A layered approach to the re-use of content and its presentation
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Abstract
This paper deals with techniques for overcoming the mosaic effect - an impediment to the sharing of content, and proposes layered re-use as a conceptual framework for solving the problem.

The mosaic effect occurs when a course is built by sequencing Shareable Content Objects (SCOs) from a variety of independent sources. Because SCOs have their own individual "look and feel", courses made up of SCOs from different sources suffer from inconsistent presentation styles and interfaces in the format of the learning content. To overcome the mosaic effect, it is necessary to separate content from its presentation. Two techniques have been put forward as solutions to the mosaic effect in the SCORM environment. The first is the Dynamic Appearance Model (DAM) and the second is SCORM with Style-Sheet Support (SCORM-SSS). While the DAM proposes content to be encoded in XML and uses XSL transformations for correct rendering, SCORM-SSS is based on content in HTML and proposes course related style-sheets to ensure the desired course presentation.

This paper develops the concept of layered re-use in which the re-use of content and content structures is governed by specifications appropriate to the content level (e.g. SCORM, IMS QTI specifications) and the re-use of "look and feel" properties and their application throughout a course is governed by HTML-based specifications applied at the display level. In layered re-use terms, for any one course there may be many content models within the content layer and for a particular user or cohort there is a single display model.

The advantages of adopting layered re-use include, a) ease of technical implementation (at scale and wide scope), b) low impact on course development work-flows, c) ease of maintenance against growing complexity in course design and re-design and d) it supports the DAM and SCORM-SSS developments as complementary approaches to overcoming the mosaic effect.

Common acronyms used in this paper
ADL Advanced Distributed Learning
AICC Aviation Industries CBT Committee
DTD Document Type Definition
EML Educational Modeling Language
IEEE Institute of Electrical and Electronic Engineers
LCMS Learning Content Management System
LMS Learning Management System
LTSC Learning Technology Standards Committee
SCO Sharable Content Object
SCORM Sharable Content Object Reference Model
XML Extensible Mark-up Language
XSL Extensible Style-sheet Language

Introduction
International standards for eLearning have been under development for more than a decade (Sonwaklar. 2002) but it is only since the advent of large scale deployment of web-based learning and the subsequent adoption of Learning Management Systems (LMS) across education, private enterprise and government that such standards have attracted broad interest. One of the key promises of these standards is that they will reduce the cost of online learning by enabling the re-use and sharing of content between standards compliant
LMSs (CETIS, 2002). However several factors are hindering widespread re-use of content. One is the mosaic effect which occurs when a course is built by sequencing Shareable Content Objects (SCOs) from a variety of independent sources. The SCORM specification for content interoperability is silent on the display properties of SCOs. The result is that SCOs written as standard HTML pages typically contain elements contributing to page layout and appearance (i.e. the HTML tags contain style properties). SCOs originating from different courses have their own individual “look and feel” so that when they are mixed and re-aggregated into new courses, the mosaic effect arises. The new course is compromised by inconsistency in fonts, colours and styles that is likely to hinder rather than enhance the educational experience of the learner.

To reuse these SCOs in different courses, or in combination with SCOs from other providers, the content developer must edit the HTML tags to change the appearance of the SCO to suit the new context. The cost of this re-work severely compromises a key promise of the SCORM initiative: “the flexibility to incorporate instructional components into multiple applications and contexts” (Dodds, 2001). Unless content sharing can be achieved with no intervention or recoding of a SCO, there is little hope of widespread re-use being successfully promoted.

Substantial benefits flow from solving the mosaic effect. They include:

- Reduced re-work of SCOs being re-used in new sequences and courses;
- Facilitation of courses with identical content and presented as appropriate to the needs of individual (e.g. vision-impaired) students or defined student cohorts (e.g. differential branding) as required;
- Greater ease of devising adaptive support for different learners by using different combinations of SCOs.

Two solutions to the mosaic effect have been proposed. They are the Dynamic Appearance Model (DAM; St-Pierre, Hope & Skublcs, 2002; St-Pierre & Hope, 2003) and SCORM with Style-Sheet Support (SCORM-SSS; Ip, Radford & Canale, 2003).

**The Dynamic Appearance Model**

The DAM proposes to separate the appearance elements from content using XML and XSL. Implementation of the Dynamic Appearance Model requires that a SCO be written in XML rather than HTML. During delivery, the SCO (in its XML format) is transformed by an XSL related to the course, thus ensuring that all SCOs in the course have a consistent presentation.

The DAM model takes a giant step: to transform all content models to their final rendering through the XSL transformation. If a particular style sheet needs to apply across all the courses in an organisation and assuming there are many different content models used by different parts of different courses, the XSL would be a very complex encapsulation of all the domain knowledge of all the content models currently in use. This is a near-impossible requirement to meet if applied to higher education or any other sector in which teaching practices are highly diverse.

**SCORM with Style Sheet Support (SCORM-SSS)**

SCORM-SSS assumes and requires no content model knowledge about any SCO that it is
go to render. The only requirement is that the SCO be expressed in a well-formed, validated HTML. SCORM-SSS applies course-related style-sheets to the SCOs at the time of delivery. This is achieved by using the data communications already provided in the SCORM Run-Time Interface. Within the SCORM model, a SCO can initiate a call to the LMS to fetch data that it needs (for example, the student’s name). Since the look and feel of a SCO should be determined by the conventions within the course and the needs of the student, not the SCO itself, a SCO should be able to “fetch its look and feel” in the same way it fetches other data.
**Layered re-use as a model for the separation of content and its presentation**

Both the DAM and SCORM-SSS can be used to achieve separation of content from its presentation. In practice, the techniques used for separating content from its presentation must be compatible with a wide range of educational designs and their associated pedagogical tools to enable consistency across an entire course. This is because accomplished course designers employ a range of pedagogy and by implication, a range of content models and tools in any one course. Developers therefore need a single standardised mechanism for defining course presentation characteristics across all the content models deployed within any course.

The concept of layered re-use can help clarify these issues by introducing the idea of a content level and a display level as shown in Table 1. The content of a course may be considered as occurring in a content layer where the re-use of content and content structures is governed by specifications appropriate to the content layer (e.g. SCORM, IMS QTI specifications). The re-use of “look and feel” properties and their application throughout a course is governed by HTML-based specifications applied at the display level. In *layered re-use* terms, for any one course there may be many content models within the content layer and for a particular user or cohort there is a single display model.

<table>
<thead>
<tr>
<th>Table 1. A representation of the Layered Re-use Model.</th>
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<tbody>
<tr>
<td><strong>DISPLAY LAYER</strong></td>
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<td>Course Designer perspective of re-use</td>
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<td><strong>CONTENT LAYER</strong></td>
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DAM proposes to transform content models from XML, directly to a form suitable for rendering using XSL. The DAM works by using XML to transform the various content models deployed in a course from the content level to the display level. In contrast, the SCORM-SSS technique assumes the content is already in HTML format and requires no transformation of content models for a display model to be applied to the content. In this case the display model is the collection of HTML style-sheets applied to the content of the course at the time of delivery.

It follows that the DAM and SCORM-SSS may be used together to some advantage. For example if a requirement of course delivery is to meet the needs of visually impaired students as well as visually non-impaired students, the DAM would require two transformations of the XML content in the course. As the number of cohorts and groups requiring different display models increases, so too does the number of required XSL transformations increase and this represents a significant overhead. An alternative is to use one XSL transformation on the XML to produce content in HTML format and apply style-sheets according to SCORM-SSS to meet the different display model needs for course delivery.

**Ease of implementation**

The DAM has two major hurdles to implementation. The first is the requirement for SCOs to be written in XML and the problem this poses is that tools in common use for the creation of courseware are HTML-based. There is little incentive for developers to change from their existing tool-set. The second hurdle is the high degree of difficulty associated with semantic representation of a wide (and growing) range of content structures in XML and
this would inhibit course design towards simpler structures. The solution would be highly complex and difficult to implement in educationally rich course designs.

By contrast, SCORM-SSS is based on HTML content and has no impact on the usual tool-set used by content developers. Style-sheets can be created with commonly used tools such as Dreamweaver and there is ample information and resources available to designers on how to use cascading style-sheets for a range of purposes (see: http://www.alistapart.com/topics/css/ and http://www.csszengarden.com/).

Furthermore, in the interests of re-usability, the HTML content does not need to be marked up in a particular way to enable style-sheets to be applied. If normal HTML elements (H1, H2 etc.) are used as the basis for selectors by the style sheet then in the absence of a style-sheet the content will render correctly according to its HTML markup. Hence, if the LMS does not support the extensions proposed in SCORM-SSS, but supports SCORM 1.2, then SCORM-SSS content will degrade gracefully and render correctly without style-sheets.

A greater implementation hurdle exists for the LMS because it must support the extended data schema for SCORM as proposed by Ip and Canale (Ip & Canale 2003, Ip et al. 2003). In some cases the LMS vendor must carry this out as a customization, although if the LMS is sufficiently open and extensible it may be achieved locally. One of the benefits of the proposed approach is that the system enhancements are immediately available to all users and do not require re-work of existing content and courses.

**Impact on course development work-flow**

There are many different levels of re-use that occur within the course development process. Each level of re-use contributes towards the overall objective of cost reduction. Re-use practices may also improve the quality of courses through re-use of proven designs, strategies and techniques.

Several roles are involved in a typical development cycle but for the purposes of illustration an over-simplified work-flow is used here. A **course designer** is responsible for the curriculum and will specify the learning objectives for the cohort and determine the overall structure of the course. The course designer will also select and sequence existing SCOs for the new course. If part or whole of the content is not available, a **content developer** will be engaged to produce the content. Content developers re-use fragments of content, media and software code. They apply standardised specifications to the content (e.g. SCORM, IMS Question and Test Interoperability Specification).

The content developer works in the content layer and is concerned with content models. The content model is the structure of the content, how it is encoded and unitized for re-use and further manipulation by the content developer.

A course designer is typically interested in content from an entirely different perspective and focuses on the educational purpose of the content and the nature of student use and interaction with the content. The course designer is interested in a different **layer of re-use** that deals principally with presentation of the course to maximise educational advantage for all students.

Course designers should not need to ask content developers to abandon content interoperability standards to meet challenging course design objectives. A layered approach to content re-use will reduce the likelihood of this situation arising. Content designers will be able to continue to fulfill their normal role and design courses of growing complexity without causing major impact on the work practices of content developers. Content developers will be able to maintain standard re-use practice in the content layer and at the same time address complex design requirements within the display layer of re-use. In this way, the different re-use perspectives of the course designer and the content developer are preserved and supported.
A Christmas Party at Ausis Institute of Technology

A role playing experience not for the faint of heart...enter here... if you dare!

Welcome to this role play on issues related to sexual harassment in the workplace. Participate, create, collaborate, plot, learn, laugh and reflect. A playful approach with serious intent.

Figure 1: A demonstration of the same content embedded in two different cascading style-sheets to achieve strikingly different layout and interface properties.

Welcome:
Alison Davies
Help
Quit

Resources:
Organisation Chart at ATI
Read Scenario
Read Scenario 2
Resource Center
Sexual Harassment
Policy and Grievance Procedures

Conferences:
ATI NewsPage
Educational Managers Forum
Executive Management Forum
Staff Room
To do list:

Mod Message
This is the message loaded at runtime supplied by the Moderator or super-moderator.

Are you in the know?
There's a rumour going around about a faux pas last night at the Christmas Party by a very senior person at Ausis. Was it "you know who" putting his foot in it again? Who was it and what happened? Are you in the know or still to find out?

Interesting dynamics at this place. Alison the new Communications Officer will do her best to smooth things over - shall be in the Inner Circle in no time. Verty is bound to refer to it in the next edition of the Ausis newsletter - better watch out for that as she doesn't pull punches as the editor. Josh's new Personal Assistant is keeping a low profile. Some say he only got that job as a reverse equity thing, but when Anna Leuka the EO person heard that, she squashed it real quick - none of that nonsense gets by her. She's an OK person...
Conclusion

The presentation mosaic effect caused by inter-mixing of SCOs from differing original contexts is a serious impediment to their re-usability. To solve this problem the content of the SCO needs to be separated from its presentation. Two solutions have been reviewed, The Dynamic Appearance Model (Canadian) and SCORM with Style-Sheet Support (Ip & Canale, 2003).

This study proposes that in addition to achieving separation of content from its presentation, the techniques must:

- be compatible with a wide range of educational designs and their associated pedagogical tools to enable consistency across an entire course, and
- preserve the different perspectives of re-use of the course designer and content developer roles in the course development process.

A concept of layered re-use is proposed that supports the different interests of key roles in the course development process. The model makes explicit a separation of the content layer with its own inter-operability specifications and re-use practices, from the display layer which also has its own re-use specifications and practices.

We and many other developers have proved that cascading style sheets can significantly modify the appearance of a HTML document to meet almost any look and feel requirement. We have suggested a mechanism, in line with the SCORM specification, to fetch the course style sheet and apply the style sheet to the SCO (Ip, Radford & Canale, 2003). This approach opens up the possibility of re-usable style-sheets designed for example, to meet the needs of sight-impaired students or to provide course adaptations for specific groups of students.

With the SCORM-SSS, SCOs continue to be coded as HTML and style-sheets may be applied to the course or individual student and remain under the design control of the course designer. The additional effort needed for SCORM-SSS is minimal and the technique is fully consistent with the general methodology for implementing the SCORM communication framework.

References


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