The Application of an Event-Aware Metadata Model to an Online Oral History Project

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Abstract

In this paper we test the ABC event-aware metadata model, developed within the Harmony project, by applying it to a complex multimedia oral history archive. Based on a metadata schema, generated using the ABC model, we developed indexing tools, a database and a search and browse Web interface, for an oral history collection consisting of audio tapes and posters generated from a series of interviews and photographs. The objective was to build a testbed to test and refine the ABC model and also to demonstrate that use of the model will ensure consistent, well-structured, unambiguous metadata descriptions for complex multimedia collections. Such descriptions will hopefully lead to improved fine-grained resource discovery, interoperability between different metadata schemes and explicit tracking of intellectual property rights.

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1. Introduction

The future will lead to many more compound multimedia documents on the web which combine text, image, audio and video in rich complex structured documents in which temporal, spatial, structural and semantic relationships exist between the components. The problems associated with indexing, archiving, searching, browsing and retrieving these kinds of structured dynamic documents are infinitely more complex than the resource discovery of simple atomic textual documents. In addition, the intellectual property rights associated with the components which make up such documents are frequently enmeshed within a complex and dynamic web which is extremely difficult to manage.

The Dublin Core [**HREF1**], bibliographic [**HREF2**], museums [**HREF3**], archival [**HREF4**] and MPEG-7 [**HREF5**] communities are developing international standards for describing textual, physical and audiovisual resources to enable their resource discovery over the Internet. The INDECS organisation [**HREF6**] is developing metadata standards to support network commerce in intellectual property. Managing the new heterogeneous multimedia resources which are being developed and traded via the Internet is going to require interoperability between these disparate standards [**HREF7**].

The Harmony International Digital Library project [**HREF8**] is investigating models and tools which will facilitate machine-understandable communication between the content description domains (Dublin Core, MPEG-7, IFLA, CIDOC) and the e-commerce and rights management domain (INDECS). The collaborators are developing a common data model and metadata vocabulary which will hopefully provide a stable underlying infrastructure for the exploitation of digital multimedia content over the Internet.

In this paper we apply an event-aware metadata model [**HREF9**] which has been developed within the Harmony project, to provide a clear understanding of the individual resources, events, contributions and relationships which constitute a complex collection of digital multimedia resources. By applying the proposed model, we hope to generate consistent, well-structured, unambiguous and modular metadata descriptions which will lead to improved fine-grained resource discovery, easier mapping between different metadata schemes and the explicit tracking of intellectual property rights.

In order to test the model and the quality of the derived metadata, we built an online digital audio (MPEG-2 Layer3 (MP3)[**HREF10**]) and image archive, together with indexing tools and a search and browse interface, for an oral history project. The From Lunchroom to Boardroom project [**HREF11**] combines oral, written and visual art techniques to highlight the achievements of women in the Labor movement in Queensland from the 1930's to the 1960's. The collection consists of posters and audio tapes generated from a series of interviews and photographs. It provides an ideal multimedia testbed for applying and testing the proposed ABC metadata model. In addition, the development of a digital online version will greatly increase the accessibility and dissemination of this valuable historical collection.

Based on a metadata schema which was derived by applying the proposed model to this collection, we built a multi-level metadata editor/generator application, MEGGIE. This Java application includes a computer-assisted audio file transcriber which enables the input of transcripts and their alignment with the corresponding digital speech files. The structured and validated metadata descriptions can be output as: ID3 tags [**HREF12**] embedded in the MP3 files; Dublin Core descriptions encoded in RDF [**HREF13**]; MPEG-7 descriptions [**HREF14**] encoded in XML [**HREF17**]; HTML metatags [**HREF15**]; or tables in an Oracle database with links to the MP3 files. A web-based search interface was also built which enables users to search and browse the archive via speaker name, keywords or transcript content and to retrieve and play the matching segment of the relevant MP3 file. Figure 1 provides an overview of the system architecture.

**Figure 1: Overview of the System Architecture**
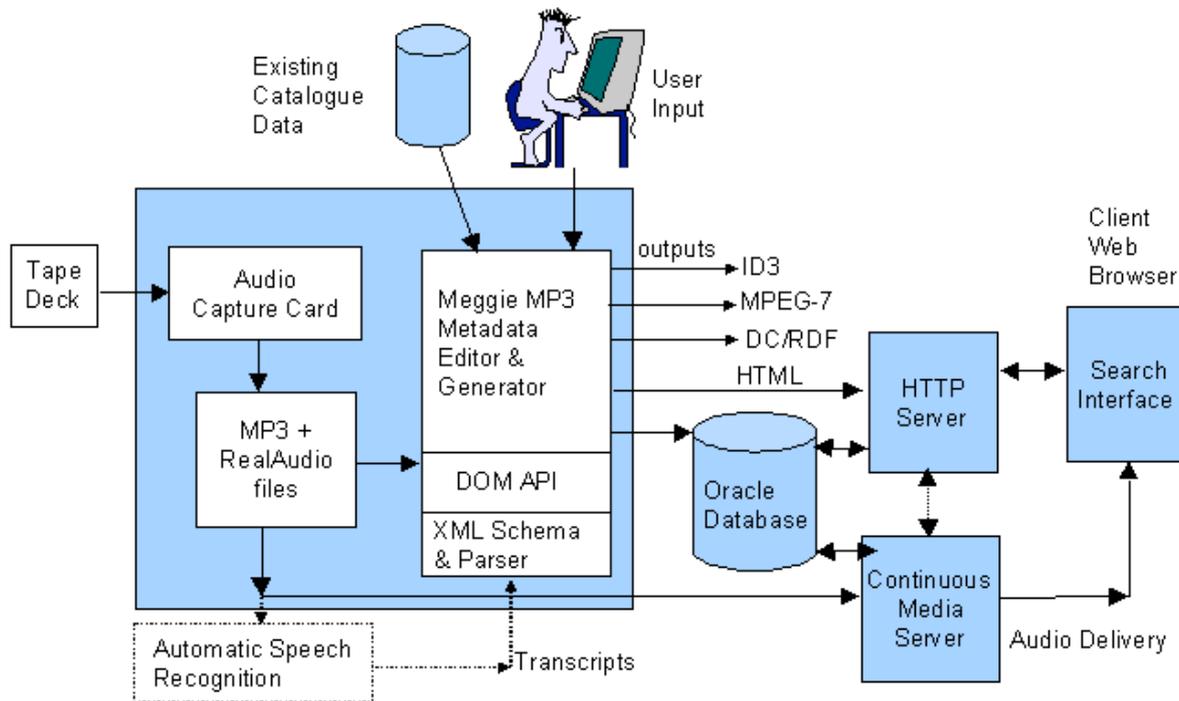
The rest of the paper is as follows. In Section 2 we describe the ABC model [**HREF9**] briefly. Section 3 describes the results of applying the ABC model to this project and the metadata schema which was generated. In Section 4 we describe the MEGGIE metadata/editor generator application which was built to enable the computer-assisted generation of metadata descriptions for a number of different domain-specific vocabularies. Section 5 describes the search, browse and retrieval web interface to the collection. The paper concludes in Section 6 with an evaluation of the ABC event-aware metadata model in the context of this digital multimedia collection and the anticipated future work directions.

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2. The Harmony Event-Aware Model for Metadata Interoperability

The Harmony Project [**HREF8**] is investigating a generic approach towards metadata interoperability and, in particular, its application to multimedia digital libraries. Through the event-aware ABC model and vocabulary, it is attempting to:

- formally define common entities and relationships underlying multiple metadata vocabularies;
- describe them (and their inter-relationships) in a simple logical model;
- provide the framework for extending these common semantics to domain and application-specific metadata vocabularies.

Figure 1: Mapping between Metadata Descriptions using the Harmony Model
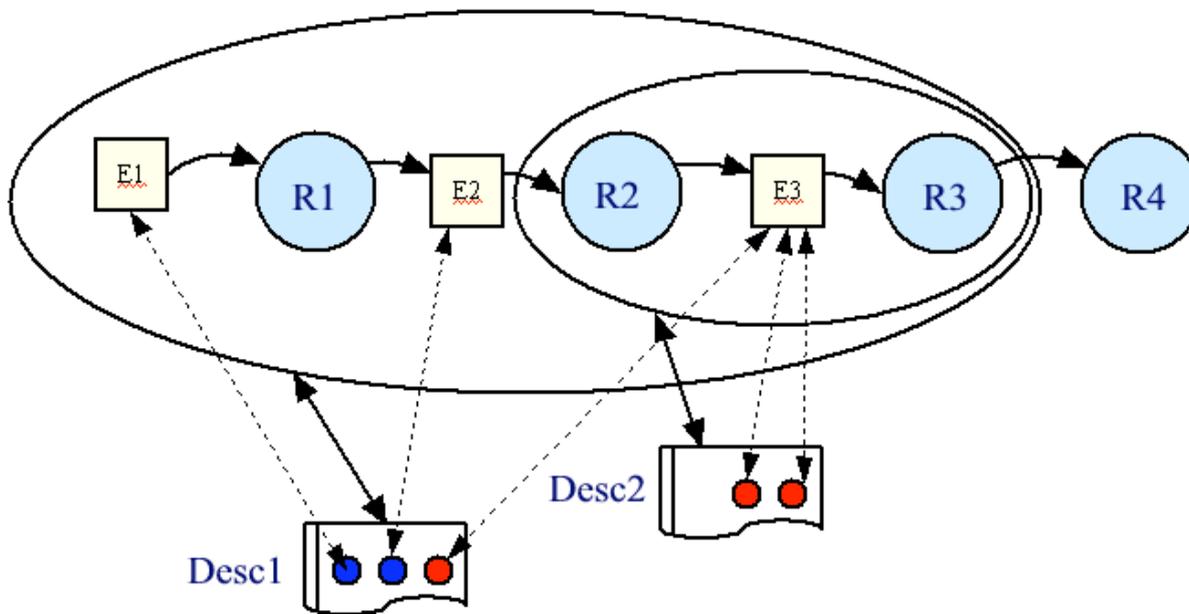
(**Note:** this image taken from the **Harmony ABC Strawman Document)**

   The ABC model [**HREF9**] defines a set of fundamental classes which provide the building blocks for expression (through sub-classing) of application-specific or domain-specific metadata vocabularies. These base classes were determined by analysing commonalities between different communities' metadata models (including IFLA, CIDOC, INDECS, MPEG-7 and DC):

- Resources
- Events
- Inputs and Outputs
- Acts
  - Agents
  - Roles
- Context
  - Time
  - Place
- Event Relations

   ABC adopts an event-centric view for modeling the relationship between the various manifestations of a creation. This event-centric view provides semantically clear attachment points for the association of properties amongst the various manifestations and contributors (agents) to the manifestations. In addition ABC provides a multiple views philosophy for metadata modeling and recipes for inter-conversion. When rich information is required, ABC provides the event model. This involves describing the event through which that relationship was realized as an object in itself, describing the hidden detail implicit in a simple binary relation. When concise/simple metadata is needed, flatter relations are used.

   In the next section we apply this underlying model to the *From Lunchroom to Boardroom* project with the goal being to generate well-structured unambiguous and interoperable metadata descriptions.

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3. A Metadata Model for an Online Oral History Archive

3.1 Description of the Application

In order to test the ABC model, we chose a typical example of a complex multimedia archive - an oral history project which consists of a collection of both analogue and digital resources of multiple media types and involves a complex web of events, contributions and relationships. In this section we outline the background of the project and then we model it diagrammatically using the ABC event-aware metadata model.

   The From Lunchroom to Boardroom project was first proposed by oral historian, Therese Collie, at the ALP Centenary Celebrations in Barcaldine in Queensland in 1991. Later that year, the project received funding from the Australia Council, the Trades and Labor Council's (TLC) Women's Equal Opportunity Committee and the Public Sector Union of Queensland. During 1991 and 1992, Therese Collie interviewed 16 women of varied backgrounds and living throughout Queensland, who had been involved in the Labor movement between the 1930's and 1960's. The interviews were recorded onto 40x26

minute AGFA professional tapes. These were later transcribed by Sue Pechey and the transcripts were stored as word documents. In addition, visual artist Judith Hewitson, produced four A2 colour posters from photographs and memorabilia collected during the interviewing process. The posters were created using Adobe Photoshop and stored as TIFF images. Each interviewee signed a release form in which they agreed to release all property rights in the tapes and photos to the TLC.

After gaining the approval of the rights owners (the TLC), DSTC digitized the audio tapes into both RealAudio (multi-rate, 56Kbps) and MPEG-2 Layer 3 (MP3) (44.1kHz, mono) formats. The A2 posters were converted to GIF thumbnails and A4 JPEG images. A comparison of RealAudio and MP3 versions of the same 24 minute recordings, demonstrated that, although each MP3 file was approximately 25-30% larger in size, the sound quality was significantly better. MP3 offers sound quality that comes close to the quality of .WAV files but at greatly reduced file size which means that they download much faster. For this reason, the MP3 file format was selected as the final storage format.

After digitization, the project metadata (for the collection, interviews and recordings) was entered using the MEGGIE application described below. The PEGGIE application, described in [HREF16], was used to index the images associated with the posters. The final step in the indexing process involved the temporal alignment of audio file segments with their corresponding transcript segments. The metadata descriptions were saved to an Oracle database and a Web search interface was developed to enable the retrieval and playback of audio segments based on speaker, word or keyword (subject) searches.

3.2 Applying the Harmony ABC Model

Figure 2 below is a diagrammatic representation of this scenario based on the ABC event-aware metadata model, which in turn adopts the FRBR model [HREF2] for understanding the lifecycle of intellectual content associated with resources. This model explicitly identifies all of the resources and events which occurred from the original creation of the concept to the development of the online digital archive.

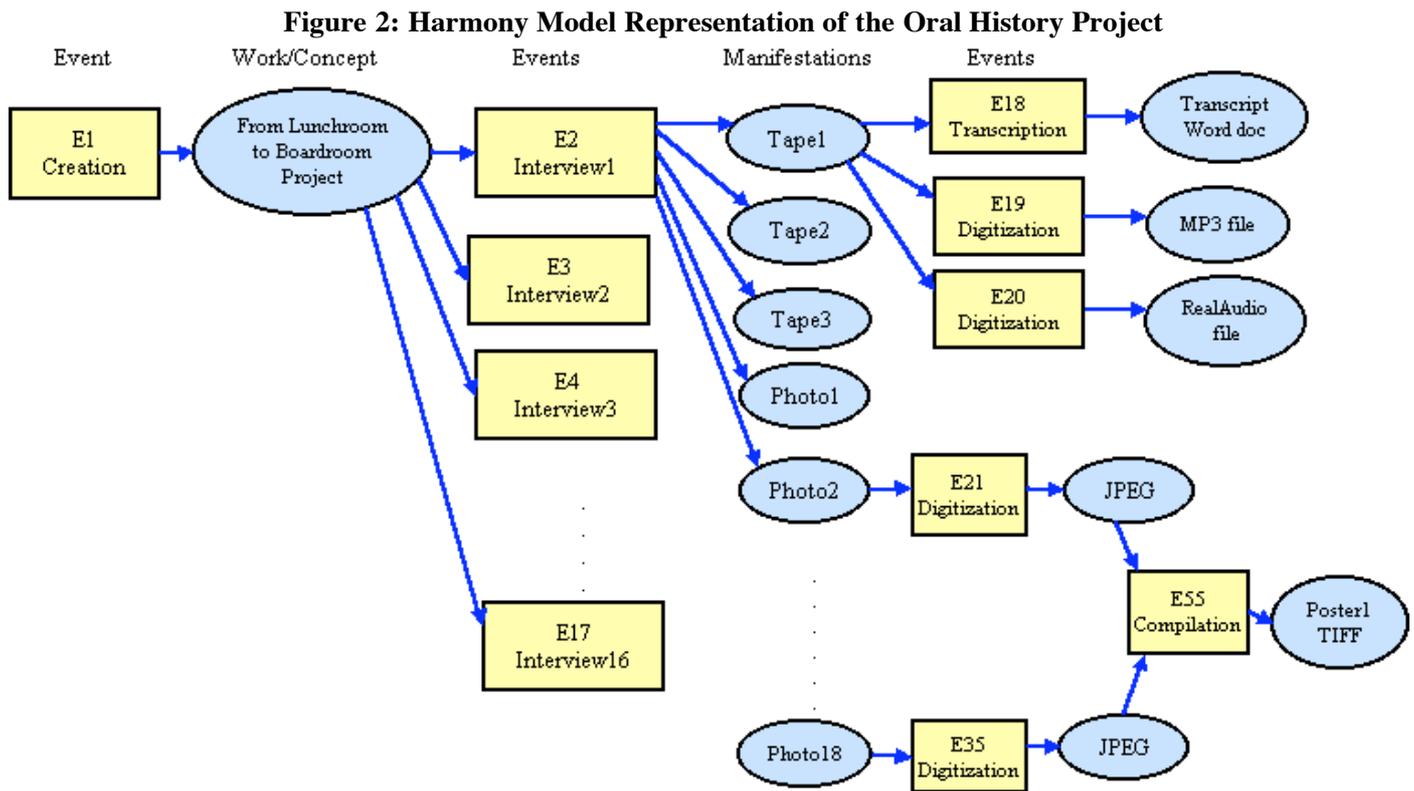**Figure 2: Harmony Model Representation of the Oral History Project**

Figure 3 illustrates the association of properties with events and resources. Under the ABC model, events have inputs, outputs, acts and contexts associated with them. The specific resource attributes will depend on the type of resource and the domain-specific requirements. Figure 3 shows the inputs, outputs and attributes associated with the concept creation event and one of the interview events.

Figure 3: Properties Associated with Events and Resources
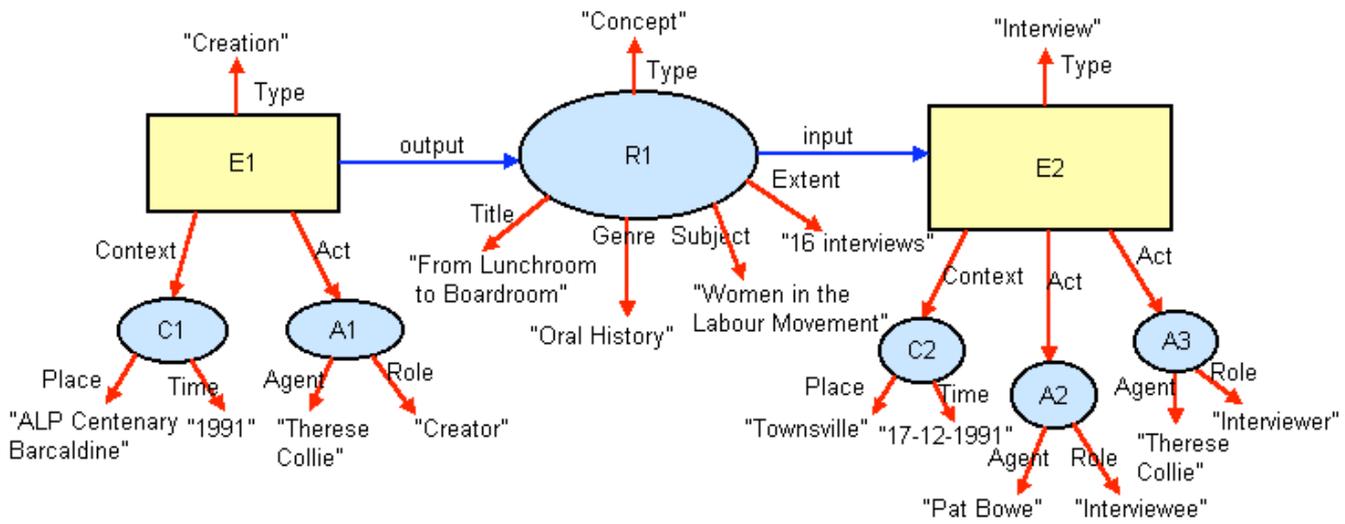
Figure 4 proposes an approach for modeling rights metadata. The output from a rights agreement event (between a rights holder and a rights receiver) is a Right entity. A basic Right entity has a Type (e.g. Permission), a target resource to which it applies, the EventType to which this Right applies and one or more constraints which may be duration-based, fee-based or some other condition.

Figure 4: Properties and Resources associated with a Rights Agreement Event
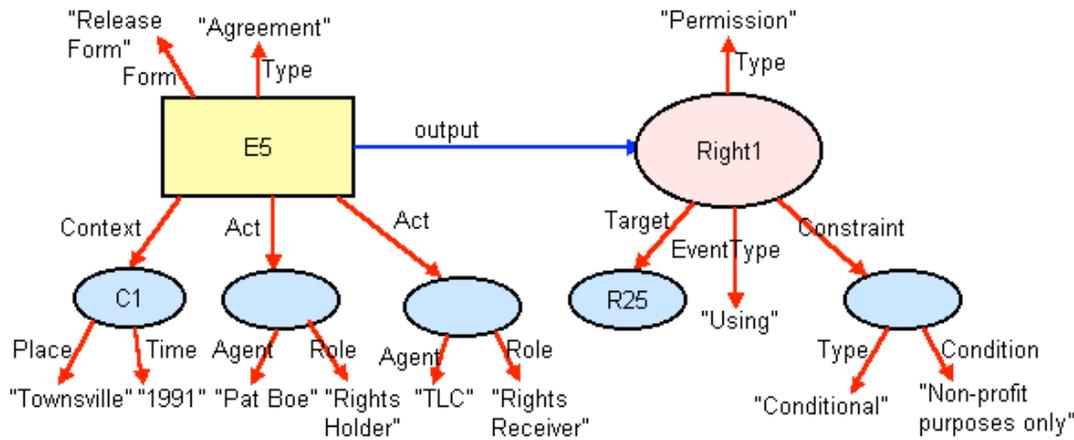
In this application, we want to be able to link segments of the transcripts to the corresponding audio file segments to enable word or subject (keyword) searching on the transcript and playback of the relevant audio segment. Figure 5 illustrates how the ABC model can be used to model the structural metadata associated with each MP3 file. Using the ABC model it is possible to describe the segments of an audiovisual recording of a real-world event in terms of the sub-events of that real-world event. In this application, we break each interview event into Question-and-Answer sized sub-events. Figure 5 shows the segmentation of the MP3 recordings to reflect this same descriptive granularity.

Figure 5: Example of Structural Metadata for a Digital Recording (MP3)
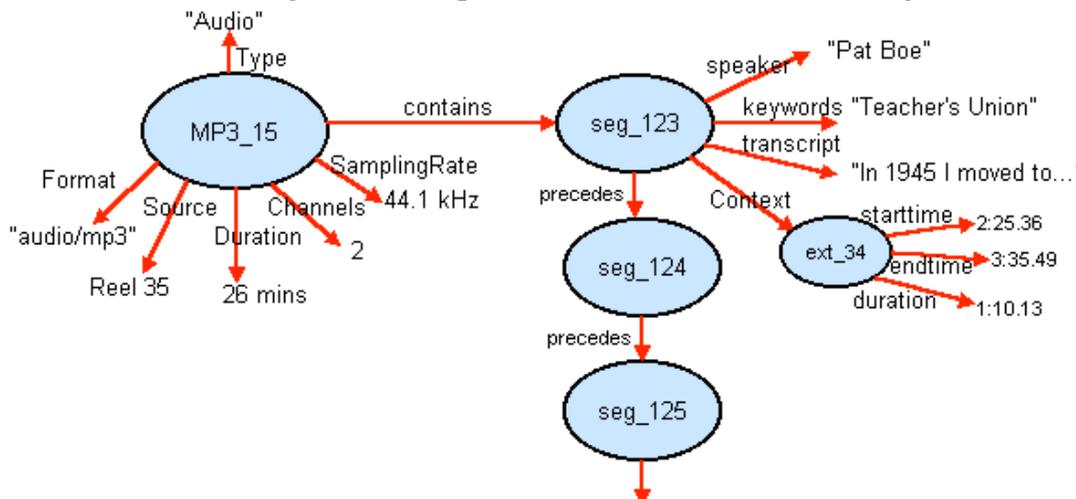
Using the ABC model, we have been able to completely describe all of the significant information associated with the

project in an unambiguous and well-formed manner. The next step is to decide which resources and events need to be described for the particular application's purposes and then to represent these using the ABC model vocabulary in a schema definition. For our application we have decided that only metadata for the following four entity types is significant and needs to be recorded:

- The Collection;
- Interviews;
- Digital Recordings;
- Segments.

3.3 The Schema Representation

There are a number of possible alternatives for defining a schema to constrain and validate descriptions. These include XML DTDs [**HREF17**], RDF Schema [**HREF18**] or XML Schema Language [**HREF19, HREF20**]. We intend using XML Schema language in the near future but due to its immaturity and instability at the time of development of this project, we chose to use a simple XML DTD. Appendix A contains the XML DTD for this project. When we change to an XML Schema to constrain the metadata input, an XML Schema parser will be integrated into the MEGGIE application to perform the description validations. The DOM API [**HREF21**] generated by the parser will provide a user interface to browse the tree structure of the metadata descriptions and to manipulate their content.

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4. The "Meggie" Application

4.1 Inputing the Metadata

MEGGIE (MP3 metadata Editor and Generator) is a Java application which enables the input of metadata for a collection of oral history tapes, based on the underlying XML schema described above and contained in Appendix A. Figures 6, 7 and 8 below illustrate the input forms for the Collection-level, Interview-level and Recording-level metadata for the collection.

The collection-level metadata (Figure 6) consists of the 15 Dublin Core [**HREF1**] elements (with some extra contributors such as Transcriber, Graphic Artist and Coordinator) plus a Size element to store the size of the collection. The Dublin Core Element Set (with extensions) was chosen for the top level metadata description to enable Dublin Core-based search engines to find the collection's Home Page.

Figure 6: Metadata Input Form for the Oral History Collection

The interview-level metadata (Figure 7) includes the Interviewer, Interviewee and Transcriber contributors as well as the Date and Place at which the interview took place.

Figure 7: Metadata Input Form for an Interview from the Oral History Collection

The recording-level metadata (Figure 8) describes the file format details for each of the digitized audio recordings. It includes: format (mime type), duration, channels, sampling_rate, sample size.

Figure 8: Metadata Input Form for a Recording from the Oral History Collection

In addition, the application enables users to open a digital audio (MP3) file and either load the corresponding transcript file (generated manually or using automatic speech recognition techniques) or to enter the transcript manually. Users can play back the audio file whilst simultaneously editing the transcript and aligning it temporally with the audio file. The finer the granularity of temporal indexing, the greater the precision of search and retrieval capabilities but the higher the cost of the indexing procedure. For this application we aligned each Question-and-Answer in the interview to its corresponding audio segment.

Figure 9 shows the transcript window with the audio play-back bar at the top and the currently-selected transcript which is highlighted. Figure 9 also shows the Segment metadata window in which the speaker names, keywords and start and end time stamps are specified. Default values for speaker names and keywords can be retrieved from the corresponding Interview metadata. Start and end times are retrieved automatically from the current position of the audio playback bar.
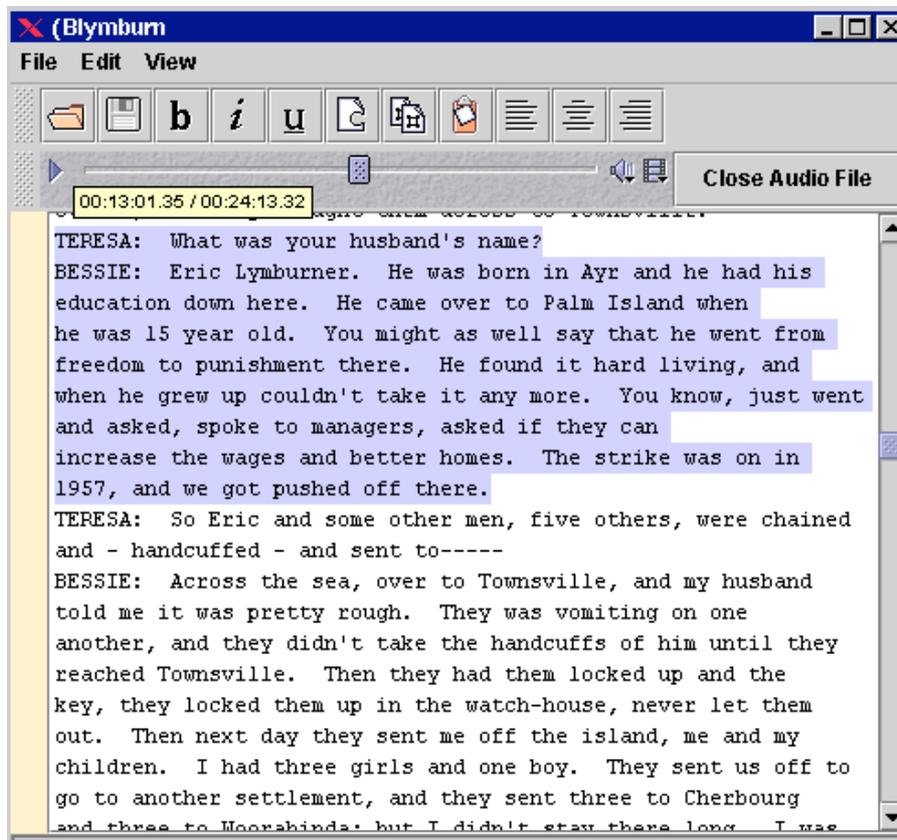

Figure 9: Metadata Input Form for a Segment of a Recording from the Oral History Collection

X (Blymburn)

File   Edit   View

00:13:01.35 / 00:24:13.32   Close Audio File

TERESA: What was your husband's name?
BESSIE: Eric Lymburner. He was born in Ayr and he had his
education down here. He came over to Palm Island when
he was 15 year old. You might as well say that he went from
freedom to punishment there. He found it hard living, and
when he grew up couldn't take it any more. You know, just went
and asked, spoke to managers, asked if they can
increase the wages and better homes. The strike was on in
1957, and we got pushed off there.
TERESA: So Eric and some other men, five others, were chained
and - handcuffed - and sent to-----
BESSIE: Across the sea, over to Townsville, and my husband
told me it was pretty rough. They was vomiting on one
another, and they didn't take the handcuffs of him until they
reached Townsville. Then they had them locked up and the
key, they locked them up in the watch-house, never let them
out. Then next day they sent me off the island, me and my
children. I had three girls and one boy. They sent us off to
go to another settlement, and they sent three to Cherbourg
and three to Woorabinda; but I didn't stay there long. I was

4.2 Saving the Metadata

One of the fundamental assumptions of the ABC model is that no single metadata schema is the correct one and that different users or application contexts require different views of the same set of objects, events and relationships. The underlying data model enables any of these different views to be generated from the underlying description, without lossiness, misinterpretation or ambiguity. For this particular application, there are a large number of possible views or output options for saving the metadata descriptions. Each of these alternatives offers particular advantages within certain contexts:

- ID3 tags [**HREF12**] embedded within the MP3 files - this approach enables the MP3 files to be found by most generic MP3 Internet Search Engines. It also has the advantages associated with encapsulating the metadata and the actual object together in a single container;
- HTML Pages with metatags [**HREF**]15] in the headers - this approach enables either the collection or individual interviews to be found by generic Web Search Engines such as Yahoo, Altavista or HotMeta [**HREF22**];
- Dublin Core (DC) [**HREF1**] descriptions encoded in RDF [**HREF13**] - this approach enables interoperability with other DC-based systems or users. It has the advantage of being media-independent;
- MPEG-7 Description Schemes [**HREF14**] encoded in XML [**HREF17**] - this approach enables interoperability with other media-specific MPEG7-based systems or users;
- Relational tables in a backend database linked to the MP3 files - this approach provides a fast, scalable but application-specific web search interface with high precision and recall.

4.3 Implementation of the Schema Mappings

Currently these mappings are being done programmatically, however we are investigating more generic, flexible and scalable approaches, including:

- Merging a XML Infosets into a single composite Infoset [**HREF23, HREF24**];
- Using Equivalence classes within XML Schema Language to define mappings [**HREF19**];
- Using XSLT (XSL Transformation Language) [**HREF25**] to transform an XML description from one domain to another.

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5. The Search and Browse Interface

A Web front-end [**HREF11**] was built to enable Internet access to the oral history interviews (transcripts and audio files)

and the posters which were developed for the *From Lunchroom to Boardroom* project.

Through this interface, users can search the collection for particular words in the transcripts or for *keywords* which describe the general subject or topic of each interview segment. Figure 10 below is a screen dump of the search interface.

Figure 10: Search Interface to the MP3 Oral History Archive

Each search request is passed to a Java Servlet which connects to the Oracle database using JDBC and invokes an SQL statement reflecting the search request. When a match is found, the following information is returned:

- The context of the matching word/keyword (either the complete Question&Answer or 200 words, whichever is smaller);
- The interviewee of the segment which contains the match;
- Unique identifiers for the recording, interview and collection which contain the match;
- The duration of the matching segment (hrs:mins:secs);
- URLs to:
  1. the transcript for the segment;
  2. the MP3 audio segment which contains the match;
  3. the MP3 audio file for the complete recording which contains the match;

The search results page (Figure 11) contains links to these URLs via three image buttons. If any of these hyperlinks are selected another Java servlet is invoked which connects to the database and retrieves either the transcript, a segment of the MP3 file or the complete MP3 file (corresponding to a complete recording). If an MP3 audio file or segment is requested, then whichever MP3 player plugin is currently configured for the Client's browser, is invoked. Recommended MP3 players include: MXAudio (Solaris), Winamp (WinNT), RealPlayerG2 (Solaris, WinNT, Win97).

Figure 11: Results of a Keyword Search and the MXAudio MP3 Player

Search Results

"FROM LUNCHROOM TO BOARDROOM"

Your search returned 8 results, which are presented in an unranked order.

Transcripts found by keywords: Aboriginal

...our people used to go out to work, and the same thing happened. They'd just give them a couple of weeks order, and tell them they're broke. I believe the Government at that time was the Trustee for *Aboriginal*s, even the people that was on the mainland, the men used to work cattle stations and the women did the same work, washing and ironing, cooking. They were treated the same. They were un...
[More text is available – click Read Transcript]

Result 1

Duration (hr:min:sec)
0:2:34.960

Read Transcript
Play Segment
Play Recording

Collection: 1
Interview: Interview 15
Interviewee: Bessie Lymburner
Recording: Reel 37

Choose from the options on the right to view/hear more information. NOTE: You need an installed mp3 player to listen to the audio.

...e boy. They sent us off to go to another settlement, and they sent three to Cherbourg and three to Woorabinda; but I didn't stay there long. I was fighting to get out of it. I wrote to Director of *Aboriginal*s down in Brisbane if I could be exempted, and told them why I was in Cherbourg and what was happening, so I was lucky because he knew me. Before he went down there being a Director, he...
[More text is available – click Read Transcript]

Result 2

Duration (hr:min:sec)
0:5:45.973

Read Transcript
Play Segment
Play Recording

Collection: 1
Interview: Interview 15
Interviewee: Bessie Lymburner
Recording: Reel 37

Choose from the options on the right to view/hear more information. NOTE: You need an installed mp3 player to listen to the audio.

MXaudio - M038FA61BF00121A3

File   Play_list   Panels   Windows   Help

Speaker   Master
Headphone   Volume
Line Out   Balance
Mute   Mode: Stereo   Quality: High

/tmp
M038FA61BF00121A3

Loop   Random   Database   Add   Del   Clear

Port   Tune   Scan..   No information available

00:06   MONO STEREO   64 kbps   44 kHz
00:40
M038FA61BF00121A3

6. Conclusions and Future Work

6.1 Conclusions

Although there are quite a large number of oral history sites on the Internet [**HREF26, HREF27**], they generally only provide access to transcripts and only occasionally do they provide sample audio clips in RealAudio, WAV or MP3 formats [**HREF28, HREF29**]. The authors of this paper believe that this project is the first online demonstration of an oral history archive which enables the fine-grained retrieval and replay of MP3 audio segments based on word or subject searches. This demonstrator will greatly increase the profile, accessibility and dissemination of the valuable historical resources contained in the From Lunchroom to Boardroom collection.

The MEGGIE application enables efficient, accurate, economically-viable, fine-grained indexing of audio files through the computer-assisted input of multi-level metadata descriptions and temporal alignment of audio with transcripts and keywords. This indexing approach enables the search and retrieval of very specific and precise audio content based on particular words or keywords in the transcript.

The use of the underlying ABC event-aware model enables the recorded metadata to map to any of the five domain-specific vocabularies which are applicable in this context, without ambiguity or loss of integrity or information. Although the ABC model is still undergoing refinement, this project has shown that the fundamental concept of ABC, which is the explicit recognition of events (and their properties) in resource lifecycles, is essential to the generation of interoperable metadata descriptions, particularly in the context of multimedia collections.

6.2 Future Work

The plans for future work include:

- Replacing the XML DTD with an XML Schema;
- Integrating an XML Schema parser into the Metadata Editor/Generator to constrain and validate the metadata descriptions and use the DOM API generated by the parser to browse and edit the structured metadata descriptions;
- Investigating non-procedural mechanisms for mapping between schemas e.g.
  - XML Infosets;
  - XML Schema Equivalence classes;
  - XSLT (XSL Transformation Language);
- Further refinement and extension of the ABC model to support the explicit modeling and recording of intellectual property rights metadata;
- Integrating the MEGGIE, PEGGIE [**HREF16**] and VEGGIE [**HREF30**] applications to create a media-independent metadata editor/generator.

Acknowledgements

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Appendix A: XML PD for the Oral History Collection

```
<?xml version='1.0'?
 <!--     PD for Oral Histories    -->
 <!DOCTYPE oral_history_collection [
 <!ELEMENT oral_history_collection (title, subject, description,
creator, publisher?, contributors, date, type, format_supplied+,
 identifier, source, language, relation, coverage, rights, size?,
interview*)>
 <!ELEMENT title (#CDATA)>
 <!ELEMENT subject (#CDATA)>
 <!ELEMENT description (#CDATA)>
 <!ELEMENT creator (#CDATA)>
 <!ELEMENT publisher (#DATA)>
```

```
<!ELEMENT contributors(transcriber,graphic_artist,
                        project_coordinator)>
    <!ELEMENT transcriber (#CDATA)>
    <!ELEMENT graphic_artist (#CDATA)>
    <!ELEMENT project_coordinator (#CDATA)>
<!ELEMENT date (#CDATA)>
<!ELEMENT type (#CDATA)>
<!ELEMENT format (#CDATA)>
<!ELEMENT identifier (#CDATA)>
<!ELEMENT source (#CDATA)>
<!ELEMENT language (#CDATA)>
<!ELEMENT relation (hasParts*) >
  <!ELEMENT hasParts (#CDATA)>
<!ELEMENT coverage (#CDATA)>
<!ELEMENT rights (#CDATA)>
<!ELEMENT size (#CDATA)>
<!ELEMENT interview (title, subject, description, publisher?,
 contributor, date, type, language,  relation, coverage, rights,
 size?, recording*)>
  <!ATTLIST interview id    #REQUIRED>
  <!ELEMENT title (#CDATA)>
  <!ELEMENT subject (#CDATA)>
  <!ELEMENT description (#CDATA)>
  <!ELEMENT publisher (#DATA)>
  <!ELEMENT contributor (interviewer, interviewee, transcriber)>
      <!ELEMENT interviewer (#CDATA)>
      <!ELEMENT interviewee (#CDATA)>
      <!ELEMENT transcriber (#CDATA)>
  <!ELEMENT date (#CDATA)>
  <!ELEMENT type (#CDATA)>
  <!ELEMENT language (#CDATA)>
  <!ELEMENT relation (isPartOf , hasParts*) >
      <!ELEMENT isPartOf (#CDATA)>
      <!ELEMENT hasParts (#CDATA)>
  <!ELEMENT coverage (#CDATA)>
  <!ELEMENT rights (#CDATA)>
  <!ELEMENT recording (format, duration, channels, samplingRate,
                       samplingSize, identifier, segment*)>
   <!ATTLIST recording id    #REQUIRED>
   <!ELEMENT format (#CDATA)>
   <!ELEMENT duration (#CDATA)>
   <!ELEMENT channels (#DATA)>
   <!ELEMENT samplingRate (#CDATA)>
   <!ELEMENT samplingSize (#CDATA)>
   <!ELEMENT identifier (#CDATA)>
   <!ELEMENT source (#DATA)>
   <!ELEMENT segment (keywords, transcript)>
      <!ATTLIST segment
          id    #REQUIRED
          speaker #PCDATA
          startTime #PCDATA
          endTime #PCDATA
          duration #PCDATA>
      <!ELEMENT keywords (#CDATA)>
      <!ELEMENT transcript (#CDATA)>
]>
```