will have the time, resources or expertise to develop synchronised multimedia.

Are those academics that wish to make use of intranets as a learning and teaching tool therefore doomed to keep to the static multimedia pages afforded by HTML? One possible solution to some of the problems discussed above is to use SMIL.

3. SMIL

3.1 SMIL history

HTML already supports multimedia but, as noted above, most Web pages employ only static multimedia. The W3C Synchronised Multimedia (SYMM) Working Group set out to develop a language that would maintain the spatial formatting and linking capabilities of HTML whilst assigning a temporal dimension to Web pages. The SMIL 1.0 specification was released on 15 June 1998 as a W3C recommendation.

This temporal dimension to a Web page allowed synchronisation over time of different media: text, images, audio, video, hyperlinks and indeed any format capable of being played by a particular SMIL player (SMIL itself is 'format agnostic'). Various SMIL players were quickly announced (including the Real Player, which provided support to the Real streaming media types as well as support for non-streaming audio and video files; GriNS, which conformed most closely to the SMIL standard; and SOJA, a Java-based implementation).

Nevertheless, SMIL's early development was hampered by the fact that a consortium of Compaq, Macromedia and Microsoft withdrew support for the proposed standard and submitted a rival standard called HTML + TIME (HTML + timed interactive multimedia extensions). Perhaps the uncertainty created by this move is the reason why, to date, relatively few SMIL applications have been developed. In recent months, however, the situation regarding SMIL has improved. RealNetworks continue to integrate SMIL tightly into their player; Apple's QuickTime 4.1 is SMIL 1.0 player; and Microsoft have rejoined the SMIL development process and are involved in W3C's work on the next version of SMIL (known as SMIL Boston). Since SMIL Boston is still in the draft stage, all subsequent mention of SMIL refers to SMIL 1.0.

3.2 Some SMIL technical points

Syntactically, a SMIL document is a well-formed XML 1.0 document. Although based upon XML, as we shall see SMIL is as simple to code using a text editor as HTML.

Unlike most proprietary approaches to the task of synchronising multimedia, the components of a SMIL multimedia presentation are not physically embedded into the SMIL file; rather, they are referenced via URLs. An important implication of this for electronic publishers is that media components can be re-used in many different presentations, whilst ensuring that the load on servers can be balanced.

SMIL documents may be delivered via HTTP or RTP/RTSP (Real-Time Streaming Protocol), or a combination of the two. So, for example, text could be delivered by HTTP whilst streamed audio could be delivered via RTSP.

As can be seen in Figure 1, a SMIL file is similar in appearance to an HTML file. The head contains layout information (since SMIL is consistent with CSS-2, one can position regions with precision using standard CSS-2 techniques; one can also assign IDs and *z*-order indexes to regions). The body of the SMIL file contains the content and synchronisation tags.

```
<smil>
     <head>
         <layout>
            <!-- layout tags -->
         </layout>
     </head>
         <body>
            <!-- media and synchronisation tags -->
         </body>
</smil>
```

Figure 1: A SMIL skeleton showing head and body elements

The head of a typical SMIL file is shown in Figure 2. The coding is straightforward. A region of width and height 100 pixels has its top-left corner 5 pixels from the left of the screen and 5 pixels from the top (the name suggests that this region will be reserved for video media, although any media can be placed here). Similarly, a region is defined for graphics (the fit statement determines how the graphic fits into the region; here it will expand to fill the region). Finally, a text region is defined of width 780 pixels and height 350 pixels.

```
<head>

<meta name=”lecture1” content=”Epublishing” />
<meta name=”Webb” content=”stephen.webb@unn.ac.uk” />

<root-layout width="800" height="600" background-
color="#660066" />

<region id="VideoRegion" width="100" height="100" left="5"
top="5" />

<region id="GraphicRegion" width="150" height="150"
left="600" top="5" background-color="#660066" fit = "fill"
/>

<region id="TextRegion" width="780" height="300" left="10"
top="275" background-color="#660066" />

</layout>

</head>
```

Figure 2: the head of a typical SMIL file

Figure 3 shows some example code that might be used to put media into the page layout defined above. The code is self-explanatory. But note the use of the `<par> tag`. SMIL has two tags, `<seq>` and `<par>`, which are where most of the power of SMIL lays. SMIL allows you to play files sequentially (usually within a single region) or in parallel. When presenting files in parallel, one can synchronise elements to ensure that certain elements are always rendered together

```
<body>
<par dur="3">

<img src="video/elpub.avi" region="VideoRegion"
begin="1.6s" />

<img src="image/van-bush.jpg" region="GraphicRegion"
begin="5.6s" />

<text src="text/van-bush.txt" region="TextRegion"
begin="10s" />

</par>
</body>
```

Fig 3: the body of a typical SMIL file

4. Using SMIL in an educational setting

4.1 Background to the study

The School of Information Studies within the University of Northumbria at Newcastle has developed an intranet which is used, as are most intranets, as a means of disseminating shared administrative information to stakeholders in the organisation. Members of academic staff within the School are investigating several different approaches to using the intranet (which functions for some of our students as an extranet) for effective delivery of learning materials. It was decided by the present author to undertake a small study to investigate the potential use of SMIL for delivery of learning materials. The aim was to investigate the technological and human resource requirements for the creation of synchronised multimedia Web-based presentations using SMIL, compared to the requirements when using proprietary multimedia packages.

4.2 Content generation

The author chose to focus on one particular taught unit (a second-level unit on Electronic Publishing, consisting of ten lectures and ten seminars), for which he was responsible. The reasons for this choice were threefold. First, Web pages containing text, graphics and hyperlinks to external sites had already been developed for the lectures and seminars. Students would continue to have access to these 'traditional' Web pages regardless of whether or not SMIL documents were available. Second, these Web pages were consistent in their structure and amount of content since they had initially been authored using a template. Third, because much of the teaching and learning content already existed, and audio was the only medium that had to be generated, the problem was in essence simply one of HTML-to-SMIL conversion. If the study showed that SMIL was a feasible delivery mechanism, this conversion would be a commonly occurring situation on the School's intranet.

Since this study was intended as an investigation of the potential pitfalls of generating SMIL presentations, it was deemed unnecessary to use a SMIL editor and 'hand craft' each of the presentations. Instead, it was decided to use a text editor to write a generic SMIL template for the presentations (see below). The template would specify the spatial layout of the presentations; the timing within each presentation would have to be added in each individual case.

To render the presentations it was decided to use SOJA (SMIL Output in Java Applets), a freely available SMIL player (**http://www.helio.org/products/smil/**). SOJA uses HTTP to deliver simple media; in other words, it does not support streaming and it is limited to text, graphics and sound (it supports gif and jpg graphics file formats, and au and auz audio file formats). Nevertheless, this was sufficient for the purposes of the present study: the relevant text and graphics files already existed, and if audio was to be used the files would have to be

created no matter which authoring package would ultimately be used to generate the presentation. There was no intention, at this stage, to make use of video.

The first stage in the process was to record the audio component of the presentations. The unit lectures were delivered in the English language, and the Web pages were written in English. However, the commentaries were recorded in Spanish and French, in addition to English, since each year several European exchange students opt to take this unit. Advantage could then be taken of the SMIL `<switch>` tag, which enables an author to specify a set of alternative elements from which only one acceptable element is chosen. See figure 4. (With sufficient time and resources, it would be possible to translate the textual part into other languages and use the `<switch>` tag on the text files. The result would be that the foreign-language student experiences a tailored presentation delivered solely in his or her native language.)

Once the audio was recorded, it remained to time the duration of the various audio files for synchronisation purposes. The three media elements capable of being rendered by SOJA, namely text, graphics and audio, were then available.

```
…
<switch>
      <audio src="en_point5.auz" language="en" />
      <audio src="es_point5.auz" language="es" />
      <audio src="fr_point5.auz" language="fr" />
</switch>
…
```

Fig 4: the zipped audio file for point5 is available in English, Spanish and French

4.3 SMIL presentations

A storyboard was generated for each presentation, and a basic screen layout was designed and coded in SMIL. The design was purposely kept simple and consistent, in an attempt to increase coherence and to reduce cognitive load – factors that are related to cognition (Szabo and Kanuka 1999). In summary, the top-left region of the screen was assigned to video media. (As mentioned above, no video was taken and even if it had been SOJA could not render it; nevertheless, subsequent developments may make use of video and so a portion of screen 'real estate' was assigned to it. In the absence of video, this portion of the screen will always appear blank.) The top-middle region of the screen was reserved for titles (simple text files). The top-right region of the screen was assigned to graphical media (in jpeg and gif formats). The bottom-right region of the screen was assigned to navigational links which, like the other media, could have duration attached to them ('temporal hyperlinking'). The full SMIL code is available from the author upon request.

Conversion of existing HTML documents into a form suitable for SMIL presentations was straightforward; indeed, much of the conversion was handled by a perl script. The audio component, which differed from presentation to presentation, required some manual intervention. Nevertheless, the conclusion is that – given the content – SMIL presentations can be quickly and easily authored.

4.4 Evaluation

Since the purpose of this project was to study the technological and resource implications of using SMIL as a tool, evaluation of the presentations has so far been undertaken only by a small, focused group of students. As well as helping to eliminate bugs in the presentations, the students were asked to give their qualitative opinions on the presentations. In every case, the students preferred the SMIL presentation to the equivalent static HTML presentation.

However, some students were accustomed to *Flash*-based Web sites and commented that, compared to such sites, the SMIL presentations appeared 'primitive'.

A full evaluation of the SMIL presentations, including most importantly their pedagogical value, will take place in the next semester.

5. Conclusions and further work

The introduction of a temporal dimension to Web pages inevitably leads to complications. Nevertheless, this preliminary study demonstrated that it is possible to generate 'slideshow-type' presentations with relatively little difficulty and over a relatively short timescale. The SMIL was coded using a text editor; the use of an author-friendly authoring tool would shorten the development time even further. Since SMIL is an emerging standard, and the major software companies involved in this field have re-joined the development process, one would hope that a variety of useful authoring tools should soon be available.

Given the limitations imposed by SOJA, it is inevitable that SOJA-rendered SMIL presentations will lack the sophistication and complex interactivity that is possible with proprietary packages like Macromedia *Authorware* and Asymmetrix *Toolbook*. However, it is important to remember that these packages require plug-ins in order for content to be viewed over the Web; furthermore, gaining sufficient proficiency in these packages to enable one to develop media-rich interactive multimedia can be a time-consuming process. In contrast, if one can author an HTML document with a text editor, one should be able to create a SMIL document with relatively little difficulty. Whichever means one choosese to deliver multimedia, the media content itself must first be created; this aspect of authoring will of course never disappear. However, once the content has been created, if one follows an existing template and a clear set of instructions, it should be possible to create synchronised multimedia with very little knowledge of SMIL.

Students compared the visual appearance of SMIL presentations unfavourably with *Flash*-based designs. This is unsurprising, since it is certainly possible for designers and graphic artists to generate compelling, visually attractive animations in *Flash*: the *Flash* authoring tool is far in advance of any SMIL authoring tool (at least of which the present author has knowledge). Nevertheless, the comparison between *Flash* and SMIL is not really valid. SMIL is format agnostic. *Flash* is an animation format; to SMIL, it is simply another media type to be integrated into a presentation. Visually, SMIL and *Flash* may appear to attempt to do the same thing; at a deeper level, they fulfil quite different functions.

If the usefulness of the SMIL presentations discussed in this paper can be demonstrated, and their pedagogic effectiveness clearly shown, there are several avenues for possible future development. One obvious development would be to use streaming media and RTSP; this, however, has server (and cost) implications. A second development would be to make more use of SMIL functionality. At present, the SMIL files use the `<par>` and `<seq>` tags but little else. With more development time it would be possible to create hotspots on the screen and many more temporal hyperlinks, for instance.

When authoring several similar SMIL documents, one point springs forcibly to mind. It is considered good practice to separate the formatting of a document from its structure. This is achieved in HTML with CSS. It is natural that timing information should appear directly in a document, since it is likely to be specific to a particular document. However, if storylines share an identical temporal development order, then it would make sense to separate timing from the content and the formatting. In other words, one could have a stylesheet for the formatting, a *timesheet* for the timing, with both format and timing separate from the content or body of the document. Interesting research in this area is currently being undertaken by ten Kate *et al* (2000).

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