

Best Practices for Structural Metadata

Version 1

Yale University Library

June 1, 2008

Background

The Digital Production and Integration Program (DPIP) is sponsoring the development of documentation outlining best practices, standards, and examples for various aspects of digitization initiatives in the library. The best practices are intended to provide a survey of current practices at Yale and other institutions and to establish guidelines or benchmarks for adoption at Yale. In addition to best practices for structural metadata, best practices for still image capture, multimedia reformatting and preservation, and descriptive metadata are available from the Yale University Library Best Practices web site.¹ For additional information on these best practices, please contact Rebekah Irwin (rebekah.irwin@yale.edu), Fred Martz (frederick.martz@yale.edu), Youn Noh (youn.noh@yale.edu), or Dajin Sun (dajin.sun@yale.edu).

Introduction

Structural metadata can be used to represent the physical or logical structure of a complex object, e.g., the organization of a book into chapters or of news footage into stories. For each chapter or story, we might record its physical or logical boundaries, its relative position, its relationship to other components, or a description of its content. Ideally, the structural representation of the object will reflect how it is used and perceived.

Structural metadata presented in a user interface can enable more effective utilization of resources. A preliminary study conducted with Yale undergraduates suggests that the presence of structural metadata increases user satisfaction by enabling more efficient navigation of resources.² Structural metadata can also be used to manage complex digital objects. For example, different migration strategies might be applied to parts of a complex multi-format object, depending upon the stability of the format.

The amount, type, and granularity of information required to support end user functionality and resource management will vary from project to project. We list some basic questions that can be used to assess the structural metadata needs of individual projects. Then we identify six levels of structural metadata that can appropriately be applied to digital content, depending on the goals of the project, the nature of the source material, the available funding, and the projected future use of the digital content, especially in a public interface. The six levels (with examples) are as follows:

1. No Structural Metadata (page 2): cultural heritage materials (single images)
2. Structural Metadata Embedded in a PDF Document (page 4): course reserves
3. Structural Metadata Defining File Sequence (page 4): books, journals, and cultural heritage materials
4. Structural Metadata Defining Logical Components (page 11): books (journal example not provided, but also appropriate for journals)
5. Physical and Logical Structural Metadata Encoded in a Finding Aid (page 14): manuscript collections with digital files
6. Structural Metadata with Analyzed Page Layout (page 16): newspapers

¹ <http://www.library.yale.edu/dpip/bestpractices/>

² http://www.library.yale.edu/libepub/usability/studies/ebooks_final_report.doc

For each level, we describe data elements, encoding options, associated interface features, and implementations at Yale and other institutions. In the appendices, we provide the following tables:

- A. Levels and Functions: summarizes information presented in the body of the document, for use by project managers
- B. Environmental Scan: description of projects at other institutions, for use by project managers
- C. Metadata Schemas: comparison of encoding options, not all tested at Yale

The scope of these best practices is paged objects, either text or images. This document may be supplemented by best practices for structural metadata for audiovisual resources as the library gains experience in managing and providing access to these formats.

Needs Assessment

The creation of structural metadata is by no means necessary for all paged text or image objects. Here are some questions to consider when deciding how much and what kind of structural metadata are required for a project:

- For paged text objects, is the text searchable? For paged image objects, is a textual description provided at an appropriate level of granularity?
- Taking into account the nature and size of the collection and the audience, will users be able to make sense of search results?
- Taking into account the typical page length of objects in the collection, will users be satisfied with the amount of time and the level of effort required to select and to navigate resources?
- Are users likely to seek individual items from the collection? Is contextualization a luxury, not a necessity?

If each question is answered yes, then structural metadata may not be required for the project. The six levels of structural metadata described below can be compared to further clarify the needs of individual projects and to decide upon the most suitable strategy for addressing those needs.

1. No Structural Metadata

Structural metadata is unnecessary for objects of limited length or with constituents that are viewed or used independently. Each object or constituent has accompanying descriptive metadata, is indexed separately, and is displayed to the viewer as a single item.

The Visual Resources Collection (VRC) has successfully implemented and documented this practice. While it would certainly be possible to use structural metadata to provide multiple views of a three-dimensional object (e.g., a 360-degree rotation of a Greek vase) or to define relationships between multiple images (e.g., various exterior and interior views of Chartres cathedral), few libraries have implemented metadata standards or presentation systems that elegantly achieve these results. In fact, the Beinecke Library has adopted one such solution, described in section 4, which will be implemented in the VRC, going forward, to present related images.

The screenshot below displays search results for the phrase *chartres cathedral*. The number of hits (624), some obviously related, suggests that the ability to filter or group search results would be useful. Creating structural metadata is one approach to handling large result sets.

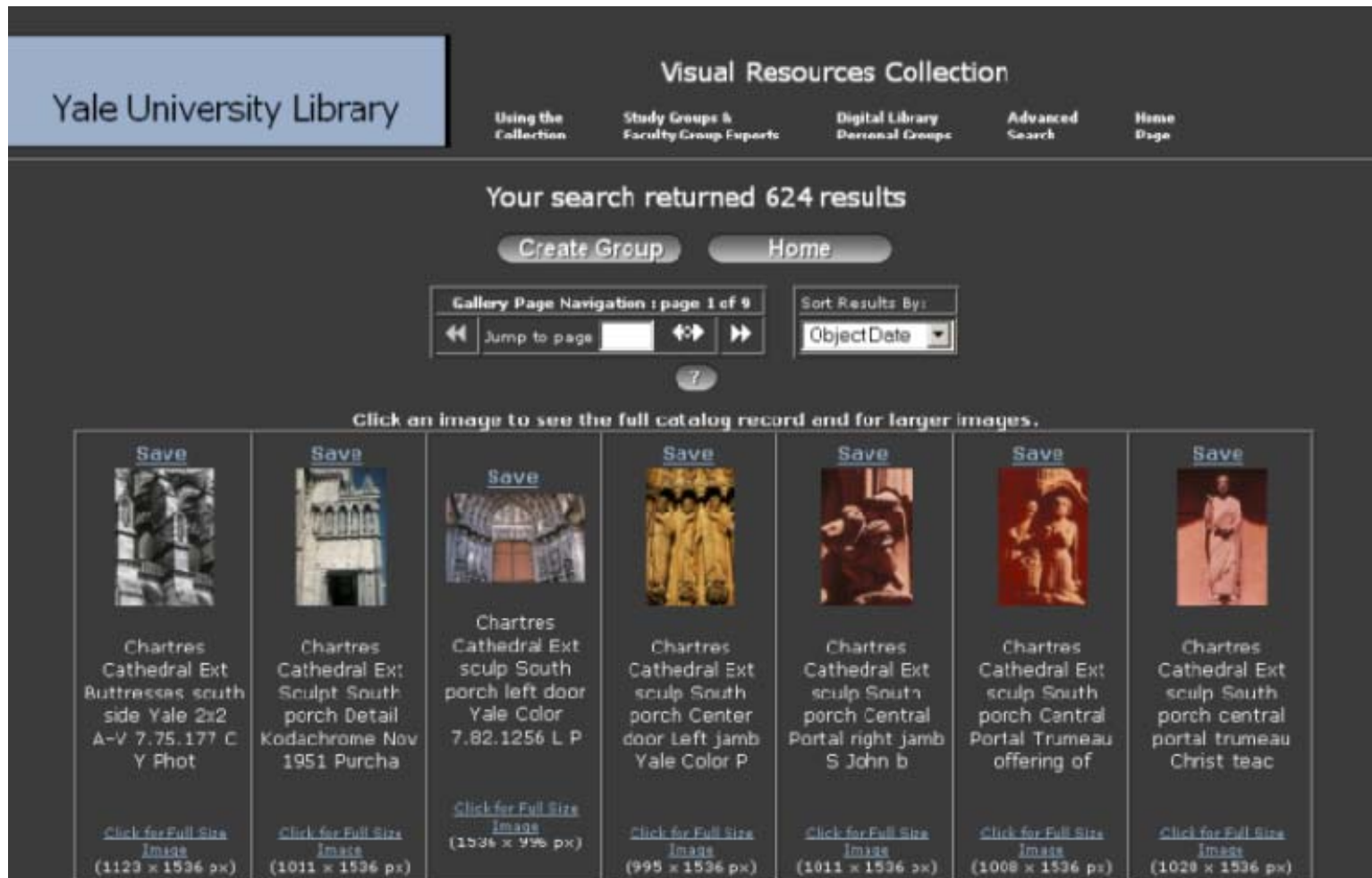


Figure 1: Visual Resources Collection: search results for “chartres cathedral”

2. Structural Metadata Embedded in a PDF Document

When the intended use of the digital material is narrowly defined and transitory, the most efficient and economical approach is to convert the set of page images into a PDF document. This solution provides a utilitarian mechanism for delivery and navigation of the material, especially if it is limited in length (less than 100 pages). This method has proven highly successful in the e-reserves service at Yale.

3. Structural Metadata Defining File Sequence

If each page of the object is managed and presented as a separate file, the file sequence should be tagged in order to enable sequential navigation. The file sequence may be encoded as part of the filename or as metadata. An advantage of the latter approach is the ability to associate additional properties (e.g., actual page numbers) with the file sequence. The file or page sequence can be used to support page-to-page navigation and go-to-page navigation.

File sequence is encoded as part of the filename in materials digitized for the Arabic and Middle Eastern Electronic Library (AMEEL) and the reformatted books collection.

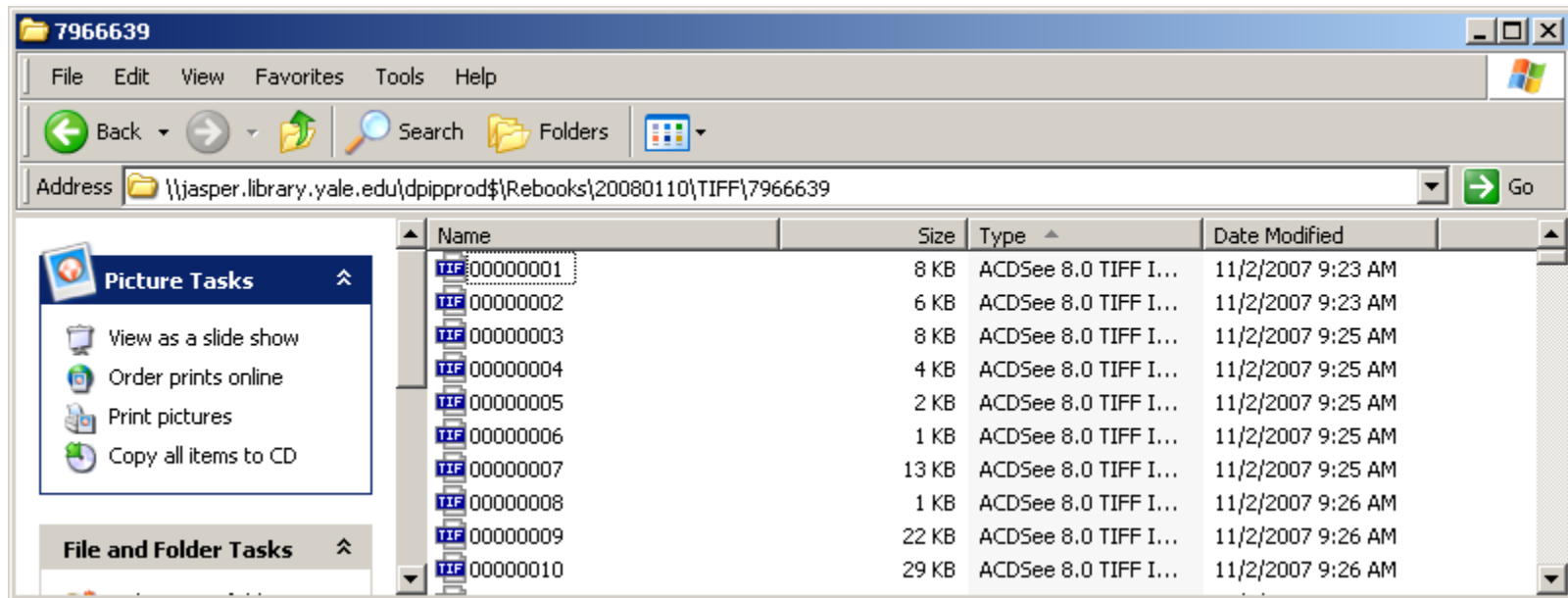


Figure 2: TIFF filenames for reformatted books based upon file sequence

A locally developed page viewer for the AMEEL project supports page-to-page navigation and go-to-page navigation based upon file sequence.

YALE UNIVERSITY LIBRARY
Arabic and Middle Eastern Electronic Library

SEARCH Full Text Content

Issue Pages Available: 1 to 134

Go to Page:

[View Table of Contents](#)

[Return to Results](#)

Title:	al-Mawrid, vol. 28, iss. 1
Title:	المورد، 28: 1
Subject:	Civilization, Arab Periodicals
Subject:	Civilization, Islamic Periodicals
Contributor:	Wizārat al-Ilām, al-Jumhūrīyah al-Irāqīyah, vol. 28, iss. 1
Contributor:	وزارة الاعلام العراقية المورد، 28: 1
Date:	2000
Date:	2000
Type:	text

Current Page: 133

Navigation:

resize

ختامها مسك

لغة حضارة ... وحضارة لغة

خمسة وأربعون قرناً تمتد بين زمن وامن
الجنود ضاربة في عمق التاريخ حتى تكاد تحس سرا
الأرض ... والغروب تفرش صفحة السماء حتى تكاد تلمس
حصرة الوعد ،
ويلى لدى أحمد بن زمن عربي وزمن عربي عطاء:
إبداع وانجاز فكر ونض عبقية .
مجد هذه الأرض انها حين ينال من ايها الضما
تلتجيب من حضرة كتبه رجلاً وتزهر نكراً وتشر حضارة
وتستقبل نور رسالات .
وحيث كان منطق التاريخ ان تسود حصارا ثم تهيب غار
منطق تاريخ هذه الامم ان نجد رسائلها الحصارا بعد يامل
نعم الا تالو موضعهم نجم ، ولا يعطي عطاء جيل الا نض
بالحمية عطاء جيل . ويبنى قبل المادلة شامخاً حتى في
مراحل الانحسار
أنا ان كسبمت الوثائق
لسنا على الاحسان نكمل
بنينا كما كانت لوائنا
تتم ، ونفعل مثل ما فعلوا

Figure 3: AMEEL page viewer, with page-to-page navigation and go-to-page navigation based upon file sequence

In the Beinecke Digital Library, structural metadata are stored in a relational database. SQL tables are used to define one-to-many relationships between a book and its pages, a box of slides and its contents, or a folder and the group of letters it holds. Files are flagged and sequenced if they are part of a group. The files that belong to a group are identified by a common record identifier. Paired files (e.g., the front and back of a postcard) are handled by simply recording the record identifier of the other file in the pair.

The screenshot shows a table with the following columns: FILE_NAME, FILE_SIZE, FILE_WIDTH, FILE_HEIGHT, BOOK_NAME, BOOK_SIZE, BOOK_WIDTH, BOOK_HEIGHT, CO_LANG_ID, IMAGE_DESC, BASE_COLLECTION, SEQUENCER, GROUP_FLAG, PAIR_ID, CREATE_DATE, IMG_SERVER, and IMG_ID. The table contains numerous rows of data, each representing a file record with its associated metadata and sequencing information.

FILE_NAME	FILE_SIZE	FILE_WIDTH	FILE_HEIGHT	BOOK_NAME	BOOK_SIZE	BOOK_WIDTH	BOOK_HEIGHT	CO_LANG_ID	IMAGE_DESC	BASE_COLLECTION	SEQUENCER	GROUP_FLAG	PAIR_ID	CREATE_DATE	IMG_SERVER	IMG_ID
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1005061.jpg	<NULL>	979	634	1005061.pdf	<NULL>	1689	2639	<NULL>	<NULL>	2	10	Y	<NULL>	<NULL>	http://136.132.81.100	<NULL>
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TITLE: Songs of innocence. [\(View as Slideshow\)](#)
(Page 1 of 2)

Navigation controls including a left arrow, a "Jump to page" input field, a "Go" button, and a "Next" button with a right arrow.



Figure 5: Beinecke Digital Library, with images from the *Songs of Innocence* displayed as a set

In METS (Metadata Encoding and Transmission Standard), file sequence and page numbers are stored as ORDER and ORDERLABEL attributes.³

```
664 <mets:div ORDER="5" TYPE="page">
665   <mets:fptr FILEID="BSE5"/>
666   <mets:fptr FILEID="OCR5"/>
667   <mets:fptr FILEID="ALTO5"/>
668 </mets:div>
669 <mets:div ORDER="6" TYPE="page" ORDERLABEL="vi">
670   <mets:fptr FILEID="BSE6"/>
671   <mets:fptr FILEID="OCR6"/>
672   <mets:fptr FILEID="ALTO6"/>
673 </mets:div>
674 <mets:div ORDER="7" TYPE="page" ORDERLABEL="1">
675   <mets:fptr FILEID="BSE7"/>
676   <mets:fptr FILEID="OCR7"/>
677   <mets:fptr FILEID="ALTO7"/>
678 </mets:div>
679 <mets:div ORDER="8" TYPE="page" ORDERLABEL="2">
680   <mets:fptr FILEID="BSE8"/>
681   <mets:fptr FILEID="OCR8"/>
682   <mets:fptr FILEID="ALTO8"/>
683 </mets:div>
684 <mets:div ORDER="9" TYPE="page" ORDERLABEL="3">
685   <mets:fptr FILEID="BSE9"/>
686   <mets:fptr FILEID="OCR9"/>
687   <mets:fptr FILEID="ALTO9"/>
688 </mets:div>
689 <mets:div ORDER="10" TYPE="page" ORDERLABEL="4">
690   <mets:fptr FILEID="BSE10"/>
691   <mets:fptr FILEID="OCR10"/>
692   <mets:fptr FILEID="ALTO10"/>
693 </mets:div>
```

Figure 6: METS record with ORDER and ORDERLABEL attributes for file sequence and page number

³ <http://www.loc.gov/standards/mets/>

Structural metadata for books delivered by Harvard University Library's Page Delivery Service are encoded in METS.⁴ The service provides page-to-page navigation and go-to-page navigation based upon actual page numbers.

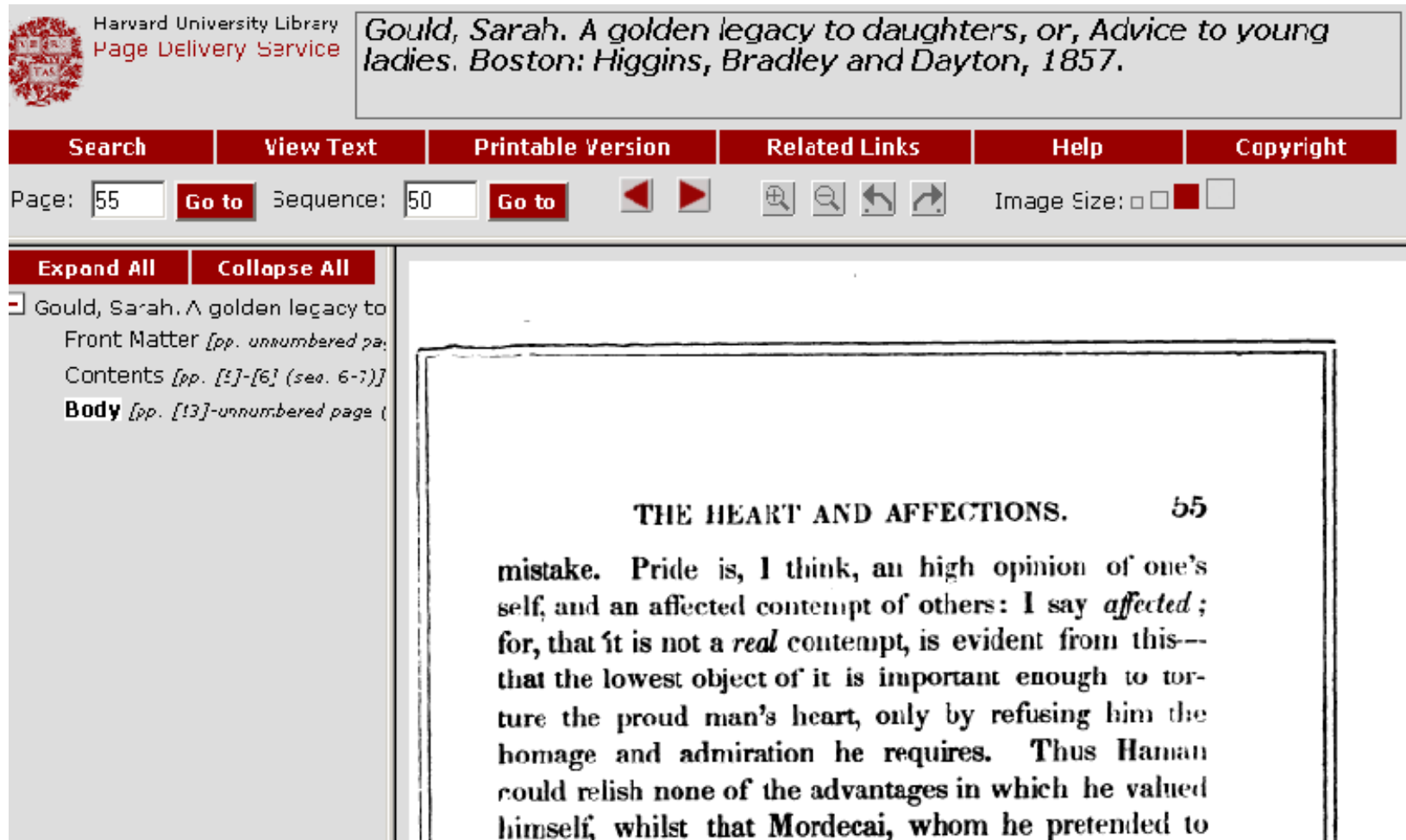


Figure 7: Harvard Page Delivery Service, with page-to-page navigation and go-to-page navigation based on page numbers

⁴ http://hul.harvard.edu/ois/systems/drs/Harvard_METS_Profile_for_Page-Turned_Objects.doc

The Google Book Search interface supports page-to-page navigation and go-to-page navigation based on actual page numbers.

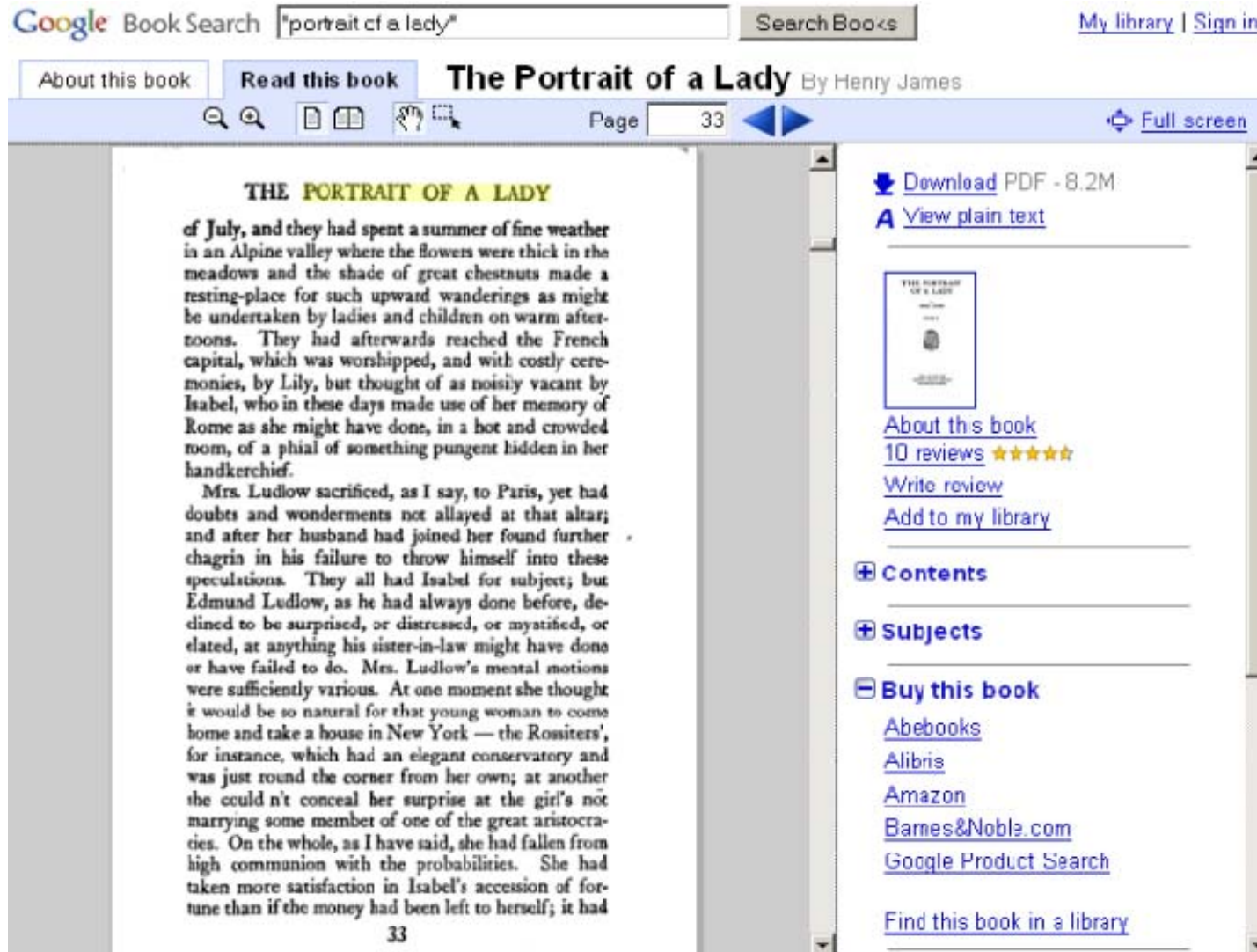


Figure 8: Google Book Search, with page-to-page navigation and go-to-page navigation based on page numbers

4. Structural Metadata Defining Logical Components

Chapters, figures, and other sections of a work can be tagged to support content-based navigation. Tagging content is especially important for longer works and for anthologies or collections with thematically related parts that are also considered independent works. Users can jump to the section of interest and then navigate files or pages sequentially. Identifying structure based on content also facilitates the management and reuse of materials, enabling, for example, the extraction of maps in a travel guide, of plates in an exhibition catalogue, or of chapters in a festschrift. Extracted items can be contextualized by using structural metadata to provide links back to the appropriate location in the source.

Different genres of document typically have a predictable logical structure. A list of types (e.g., chapter, index, map, etc.) or controlled vocabulary is recommended for use in tagging. Identifying components by type is useful for managing and repurposing resources. Descriptive information (e.g., chapter titles, figure captions, etc.) can be extracted to provide labels. Labels can be indexed and searched as metadata.

TYPE and LABEL are two forms of metadata associated with components in METS. Component-specific metadata could also be stored in a relational database.

```
<mets:div ORDER="2" TYPE="body" LABEL="Body">
  <mets:div ORDER="1" TYPE="chapter" LABEL="1. County and Shire. The Name Hertfordshire. Its Origin and Meaning">
    <mets:div ORDER="1" TYPE="page" ORDERLABEL="1">
      <mets:fptr FILEID="BSE7"/>
      <mets:fptr FILEID="OCR7"/>
      <mets:fptr FILEID="ALTO7"/>
    </mets:div>
    <mets:div ORDER="2" TYPE="page" ORDERLABEL="2">
      <mets:fptr FILEID="BSE8"/>
      <mets:fptr FILEID="OCR8"/>
      <mets:fptr FILEID="ALTO8"/>
    </mets:div>
    <mets:div ORDER="3" TYPE="page" ORDERLABEL="3">
      <mets:fptr FILEID="BSE9"/>
      <mets:fptr FILEID="OCR9"/>
      <mets:fptr FILEID="ALTO9"/>
    </mets:div>
  </mets:div>
</mets:div>
```

Figure 9: METS record with TYPE and LABEL attributes for component types and component metadata

Logical structural metadata encoded in METS can be used to generate links to chapters and to figures. The screenshot below displays a page from a book with navigation features generated from METS. Clicking on the link for a chapter or figure takes you to the first page of the chapter or figure.

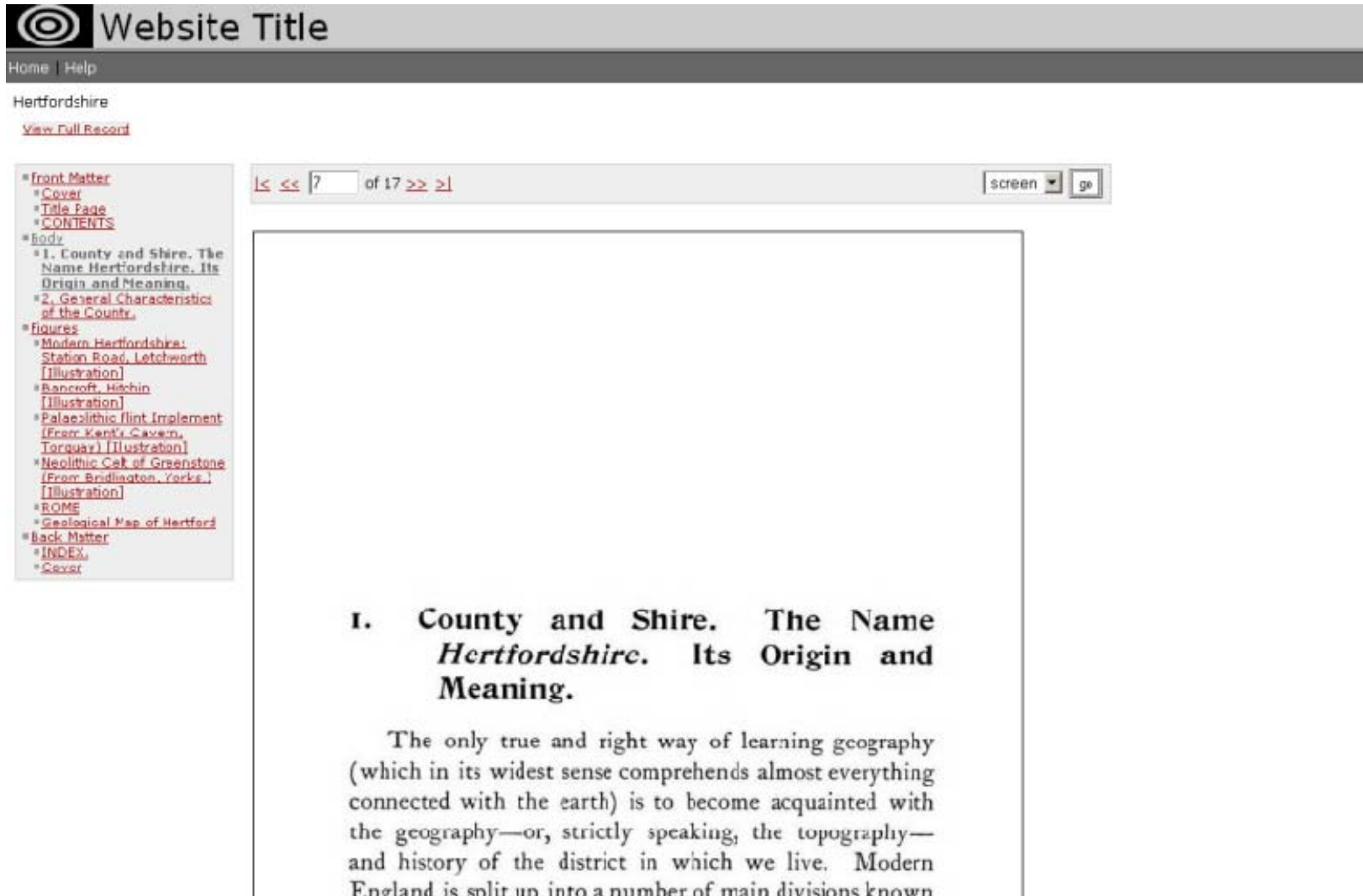


Figure 10: Indiana University METS Navigator, with navigation panel generated from METS

Google Book Search displays contents with clickable chapter titles. Clicking on a chapter title takes you to the first page of the chapter.

The screenshot shows the Google Book Search interface for the book "Football for Player and Spectator" by Fielding H. Yost. The search bar at the top contains the text "Football for player and spectator". The book title is prominently displayed in the center of the page, with the words "FOOTBALL", "PLAYER AND", and "SPECTATOR" highlighted in yellow. Below the title, it says "BY FIELDING H. YOST". On the right side, there is a sidebar with various options: "Download PDF - 4.0M", "View plain text", "About this book", "Write review", and "Add to my library". Below these options is a "Contents" section with a list of clickable chapter titles and their corresponding page numbers:

Chapter Title	Page Number
Title Page	
Copyright	
Table of Contents	
Its origin and developme...	1
What it does for the play...	18
Its varied characteristics ...	50
Passing Starting Catching	73
Individual Positions	122
Training	148
The Evenings Work	165
Team Play	183
Generalship	260
< less	

Figure 11: Google Book Search, with table of contents with clickable titles

5. Physical and Logical Structural Metadata Encoded in a Finding Aid

Finding aids at Yale are encoded in EAD (Encoded Archival Description).⁵ EAD provides mechanisms for representing the logical and physical arrangement of materials in a collection. EAD has elements for linking to digital files. Materials in a finding aid are typically described at a high level, not item by item. Item-level description can be recorded in SMIL (Synchronized Multimedia Integration Language)⁶, METS, or a relational database.

```
<c02 id="d0e151" level="file">
  <did>
    <container type="Box">1 </container>
    <container type="Folder">1 </container>
    <unittitle type="genericfolder"> The Bollingen Prize Readings at Center Church (2 discs) </unittitle>
    <unitdate>2002 Sep </unitdate>
    <daogrp xlinktype="extended">
      <resource xlinklabel="start" xlinktype="resource">Digital audio file of this recording [Disc 1]</resource>
      <daoloc xlink:href="http://inky.library.yale.edu/av/ycalmss211-folder1-disc1.smil" xlinklabel="reference" xlink:role="audio/x-pn-realaudio" xlinktype="locator"></daoloc>
      <arc xlink:actuate="onRequest" xlink:from="start" xlink:show="new" xlinkto="reference" xlink:type="arc"></arc>
    </daogrp>
    <daogrp xlinktype="extended">
      <resource xlinklabel="start" xlinktype="resource">Digital audio file of this recording [Disc 2]</resource>
      <daoloc xlink:href="http://inky.library.yale.edu/av/ycalmss211-folder1-disc2.smil" xlinklabel="reference" xlink:role="audio/x-pn-realaudio" xlinktype="locator"></daoloc>
      <arc xlink:actuate="onRequest" xlink:from="start" xlink:show="new" xlinkto="reference" xlink:type="arc"></arc>
    </daogrp>
  </did>
  <scopecontent>
    <p> Readings by Bollingen Prize winners: John Ashbery, Robert Creeley, Louise Gluck, John Hollander, Donald Justice, Stanley Kunitz, W. S. Merwin, Gary Snyder, Mark Strand, and Richard Wilbur </p>
  </scopecontent>
  <phystech>
    <p> RealPlayer required. </p>
  </phystech>
</c02>
```

links to smil files with real audio and metadata

Figure 12: excerpt from EAD for Yale Collection of American Literature Reading Series with links to digitized content

⁵ <http://www.loc.gov/ead/>

⁶ <http://www.w3.org/AudioVideo/>

When providing access to digitized materials in archival or manuscript collections, the EAD-encoded finding aid can be used as a navigation tool. In the screenshot from the Finding Aid Database shown below, a stylesheet has been applied to the EAD document to generate an HTML document that includes a navigation panel.

Series I. Audio Recordings of YCAL Readings

Box	Folder	Description	Date(s)
		<p>Series I. Audio Recordings of YCAL Readings <i>Extent: 0.42' (1 box)</i></p> <p>Series I, <i>Audio Recordings of YCAL Readings</i>, is arranged chronologically by date of reading. Digital reference copies for each reading are available.</p>	2002-2006
1	1	<p>The Bollingen Prize Readings at Center Church (2 discs) audio icon Digital audio file of this recording [Disc 1] audio icon Digital audio file of this recording [Disc 2]</p> <p>Readings by Bollingen Prize winners: John Ashbery, Robert Creeley, Louise Gluck, John Hollander, Donald Justice, Stanley Kunitz, W. S. Merwin, Gary Snyder, Mark Strand, and Richard Wilbur</p> <p>RealPlayer required.</p>	2002 Sep
1	2	<p>Howe, Susan. Poetry reading audio icon Digital audio file of this recording</p> <p>RealPlayer required.</p>	2002 Nov 13
1	3	<p>Lauterbach, Ann. Poetry reading audio icon Digital audio file of this recording [Track 1] audio icon Digital audio file of this recording [Track 2] audio icon Digital audio file of this recording [Track 3]</p>	2002 Dec 5

Yale Collection of American Literature Reading Series YCAL MSS 211

- [Overview](#)
- ▣ [Administrative Information](#)
- [YALE COLLECTION OF AMERICAN LITERATURE READING SERIES](#)
- [Description of the Papers](#)
- ▣ [Collection Contents](#)
 - [Series I. Audio](#)

Figure 13: Finding Aid Database, with navigation panel generated from EAD

6. Structural Metadata with Analyzed Page Layout

Structural metadata can be combined with page layout information to provide additional interface features such as the ability to limit searches to sections of a work, to have search results returned with query terms highlighted, and to manipulate text or page regions. ALTO (Analyzed Layout and Text Object), a METS extension schema, can be used to record the coordinates of text blocks, paragraphs, words, and images on a page.^{7, 8} METS/ALTO is recommended for publications such as newspapers where navigation of individual articles or elements is desirable. METS/ALTO enables the presentation and enlargement of selected articles or photographs in a separate window. Page layout information instructs the software how to determine article boundaries even when an article spans multiple pages. Segmentation defines the boundaries of illustrations so that they can be identified and extracted for incorporation or display in another interface.

```
<div ID="DIVL136" TYPE="PARAGRAPH" ORDER="8">
  <div ID="DIVL137" TYPE="TEXT">
    <fptr>
      <area BETYPE="IDREF" FILEID="ALTO0010" BEGIN="P10_TB00004"/>
    </fptr>
  </div>
</div>
</div>
<div ID="DIVL138" TYPE="ILLUSTRATION" ORDER="1" DMDID="MODSMD_PICT5" LABEL="R. BARRY FARRELL">
  <div ID="DIVL139" TYPE="IMAGE">
    <fptr>
      <area BETYPE="IDREF" FILEID="ALTO0003" BEGIN="P3_CB00001"/>
    </fptr>
  </div>
  <div ID="DIVL140" TYPE="CAPTION">
    <fptr>
      <area BETYPE="IDREF" FILEID="ALTO0003" BEGIN="P3_TB00003"/>
    </fptr>
  </div>
</div>
```

Annotations in the image:

- Arrow pointing to `<area BETYPE="IDREF" FILEID="ALTO0010" BEGIN="P10_TB00004"/>`: ID for ALTO file and element in file that contains coordinates of the paragraph
- Arrow pointing to `<area BETYPE="IDREF" FILEID="ALTO0003" BEGIN="P3_CB00001"/>`: ID for ALTO file and element in file that contains coordinates of the image
- Arrow pointing to `<area BETYPE="IDREF" FILEID="ALTO0003" BEGIN="P3_TB00003"/>`: ID for ALTO file and element in file that contains coordinates of the caption

Figure 14: METS file with references to ALTO files

⁷ <http://www.ccs-gmbh.com/alto/>

⁸ <http://www.diglib.org/forums/Spring2005/presentations/CCS-2005-04.pdf>

Yale Daily News Historical Archive (Selected Years)
Yale Daily News (2001 to present) : Digital Collections : Research Tools : Ask! a Librarian : Acknowledgements
home : view by period : browse : advanced search : preferences : my favorites : about : help
menu on : previous page : next page add document to favorites : add page to favorites : reference url back to results : previous : n

25.8%

Yale Daily News

The Oldest College Daily Founded January 28, 1878

Vol. XCI No. 96 Copyright 1970 NEW HAVEN, CONNECTICUT, WEDNESDAY, FEBRUARY 25, 1970 PRICE 15 CENTS

Black Coalition Meets

The Black Coalition met last night in closed session to discuss further action since severing relations with Yale on Monday. In a statement released Monday, the Coalition charged the University with failure to meet its fund-raising commitments to the black community. Monday night Yale President Kingman Brewster Jr., responded to the Coalition with a brief statement seeking reconciliation with the group. The Black Coalition is an organization of more than thirty black community groups which was formed as a result of riots in New Haven in the summer of 1967. It is concerned with uniting black organizations in order to aid economic development of the black communities. Among the members of the Coalition are the NAACP, Hill Parents Association, and Freedom Now.



O. Meredith Wilson, director of Center for Advanced Study in the Behavioral Sciences, urged drastic revisions in university curricula in a speech here yesterday.

Wilson Asks Major For 'Thinking Man'

Dinner Drama

Women's Liberation Acts

For the past two days eight members of the Yale Women's Alliance have paraded and performed skits in Yale dining halls to publicize workshops on women's liberation scheduled here this weekend. Yesterday, the female troupe, composed of both graduates and undergraduates, assembled in the Hall of Graduate Studies lounge, donned costumes, and brushed up their lines. Then, with the cry of "Let's move it on out, girls!" they walked down Wall Street on their way to Berkeley College. Aroused Bystanders The procession aroused considerable interest among passers-by. Many bystanders asked for leaflets, and the workmen on the Sterling library annex interrupted their lunches to look up with puzzled expressions. The performance at the Berkeley dining room began as two leafleters entered, followed by a trombonist who



University Contests City Hall's Control Of Yale Expansion

By WILLIAM BULKELEY
Yale University has filed suit in the New Haven Court of Common Pleas to contest the legality of the controversial Guida Bill. The so-called Guida Bill is an amendment to the zoning laws of New Haven which says no institution such as Yale or the Yale-New Haven Hospital may develop any property without asking the New Haven Board of Aldermen for permission. Yale is thus questioning the right of the city to limit institutional expansion. Robert Cavanaugh, the University attorney, explained Yale is bringing suit as a "test of the legality of the bill." Yale has raised the question in relation to a proposed expansion of the Medical School and the hospital. Both Sides Now New Haven's City Corporation Counsel, Thomas F. Keyes, said response to perennial complaints that Yale is taking residential and commercial land from the city of New Haven. The statement of purpose at the beginning of the bill says "certain types of educational and health institutions are of such size, and/or impact that their future development must be guided in order to protect the general welfare of the City of New Haven and its citizens." Playing It Safe While contesting the legality of the bill, Yale has also filed with the board of Aldermen for a special exemption in order to proceed with the new construction near the hospital. The University has also sought approval from the zoning board, the standard manner for getting city approval before the passage of the Guida bill. Cavanaugh said that operating under the terms of the bill while

Figure 15: Yale Daily News, with search term and selected article highlighted

Appendix A: Levels and Functions

Table 1: Levels of structural metadata and metadata required to implement user functions and administrator functions

LEVELS	METADATA REQUIRED	USER FUNCTIONS	ADMINISTRATOR FUNCTIONS
2-6	Pages converted to PDF or file sequence recorded as part of filename	Page-to-page navigation	
3-6	File sequence recorded as part of filename	Go-to-page navigation based on file sequence	
3-6	File properties (page number, file format, etc.) recorded as metadata	Go-to-page navigation based on page numbers	Ability to manage resources by file format
4-6	Logical components tagged and hierarchical relationships encoded in METS, EAD, etc. or in a relational database	Navigation of logical components using generic labels (e.g., Chapter 1)	
4-6	Labels entered manually or with varying degrees of automation (e.g., use bounding box to select text or to apply algorithm to OCR)	Navigation of logical components using labels extracted from text	Ability to extract and repurpose textual components
4-6	Item level description encoded in SMIL, METS, etc. or in a relational database	Ability to switch from an item view to an aggregate view	
6	Page coordinates for text (segmented by word, paragraph, etc.) and images encoded in METS/ALTO	Ability to search full text and have query terms highlighted in object with number of occurrences per object	Ability to extract and repurpose figures and segments of text (e.g., articles in a newspaper)

Appendix B: Environmental Scan

Table 2: Navigation and search functions supported in user interfaces for books and manuscripts hosted by other institutions

	INDIANA UNIVERSITY ⁹	HARVARD UNIVERSITY ¹⁰	CALIFORNIA DIGITAL LIBRARY ¹¹	GOOGLE ¹²
Page-to-page navigation	X	X		X
Go-to-page navigation based on file sequence	X	X		
Go-to-page navigation based on page numbers		X		X
Component-based navigation using generic labels	X	X	X	X
Component-based navigation using labels extracted from text	X	X	X	X
Ability to switch from an item view to an aggregate view		X	X	Not applicable
Query terms highlighted in search results		X	X	X
Number of occurrences of query term per object		No, but search results are ranked by relevance.	X	X

⁹ <http://metsnavigator.sourceforge.net/index.shtml>

¹⁰ <http://hul.harvard.edu/ois/systems/drs/delivery.html>

¹¹ <http://www.cdlib.org/inside/diglib/repository/>

¹² <http://books.google.com/>

Appendix C: Metadata Schemas

Table 3: A comparison of encoding options for structural metadata

	TEI ¹³	DOCBOOK ¹⁴	METS ¹⁵	FOXML ^{16, 17}	OAI-ORE ¹⁸	MPEG-21 DIDL ¹⁹	SMIL ²⁰
What does it model?	document	document	digital objects	digital objects	digital objects	multimedia	multimedia
What type of content was it developed for or is it primarily used for?	humanities, social sciences, linguistics	technical documentation	digital library resources	digital repository objects	Web resources	audio, video	synchronized audio, video, images, or text
What type of structure is it used to represent? What are its strengths?	used to annotate text and to mark up document structure for textual analysis	captures logical structure of content in a presentation-neutral form for publication in a variety of formats	packages digital objects with associated metadata for end-user access and resource management; metadata/library-centric	similar to METS but allows for audit tracking; less explicit about metadata; repository-centric	permits reuse of existing objects and third party aggregation for syndication and publication on Web; emphasis on Web addressability; Web-centric	container-item structure with anchors and fragments for referring to points in stream; also has descriptors for metadata	markup for timing, layout, animations, visual transitions, and media embedding

¹³ <http://www.tei-c.org/>

¹⁴ <http://www.docbook.org/>

¹⁵ <http://www.loc.gov/standards/mets/>

¹⁶ <http://www.fedora-commons.org/documentation/2.2.2/userdocs/digitalobjects/introFOXML.html>

¹⁷ The Fedora Content Model Architecture for Fedora 3.0 introduces significant changes, which are not accounted for here. For additional information, see <http://www.fedora-commons.org/documentation/3.0b1/userdocs/digitalobjects/cmda.html>

¹⁸ <http://www.openarchives.org/ore/>

¹⁹ <http://www.chiariglione.org/mpeg/>

²⁰ <http://www.w3.org/AudioVideo/>

Who developed it?	Text Encoding Initiative Consortium (TEI-C)	Organization for the Advancement of Structured Information Standards (OASIS)	developed by the Digital Library Federation (DLF); maintained by Library of Congress (LC)	Flexible Extensible Digital Object Repository Architecture (Fedora) Commons	Open Archives Initiative (OAI)	Moving Picture Experts Group (MPEG)	World Wide Web Consortium (W3C)
How long has the community or standard been around?	TEI-C since 1987; P1 released in 1990	1991	1.1 alpha released in 2001	Fedora since 1999; FOXML released with Fedora 2.0 (2005-01)	OAI since 2001; 2 year Mellon grant for OAI-ORE awarded 2006-10	MPEG since 1988; MPEG-21 DIDL released as part of ISO/IEC 21000-2:2003 in 2003	W3C since 1994; 1.0 (1998-01)
What is the current version?	P5 (2007-11)	V4.5 (2006-10); V5.0 (under development)	1.7 (2007-10)	1.0 (2005-01)	1.0 (scheduled for 2008-09); now in beta	ISO/IEC 21000-2:2005	2.1 (2005-12); 3.0 (2008-01 W3C candidate recommendation)
How active is the user community as measured by # of messages on discussion lists from 2008-01-01 to 2008-04-15?	471 on TEI-L	132 on docbook; 599 on docbook-apps	37 on METS Listserv	36 mention FOXML of 280 total on fedora-commons-users; 29 mention FOXML of 176 total on fedora-commons-developers	116 on OAI-ORE Google group	no sponsored list	53 on www-smil@w3.org