

**Optimizing the User Experience
in a Rapid Development Framework**

FINAL PROJECT REPORT

APPLICATION DEVELOPMENT MODEL for a DIGITAL LIBRARY:

Redesigning the Portal to Texas HistorySM

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Introduction

The University of North Texas (UNT) received a National Leadership Grant from the Institute of Museum and Library Services for a two-year study to redesign the interface to the Portal to Texas HistorySM, a digital library program at the UNT Libraries. In collaboration with over 100 content partners, the Portal is a gateway to humanities collections from Texas libraries, museums, archives, historical societies, and private collections. The Portal contains primary source materials, including maps, books, manuscripts, diaries, photographs, and letters, that are of interest to the users who participated in this project: genealogists and family history researchers.

Since its initial release in 2004, the user interface to the Portal had become dated and constraints in the underlying technical infrastructure of the digital library impeded implementation of new functionality. Additionally, the number of unique visitors to the Portal had grown from 1,000 per month in 2004 to over 20,000 per month by 2008. This welcome growth was accompanied by operational and management challenges, which impacted the Portal's many content partners, users, and other stakeholders.

This research project created a working model for application development within the UNT Digital Library. The process employed user centered design methods within a rapid development framework, which was implemented in conjunction with this project. Throughout the project, genealogical researchers were insinuated into the process, beginning with an assessment of their requirements and concluding with their participation in usability testing. The project was guided by the working model, which initially involved three teams within the Information Technology Services department at the UNT Libraries: developers and programmers, user interface designers, and user study researchers.

The Portal's newly minted interface and infrastructure were debuted in two public releases: Release 1 in June of 2009 and Release 2 in October of 2009. Project team members participated in a post-project review of the overall process and working model. From this review, a revised process model was created.

This report opens with background information for the project, describes the project's methods and working model, guides the reader through the project's three phases and associated feedback from the review process, and presents the revised model for application development. The report closes with measures of the project's success as well as reflections on the experience gained and its value for future digital library application development projects.¹

¹ The final reports of findings from the project's major research activities are available on the project website: http://iogene.library.unt.edu/?page_id=87

Background

Genealogists

Most user research focusing on the design of digital libraries for the humanities examines two user audiences: academic use by scholars, faculty and students; or K-12 use by teachers and students. One large segment of avid digital library users has been largely unexamined – genealogists. Genealogy has emerged as one of the most popular forms of life-long learning, yet almost no research explores genealogists’ information seeking behavior and how it might inform the design of digital library interfaces for humanities collections. The significance of this user group, and the fact that it is poised to grow considerably in the future, motivated the selection of genealogists as a focus for this research project.

As part of an online user satisfaction survey administered during the project, demographic data was collected to characterize Portal visitors and distinguish genealogists, as a group, from other visitors. The survey was administered at three points in the project (Table 1). Initial baseline responses ($n=318$) were collected prior to the first release of the redesigned Portal interface. The survey was repeated following each of the two public releases of the redesigned interface, in the summer of 2009 ($n=157$) and in the fall/winter of 2009 ($n=143$).

Survey Period	Dates	#	%
Baseline	September 26, 2008 - June 16, 2009	318	51.5
Release 1	June 29, 2009 - October 18, 2009	157	25.4
Release 2	October 19, 2009 - January 15, 2010	143	23.1
	Total	618	100.0

Table 1. Responses by Survey Period

Seventy-six percent ($n=467$) of respondents were 50 years of age and older, with half (50%) reporting their ages as 60 years and older. There were more female ($n=355$; 57%) than male ($n=263$; 43%) respondents. Most ($n=473$; 76%) have been using the Web for seven or more years and 84% ($n=517$) have a high speed Web connection (versus a dialup or satellite connection). Almost half (48%) of the respondents completed the survey on their first visit to the Portal, while 33% indicated they visited either “daily”, “weekly”, or “monthly”.

Comparing genealogists to all other respondents, as separate group of ‘non-genealogists’, significant associations distinguished the genealogists in regard to their gender, their ages, and how long they have used the Web (Table 2).

Characteristic	N	df	Actual χ^2	Critical χ^2
Age	618	6	51.990 *	22.458
Gender	618	1	17.786 *	10.828
Years of Web use	618	3	11.264 **	9.348

* $p < .001$; ** $p < .025$

Table 2. Significant Characteristics of Genealogists

Respondents who self-identified as “Genealogists/Family History Researchers” included a significantly higher percentage of females ($n=172$; 68%) and persons over the age of 60 ($n=158$; 62%) (Table 3). Likewise, a significantly higher percentage of genealogists ($n=211$; 83%) have been using the Web for seven or more years.

Characteristic	Genealogists	Other Respondents	All Respondents
Female	68%	50%	57%
Over age 60	62%	41%	50%
7+ years of Web use	83%	72%	76%

Table 3. Characteristics of Genealogists versus Other Survey Respondents

While survey respondents were self-selected volunteers and interpretation of the demographic findings are subject to that bias, it was noteworthy from a design perspective that the Portal’s user community appears to be generally an older female group who have used the Web for several years. These characteristics were even more pronounced among the genealogists who responded to the survey.

Rapid Development Framework

A rapid development framework is configured using easily interchangeable and robust modules, components, and tools, which are both highly cohesive and loosely coupled. This is sometimes referred to as shared nothing architecture. In building the framework, deliberate attention is paid to selecting components that are supported by active user communities and audited by a large base of users. Conversely, components and tools that are developed for a niche community are avoided. Components at each level within the framework are also highly scalable, which allows for distribution of costs across the framework.

Rapid application development strives to design and deliver applications within a relatively short timeframe (e.g., 30-90 days). Sometimes called agile development, the goal is to compress development into as few phases as possible, resulting in a more user-responsive development framework that can implement applications and enhancements in a timely manner. Solutions strive to be simple and straightforward as well as portable and standards-based.

To achieve this goal, functional requirements are first identified and generally remain unchanged during the application development process. Subsequent to the identification of functional requirements, developers use prototyping tools to create functional designs, which are revised in response to user feedback in an iterative process that continues until a final prototype is designed. Development of the fully functioning application then occurs. Testing is generally done concurrently with development, once again shortening the development interval.

The goals and tools of rapid application development informed the model that guided the design and development work in this project. At the outset of the project, the UNT Libraries’ legacy digital library system was replaced by a rapid development framework. The framework enabled separation of the design and development functions related to the digital library’s backend system infrastructure from those functions related to the library’s user interface. This allowed the project to include the unique expertise of the Libraries’ user interface designers in the redesign of the interface to the Portal to Texas HistorySM.

Digital Asset Management Systems

Digital library collections of humanities materials, such as those comprising the Portal to Texas HistorySM, include a range of digital resources or assets, such as photographs, maps, diaries, newspapers, and books. The digital asset management systems (DAMS) commonly implemented for these types of digital library collections have historically offered little user interface design flexibility to developers. Rather, DAMS have concentrated on providing tools and workflows to assist providers and creators of digital assets, with an added focus on description of the digital assets in a system. There is much anecdotal evidence that attests to the difficulties that user interface developers have in changing the user experience of most DAMS.

Developing the Portal’s new user interface in a rapid development framework made it feasible to include innovations that would never be possible in traditional DAMS. This project’s interface design work with genealogists was an important step in the UNT Libraries’ realization of the possibilities for customizing the user experience within its overall Digital Library System.

User Centered Design

The project involved genealogists in the application development process beginning with an analysis of their needs and continuing through usability testing of the two public releases of the redesigned Portal interface. The process was informed by user centered design methods. The five phases of user centered design are depicted in Figure 1, which is followed by a list of activities commonly undertaken in each phase.

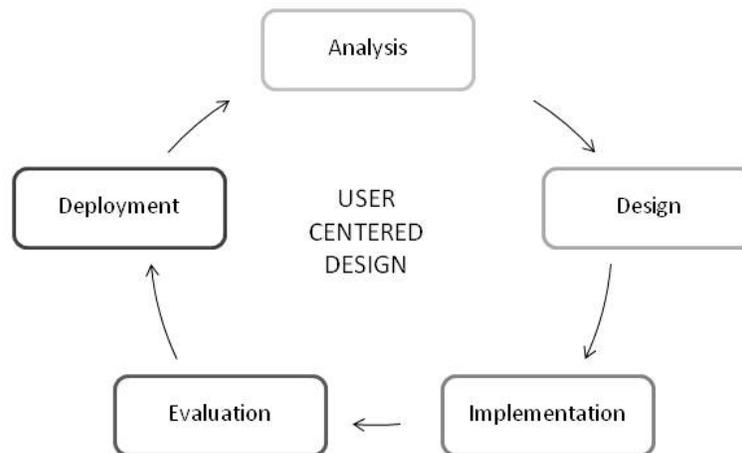


Figure 1. User Centered Design Model

Analysis

- Specify the context of use: Users and their information problems
- Conduct needs analysis to identify user requirements
- Specify requirements: functional, technical, and business-related

Design

- Create technical designs

- Create conceptual designs

Implementation

- Write code
- Produce product, e.g., alpha and beta versions

Evaluation

- Conduct quality assurance tests
- Conduct usability tests with users

Deployment

- Launch product
- Maintain product

Methods

Research Questions

The project investigated three research questions:

1. What are the information needs of genealogists as they interact with the Portal to Texas HistorySM?
2. What are the preferences of genealogists interacting with the Portal to Texas HistorySM in each of the following information seeking areas: (a) searching, (b) browsing, (c) presentation of search results, and (d) access to content?
3. What are the benefits of implementing an iterative user-centered design approach for interface development that takes advantage of an open-source rapid development framework?

Project Objectives

The first two research questions were related to the first project objective:

- Identification of the information context and information needs of genealogists interacting with the Portal to Texas HistorySM.

This objective was met, and the related research questions were answered, in the July 2008 project report entitled *Functional Requirements for the Portal to Texas HistorySM*.² This report includes the results of the needs assessment with genealogists. It describes genealogists' research process and identifies their requirements and preferences relative to the Portal. The functional requirements provided a foundation for the project's subsequent development and design work.

The third research question is answered in this report. The question relates to the three project objectives listed below:

- Implementation of an iterative user-centered design process to create a user interface to the Portal to Texas HistorySM optimized for genealogists.
- Implementation of a rapid development framework within the Digital Projects Unit of the University of North Texas Libraries, where development and design support for the Portal to Texas HistorySM reside.
- Creation of a model for the application of an iterative user-centered design process that digital libraries composed of humanities collections can implement to improve the usability and effectiveness of their libraries for targeted user groups.

To achieve the project's objectives and answer the research questions, three discrete work areas were identified:

1. Implementation of an open-source rapid development framework
2. Identification of the information needs of genealogists who utilize the Portal to Texas HistorySM
3. Design, development, and usability testing of prototype user interfaces to the Portal

² Available at: http://iogene.library.unt.edu/?page_id=87

Application Development Model: Draft

At the outset of the project, a working process model was developed to guide the work (Figure 2). Consistent with user-centered design, the three major phases of work included: Requirements Definition, Application Development, and Usability Testing. At the conclusion of the project, the process model was reviewed by the project staff and was revised to accommodate the lessons learned over the course of the project.

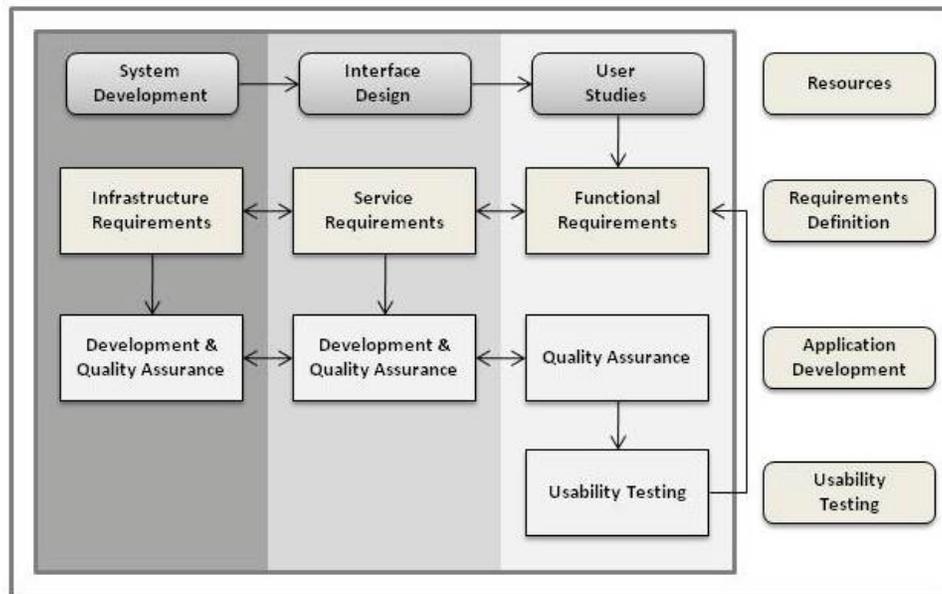


Figure 2. Draft Application Development Model

Resources

Initially, the project’s Resources included three teams: System Development, Interface Design, and User Studies. Resources for each team included team members as well as the hardware infrastructure and software tools supporting their work. The model identified the three project phases and suggested the interactions and the handoff points among the teams.

Requirements Definition

System development and interface design teams generated questions, ideas, and prototypes regarding possible features and functional enhancements to the existing Portal. The user studies team used these to develop protocols for focus group discussions with members of genealogical societies. The findings from these discussions, as well as an analysis of the Portal’s log of user-submitted comments and results from initial usability test, informed the functional requirements drafted by the user studies team. These requirements were refined by members of the three teams and classified into implementation phases or releases. Service requirements and infrastructure requirements were also identified to support the functional requirements. Additionally, infrastructure and application development requirements were identified by the system development and interface design teams.

Application Development

The system development team designed and implemented the necessary hardware and software infrastructure to create the rapid development framework. This team created specifications for the framework's overall architecture, components, tools, and workflows. Likewise, system developers developed required application specifications and code. The system development and interface design teams created and refined workflows to support their separate but inter-dependent design and development work. These two teams also performed internal quality assurance tests. The user studies team conducted quality assurance tests of completed software releases with individuals external to the design and development teams. The system development and interface design teams used the test findings to refine each release prior to its public launch.

Usability Testing

Subsequent to the public launch of each release, the user studies team conducted usability tests with members of genealogical societies. The arrow from *Usability Testing* to *Functional Requirements* in Figure 2 indicates a key feedback loop in the work, that is, usability test findings became input for future functional requirements.

Phase 1. Requirements Definition

1.1 User Studies

The needs assessment with genealogists included three separate activities: focus group discussions, comment log analysis, and initial usability testing. During February and March of 2008, three focus group discussions were held. In all, 19 persons participated from two northeast Texas genealogical societies. Participants were primarily females (84%; $n=16$) and all were over age 50. On average, participants had been doing genealogical research for 21 years. Additionally, 425 user comments submitted by Portal visitors between October 13, 2005 and January 8, 2008 were content analyzed. Finally, genealogists participated in usability tests of the existing Portal.

Analysis of the data collected resulted in a description of the genealogists' research context and in a set of functional requirements for the Portal's user interface. The requirements were categorized into existing or new functions (Appendix A). The functional requirements provided a foundation for the redesign of the interface to the Portal to Texas HistorySM. The requirements were classified by members of the three project teams into one of four development priorities:

1. Release 1
2. Release 2
3. Consider for Future Releases (2010 and beyond)
4. No Development Planned

Functional requirements for release 2 of the Portal were revised in June 2009. The major modification resulted from a decision to defer development of a shared commenting feature, which required development of a registration capability that was beyond the development resources available for Release 2.

Process Review

Stakeholder Involvement

Stakeholders, both within and without the Libraries, need to be represented and/or included in the requirements review and in establishing development priorities.

- Portal Partners. Features that relate to partners need to have their input either directly or via the program manager(s). Their requirements are critical to design and implementation. Examples in this project include:
 - Citations
 - The format included as a temporary measure in Release 1 did not include partner names, which was a critical omission for some partners.
 - Copyright and Creative Commons
 - Existing partner agreements were not consistent with some Creative Commons' licensure and use terms
- Portal to Texas History Program Managers. They need to be overtly included as project team resources. They are the liaisons representing the interests and needs of the Portals' content partners and funding agencies to the UNT Libraries as well as representing the Libraries' to partners and agencies. Their responsibilities include:

- External stakeholder relations
- Portal marketing and promotions
- Partner Agreements
- Educators' resources: content and evaluation
- Portal Newsletter
- Responses to user-submitted comments
- Departments within the Libraries. They need to be informed of changes that might impact their operations. Getting them involved early on, primarily in terms of communicating with them, would lessen any impacts from changes.

Workflow for Requirements Review

Need to implement a formal review process for draft functional requirements.

- Need to have program management involved
- There was redundancy in the requirements that could have been identified; some requirements could have been merged
- Some language was "abstract" and could have been clarified
- Documentation activities (i.e., content for *Help* and *About* areas; changes to metadata practices) could be assigned
- Did a better job clarifying requirements for Release 2

Scope of Requirements

Requirements come from many sources other than users. Including them should help improve resource estimates and workflows. A few areas to consider include:

- Administration
- Policies & Practices
- Technology & Infrastructure
 - Implementing the rapid development framework was one of three work areas in this project
 - System development was one of the three project teams in the model

Functional Requirements

User needs should be stated as general cases in requirements documents.

- Too much design specificity in requirements is not helpful, for example:
 - Include print icon on search results pages
 - Allow access to both brief record and full records
- It might be useful to establish broad classes of users, for example:
 - Novice
 - Advanced

1.2 Interface Design

Five design possibilities for the Portal's user interface were created. These incorporated web 2.0 features, such as commenting and tagging, and were used in the focus group discussions. Additionally, a survey regarding design characteristics and preferences was completed by members of the Digital Projects Unit staff (Appendix B). Further discussion was conducted on the project's management site.

The results were used to guide a group discussion among these internal stakeholders regarding priorities for the Portal's redesign in three areas:

1. Overall design
2. Functionality
3. Information architecture/content

Process Review

Prototyping of Requirements

Clarification of user requirements might be better achieved with more user involvement in prototyping efforts. This might include:

1. User needs assessment, that informs →
2. General functional requirements, that inform →
3. Mock-up of user workflow (paper-based or online), that would be used in →
4. Usability Testing with end users, the findings of which would result in →
5. Final design requirements

Impact of Technology Changes

Technology changes over the lifetime of a project, from proposal through development. This particularly impacts user interface design.

- The further up the technology infrastructure chain, the more frequently changes occur
 - The web framework (CSS) changed 3 times over the course of the project
 - Longer term projects would likely incur more changes
- Web interface design often emulates technology leaders (like Google)
 - Likewise, users adopt new habits, expectations, etc. by interacting with leading websites (like Google)
- Web 2.0 features were initially envisioned but were not implemented
 - Commenting on objects is a feature genealogists desire but time and resources were not available to develop this feature
 - Tagging photos only became readily available for adoption in last year, which was too late into the project life cycle

1.3 System Development

Although not all the configuration details were specified, the infrastructure requirements for the rapid development framework were largely known entities that had to be implemented at project start-up in order to address issues and constraints inherent in the legacy asset management system. Specifications for major system components were written and prototype implementations of key software modules were completed. This prototyping enabled testing of the technologies and standards being considered for final implementation.

Diagrams depicting the rapid development framework were created. The system diagram identified the core components in the rapid development framework (Figure C1). Applications and system component

interfaces were depicted in a second diagram (Figure C2). The tools³ comprising the development framework included:

- Apache <http://www.apache.org/>
- Django <http://djangoprojects.com/>
- jquery <http://jquery.com/>
- memcached <http://www.danga.com/memcached/>
- mod_python <http://www.modpython.org/>
- MySQL <http://www.mysql.com/>
- PerlBal <http://www.danga.com/perlbal/>
- Python <http://www.python.org/>
- Solr <http://lucene.apache.org/solr/>
- SVN <http://subversion.apache.org/>
- Trac <http://trac.edgewall.org/>
- Ubuntu <http://www.ubuntu.com/>

Process Review

Estimating Time and Resources

Ensure that adequate resources, in terms of people and time, for infrastructure work upon which a project is dependent, are identified.

- The magnitude of the framework implementation challenges were not adequately estimated
- The amount of time and resources required were not adequately estimated

Framework Implementation Challenges

The framework needed to be in place prior to beginning development of the user interface or addressing users' requirements in this project. From a system perspective, roughly half of the project involved implementing the system framework.

- Creating and implementing new backend workflows for moving digital objects in and out of the system took a great deal more time than anticipated
 - Creating new workflows
 - Defining the digital object entity
 - Defining objects in a consistent manner
 - Writing conversion code
 - Moving the objects
- New content could not be uploaded to the system for a period of time (roughly between June and September 2009); with better estimation of time and resources, stakeholder and partner expectations could have been appropriately established
- It is important to anticipate and plan for technology changes in infrastructure components
 - Operating system modifications and upgrades
 - Component upgrades
- *Edit* application

³ URLs for all tools accessed February 23, 2010.

- If there had been additional resources to develop this in parallel with other essential infrastructure work , there would not have been a suspension in Portal partners' ability to edit metadata

Framework Benefits

- Existing system constraints:
 - Development was protracted and time-consuming
 - Solutions did not scale easily
- Benefits of new framework:
 - XSLT implementation enabled a more streamlined development environment, faster and more scalable
 - Components, such as Django , allowed for development of reusable applications
 - Enabled separation of user interface design and development from the backend system

Resources

An additional team was needed to create and maintain the online documentation accessible from the Portal interface.

- Educational Information
 - Help Guides
 - FAQs
 - Glossary
- General Information about the Portal
 - Partners
 - Collections
 - Contact information
 - How to contribute
 - Best practices

Future Direction for Digital Library at the University

The system framework included requirements that went beyond the needs of the project, per se, and anticipated the long-term needs of the overall Digital Library system at the UNT Libraries.

- Authentication
 - Requirements for this function needed to be accounted for in the system architecture
- Branding
 - A placeholder specification in the system architecture was needed for this future feature
- Benefit
 - Since the infrastructure is now in place for the Digital Library, the effort required on projects that utilize this infrastructure should be easier to estimate with more accuracy

Phase 2. Application Development

2.1. User Studies

Citation Format

A citation format for objects in the Portal to Texas HistorySM was created. The format was informed by both the Chicago Manual of Style and *Evidence Explained* by Elizabeth Shown Mills. The latter is a citation guide for materials used as evidence in genealogical research. This format was implemented in Release 2 of the redesigned Portal.

Quality Assurance (QA) Testing

Subsequent to completion of a Release 1 beta system, a structured Quality Assurance (QA) test was completed primarily by members of the Information Technology Services (ITS) staff within the University Libraries. Test feedback and results informed a set of design and development tasks that resulted in a revised beta site for Release 1.

A second round of structured QA testing for Release 1, that included not only ITS staff but practicing genealogists, was completed in June 2009. Once again, test feedback informed a set of design and development tasks that were completed subsequent to the public launch of Release 1. Testers reported an overall success rating of 84% for the 46 tasks in the first QA test, and 90% success for the 37 tasks in the second QA test.

Prior to the public launch of Release 2, QA testing was again conducted with 22 ITS staff members and workers in the Digital Projects Unit at the UNT Libraries. Overall, testers successfully completed all of the tasks. With the exception of task 16⁴, 73% or more of the testers indicated they successfully completed each task, although some noted issues and problems with some tasks. As before, test feedback informed design changes for the beta system.

User Satisfaction Survey

An online user satisfaction survey was created. It was administered at three intervals during the project. Initial baseline survey responses ($n=318$) were collected prior to the first release of the redesigned Portal interface. The survey was repeated following each of the two releases of the redesigned Portal, one in the summer of 2009 ($n=157$) and the second in the fall of 2009 ($n=143$).

Process Review

Quality Assurance Testing

Quality assurance testing with users prior to public release is one activity that will be incorporated into the workflow for future application development as a result of this project. The testing was both very valuable and affordable.

⁴ Task 16: Execute a Basic Search, *limited to Newspapers* and using any keyword or phrase. Select an item from the results and view a page of the newspaper using the 'Zoom' feature. Navigate and zoom to display a specific portion of the page image and then print it. Confirm that you are able to print exactly what was displayed as a result of zooming.

- Both user interface and system development teams found the test results valuable
- Users bring issues to light that internal tests would not uncover:
 - Developers tend to have a set of searches they use to test; a wider pool of testers will use different queries and therefore uncover problems
 - There are testing limitations in Django and Python, for example, character problems, such as problems with diacritics or ampersands, are not uncovered
- In the interest of time, first round QA testing was conducted on a beta Release 1 system populated with a very limited number of objects
 - This made the results fairly useless; will not repeat this experience
- Could have included Portal partners in this activity; perhaps would have uncovered some problems that others did not see, for example, omission of partners' names in the citation format presented in Release 1
- Benefits of Participation
 - Student testers felt a part of the group; sent a message that their opinion mattered
 - For future releases of the Portal interface and for the Digital Library interface, partners and library stakeholder groups can be included in the QA; hopefully inclusion will foster a sense of the system as "theirs"

2.2. Interface Design

Initial Design

Paper prototypes of navigation structure (Figure D1) and page content layout (Figure D2) for the redesigned Portal were developed. The design and development of these paper prototypes were based on the initial usability testing results, an evaluation of the content structure of current Portal to Texas HistorySM site, and the functional requirements. As the next step, an HTML-based online mockup was created. The purpose of this mockup was to visualize all interface related requirements and to expose potential user-interface related issues. Various storyline walkthroughs and revisions were conducted.

Design and Development of Core Features

In preparation for implementation, object metadata pages and navigation pages were reviewed using the html mockups. These pages were informed by complex requirements and were an integral part of the display of every digital object in the Portal. Hence, great care was taken to ensure that the features to be implemented would serve users' needs.

User Documentation

A new team was created to develop all informational and help-related content for the redesigned Portal. Relying on both the functional requirements developed earlier in the project as well as experience with users over the last four years, the team outlined the content areas, reviewed existing content, and began creation of new content. User guides were created for each of the major functional areas of the Portal. Additionally, specific guides for educational materials and genealogical materials were created.

Implementation of Interface

Interface designs for the new Portal were implemented for the following template sets:

- Portal Home
- Basic Search
- Advance Search

- Search results
- About the Object
- View/Read the Object
- Explore by Collection
- Explore by Partner
- Explore by Location
- Explore by Subject
- Explore by Date
- Explore by Type
- Help/FAQ/Guide
- About

Quality Assurance (QA) Testing

QA testing identified areas for revisions to the interface. With the objective of optimizing information display and improving user experience, various solutions were considered, tested, and implemented. Some of the key improvements added to the interface included:

- Item citations added to the print format of brief records to promote one-stop printing
- Increased font size and design contrast for page turners on search results pages to improve readability
- A scope display for searches on the results pages of *Explore* options to eliminate confusion
- A more detailed table of contents in the Help Guide sidebars for easier exploration
- Tabs for *About the Collection*, *About the Partner*, *About the Object*, and *Read/View the Object* to improve sub-level content display and navigation

Usability Testing

Usability testing of Release 1 of the Portal interface identified areas for revisions to the interface, primarily in regard to secondary navigation features. Different design changes were considered and mockups were developed to feedback was solicited from the project team. Once consensus on the design direction was achieved, the changes were implemented, tested, and included in Release 2. Various other modifications to the interface were also included in Release 2, including:

- Link to the homepage
- Page navigation placed closer to object pages
- A scope display for searches on book object pages

Release 2 Implementation

Two major features were included in Release 2. Search results pages included a number of facets for limiting search results. Optional designs for the display of facets were investigated and tested. A feature for returning to search results was added to object pages that resulted from Portal searches.

Process Review

Design Strategies

- Given finite resources, it is prudent for a development organization to follow the design leadership of leading enterprises like Google, which invest heavily in usability testing; following their leadership, in terms of features and design, effectively leverages their investment in testing
- Templates worked well
- De-coupling of interface design and development from the underlying system is a key to easily making changes, including upgrades
 - For example, templates could be changed independently as needed without impact to the underlying system, and vice versa

Internal QA Process: User Interface Design & Development

1. Stakeholders/users review the proposed design for the user interface
2. Design is revised and stakeholders approve the design
3. A “live” storyboard of the interface, not connected to any backend system or data, is created
4. QA tests are conducted when the backend is available and the actual data “populates” the design; many problems are uncovered by testing typical user workflows

QA with Users

- There is value in this; developers do not generally catch all the problems and issues
- Making changes is “tricky”; one change may impact other aspects of the display, causing other problems and issues, for example:
 - If the size of a font is changed, other elements on the screen might be affected and some unforeseen problems can occur

User Documentation - Help Guides

- A team of people working on the help guides did not work well
 - Different approaches were taken
 - Different writing styles were used
 - Better to designate one person for this activity
- Help guides could not be fully developed until the system was complete
 - The workflow needs to include a documentation activity prior to the public launch of a new release
- Portal users seldom access the help guides, but they are helpful reference tools for Portal support staff who can refer a users to the guides

2.3 System Development

TKL2METS Conversion Script

Development and implementation of the conversion script to change the current Portal content model (TKL) to the METS model used in the rapid development framework was completed. The conversion

script was responsible for migrating from the legacy format in the TKL systems to the new METS format used by the Aubrey system. It was further refined during trial runs of the data migration activities.

Static and Metadata Servers

Servers were configured for static media (image files, ocr text, bounding box information) and metadata (mets, dc, untl). The Pairtrees for Object Storage are used for storing digital objects on the file system. Initial conversion of Portal content was completed for use in the prototype of the rapid development framework. Full data migration from the legacy system to the new system was executed during the third week of June 2009. For the actual migration, smaller data sets than those used in test operations were converted in order to further ensure a successful, error-free migration of the entire data set.

ARK Application Modification to Support Pairtree

Modifications were made to the ARK application to support the newly implemented Pairtree directory structure.

Development Environment for Project

The development environment was defined for multiple developers, each working in different areas of the project. Pieces in this development environment were put into service as needed for the project.

Branding Application Specification

The branding application was defined and implemented for use in the rapid development framework.

Solr Environment

New document scheme for Solr documents representing a digital object were specified, reviewed, and implemented:

- Solr document structure for digital object
- Digital Object URL mapping

IREX code Migration to METS/UNTL Model and Pairtree

Design specification for conversion of the current IREX indexer to a new version which supports METS and the new UNTL metadata model was completed and implemented.

Edit Application Development

An "Edit" application was written to facilitate modification of records in the new system.

Content Ingest Tools

Created and tested three tools: SIPmaker, AIPmaker, and ACPmaker. These tools enable new content additions to the system.

Production Infrastructure

Production infrastructure was deployed for the migration and public debut of Release 1 of the new Portal. This infrastructure meets current needs and provides capacity for growth both in terms of throughput and content.

Public Release of the New Portal to Texas History

From a user perspective the migration was seamless; user requests were automatically forwarded from the legacy system to the new system's URLs. Log files were monitored and additional redirect rules

were added as needed. Google Analytics was switched to the new system from the old system for continued data collection. Google, Bing, and Yahoo began including links from the new system within 24 hours of the switch to the new URL structure. Public availability occurred in two releases:

- Release 1 on June 28, 2009
- Release 2 on October 18, 2009

Process Review

Management of Development

- Subversion system worked well in terms of:
 - Provided a running log of all changes
 - Tickets assignments for development and refinement
- Shared modules can be problematic:
 - With 3 developers: need to understand who has access and needs to know changes
 - With more developers, workflows and additional rules would need to be enforced; could have more 'committers' for control
 - Better documentation would help; designer has no access to Subversion

Internal Quality Assurance Testing: System Development

- Challenges were inherent in keeping the testing framework up to date with a rapidly changing code base and with more than one programmer changing the same code base
- Unit tests
 - Primarily done in the Django environment
 - Tests a small bit of code to check if the code returns the expected results
- Function tests
 - Used to test application code (e.g., the query parsing algorithm)
 - Needs an input, performs a function, and returns a response, which can be evaluated

Design and Development

- Programming Challenges
 - Integrating a second programmer into the Aubrey system was time-consuming
 - Adding two additional programmers to the Django framework was challenging
- Specialization by technology area allowed technical team members to develop an area of expertise at two levels. It would be great to maintain these expertise areas going forward
 - Interface design v. System design
 - Specific applications or technology areas within each of these
- Tools
 - For tools without adequate documentation (e.g., load-balancer tool), a wide base of users was helpful
 - An example of a necessary toolset with a small base of implementers was Lib-WARC (an IIPC tool)
 - It did not include a lot of tools for a standard file format
 - Forced to be an early adopter
- Two of the good technology decisions were made in this project:
 - Implementation of persistent identifiers
 - Consistent and proper use of metatags

Estimating Effort and Forecasting Due Dates

In this project, the effort for many system development activities was underestimated and the expected completion dates were often moved out in time. In the future, we need to spend more time identifying the time and human effort involved to carry out project activities. With more experience in application development, we will get better at estimating.

- The amount of time it took to get the infrastructure in place pushed back the start time for getting the user interface development environment in place
- In order to establish the interface development environment, system developers delayed work on some other infrastructure components, (e.g., the *Edit* application)
- Could have waited until the *Edit* application was completed to launch Release 1
 - Would have avoided disrupting partners metadata editing
 - Release 1 would have been delayed another 3 months, which would have impacted other project activities and our ability to complete them in the project's timeframe
- Estimating human effort has to consider a number of variables (vacations, other project commitments, etc) and can be very detailed (in terms of the actual work activities involved)
- Some of the development tools were new to the staff, like Django and Subversion
 - Implications on the "backend" of the system were not known
 - Learning curves were longer than expected

Communications with Partners and Other Stakeholders

- Service interruptions may happen with any major technology implementation or change, such as the redesign of the Digital Library's infrastructure; however, advance notice to stakeholders should make those disruptions more acceptable
- Ongoing communications with partners and other stakeholders should routinely advise them of system upgrades, expected disruptions, and fairly accurate timeframe estimates
- Internal stakeholders, including program managers, need to be cognizant of system development plans and activities that may impact the external stakeholders with whom they interface

Phase 3. Usability Testing

Eighteen volunteers were recruited for usability testing by the project’s advisory board members from four North Texas Genealogical Societies. Usability tests were conducted at three periods over the course of the project (Table 4). The participants included 15 females (83%) and 3 males (17%), ranging from 31-80 years of age. Most participants (78%) were over age 50. Participants had been doing genealogical research an average of 19 years.

Test Period	Dates
Baseline (n=5)	March - April 2008
Release 1 (n=7)	August 2009
Release 2 (n=6)	November - December 2009

Table 4. Usability Test Periods

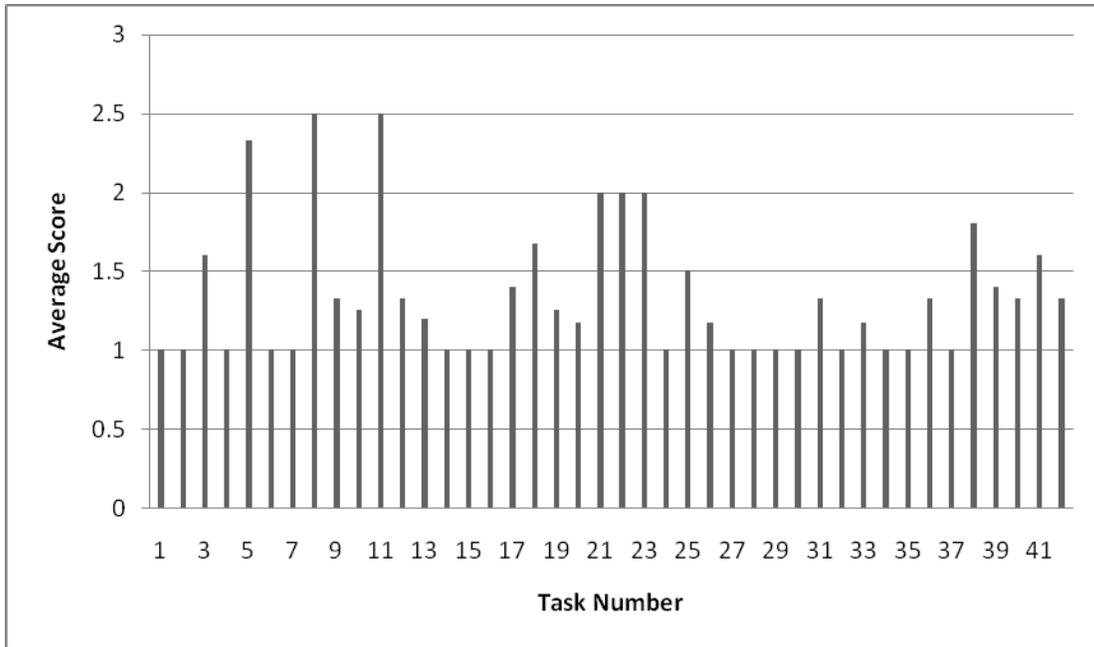
The findings of the baseline usability tests contributed to the initial functional requirements for the redesign work. Usability tests conducted subsequent to both Release 1 and Release 2 of the redesigned Portal interface used unique test scripts. For each release, the tests were targeted to evaluate specific features and functions of the user interface. There were 32 tasks included in the Release 1 script and 42 tasks included in the script for Release 2. The findings from Release 1 tests informed the design of Release 2. Likewise, the findings from Release 2 tests will inform subsequent enhancements to the Portal interface.

In the interest of communicating the findings in a timely and effective manner, the findings of the Release 1 tests were reported in a project team meeting and a number of short videos were produced to illustrate users’ behaviors. Project team members were able to access these videos as needed for their work. A summary report of all the usability testing is available on the project website⁵.

Two problem areas identified in Release 1 tests continued to be issues in Release 2 tests: Limiting searches to an object type (i.e., Books, Maps, Photos, or Newspapers) and locating secondary navigation features on the navigation bar.

As a measure of overall effectiveness after Release 2, a completion score was assigned to each task participants attempted. Figure 3 illustrates participants’ average completion scores for each of the 42 tasks.

⁵ Final Project Reports: http://iogene.library.unt.edu/?page_id=87



Average Score: 1=completed with ease; 2=completed with difficulty; 3=failed to complete

Figure 3. Average Completion Scores for Tasks

All participants completed 17 (40%) of the 42 tasks with ease. An additional 22 tasks were completed by most users, but some had difficulty doing so. The average completion scores for only three tasks were in the “failed to complete” range (i.e., average score greater than 2). These tasks were among those that tested users’ ability to locate secondary navigation features.

Process Review

Reports of Findings

- Need a written report of the findings that should:
 - List tasks
 - Identify task completion success ratings
 - Group problems by criticality
- Useful References
 - For referencing during development
 - For writing papers and reports at the end of a project
 - Valuable in writing future grants that build on this work
 - Good examples for future work with other user groups
- Proposed reporting and review process for future work:
 - Rate task completion
 - Create videos for tasks (all or just some that are problematic)
 - Team discussion of videos
 - More objective than writing up the problem
 - Team can identify if a problem is a technical or a design issue

Video Clip Illustrations

- Video works well to augment/supplement the written report; videos convey a sense of users' problems as you watch them try to complete a task
- Release 1 Videos presented some challenges
 - The lack of the users' context was good in providing anonymity but begged the question if a particular user was having problems in general with the system
 - If only one person reviews the tests and creates the videos, then interpretations are subject to this person's bias
 - Videos highlighted problems but did not assign a severity level to the illustrated problems (e.g., critical, moderate, mild), which would have been useful

Baseline Usability Test Findings

- Reinforced a lot of what was known by the project team; that was a good thing
- Was good for informing the requirements
- Were a few surprises that the team was not aware of

Secondary Navigation: Design Flaw v. Learning Curve

- We designed "against the grain" by putting secondary navigation across the top of the screen; violated our usual design policy of "following the leaders"
- However, once discovered, users generally located the secondary navigation features in subsequent tasks
- There is a learning curve with any new system

Application Development Model: Final

In light of what we learned during the project, it was valuable to revise the initial draft model for application development (Figure 2). Our internal process review clearly identified areas in need of refinement, as well as additional areas that were not included in the original mode. Perhaps most importantly, the revised model includes a fourth project team, program management, who represent content partners, external stakeholders, funding agencies, and a particular digital library program, such as the Portal to Texas HistorySM (Figure 4).

Program managers are aware of the needs of external stakeholders and end users. They communicate those needs and translate them into requirements for digital library operations and services. They are knowledgeable go-betweens among stakeholder groups, library administrators, funding agencies, and the digital library support staff.

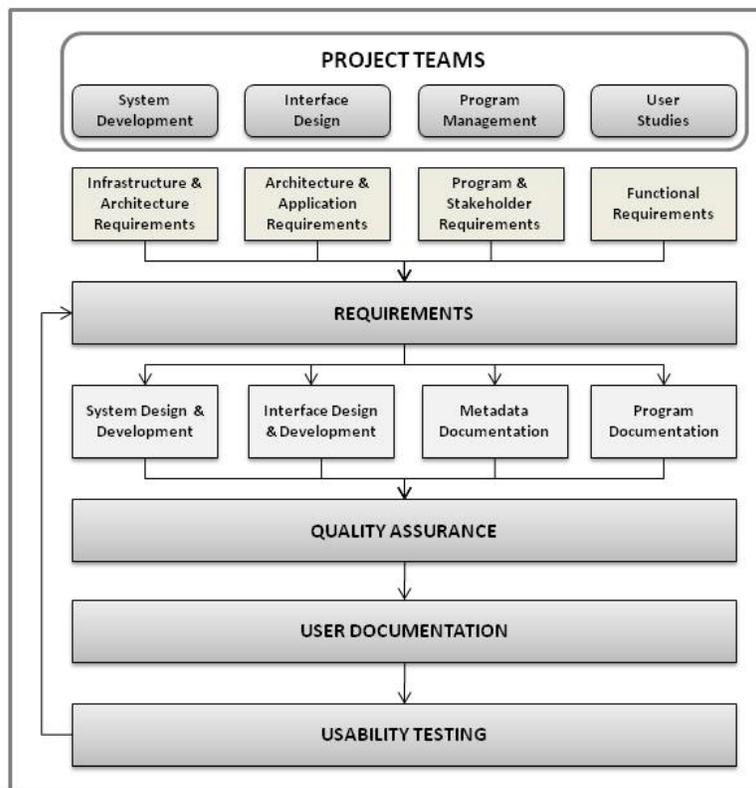


Figure 4. Process Model for Application Development

The new process model also makes explicit the activities of metadata documentation and program documentation in the application development process. Resources must be identified in the project planning process for these activities, which, in concert with design and development activities, implement requirements. Likewise, the creation of user documentation is now clearly situated in the model, occurring after quality assessment of an application is concluded and prior to usability testing with external users. This ensures that applications are deployed with documentation in place and that usability testing can encompass user documentation.

Closing

This project created a model for digital library application development informed by user-centered design methods and supported by a rapid development framework. Genealogists were involved in the design process beginning with an assessment of their information needs, which informed a set of functional requirements for the redesign of the interface to the Portal to Texas History, and continuing through usability testing of the redesigned Portal interface. Substantial amounts of time and effort were invested in the specification and implementation of components for a new rapid development framework, which provided several benefits to this project and to the overall Digital Library System at the UNT Libraries. Not least among the benefits that accrued to this project was the ability to leverage the expertise of the Libraries' user interface design team on the project's work.

We appreciate the uniqueness of the work we accomplished in this project, both in terms of the implementation of the rapid development framework and the inclusion of users in the application development process. In professional meetings and conferences, digital libraries often reflect their inability to involve users in their design and development work. Most digital libraries use groups of librarians to inform system design. Likewise, few data collection efforts involve users on the scale accomplished in this project. There are several reasons for this. Many libraries simply lack the resources to involve users. Others have neither the staff with requisite skills nor the necessary technical infrastructure. Many libraries have no programming staff at all, forcing them to choose digital asset management systems that constrain what can be modified in the user interface.

A key measure of the outcome of this project was user satisfaction with the resulting Portal to Texas HistorySM. An online survey questionnaire was created to measure this and was administered at three intervals during the project. Initial baseline survey responses ($N=318$) were collected prior to the first release of the redesigned Portal interface. The survey was repeated following each of the two releases of the redesigned Portal, one in the summer of 2009 ($N=157$) and the second in the fall of 2009 ($N=143$).

Overall, users were more satisfied with the Portal following Release 2. There was a statistically significant difference in user satisfaction between the baseline survey period, prior to the redesign of the Portal interface, and the Release 2 survey period, which followed the second release of the redesigned interface ($U = 19597.500$; $p=.017$).⁶ It seems reasonable to suggest that this significant result is the result of the redesign work accomplished in this project.

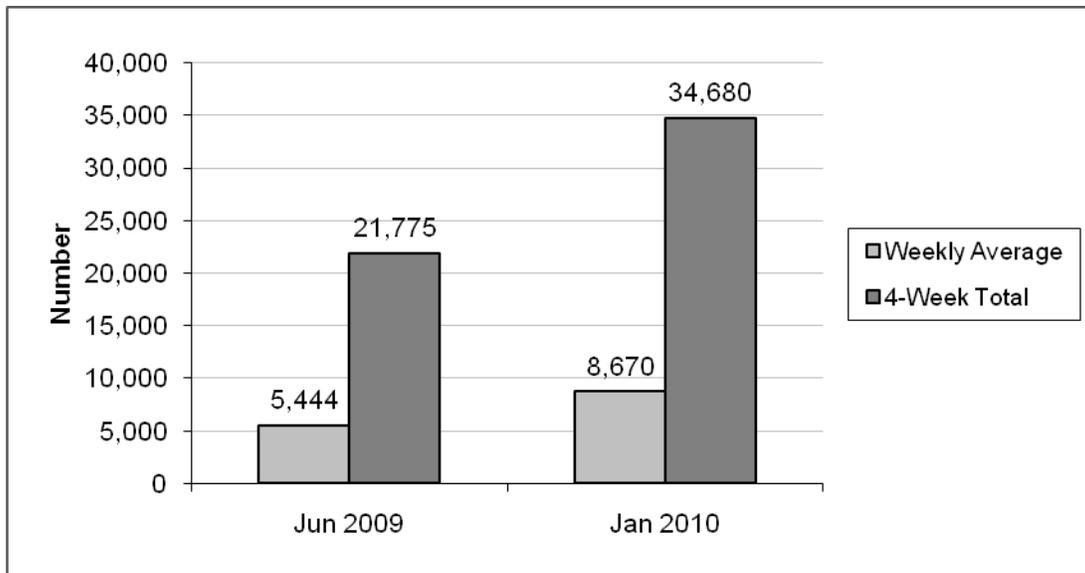
Informed by the success of our work, we advocate for the integration of user studies in digital library application development. As resources allow, we plan to involve end users in future digital library projects and to include external stakeholders in quality assurance testing prior to public releases.

We also plan to include program managers in the application development process. As our Digital Library System expands and becomes more integral to teaching and research at the university, discrete digital library programs, such as the Portal, will be identified. The need for management of these programs is clear so that the requirements of external stakeholders and end users inform application development, operational decisions, and strategic direction.

⁶ The summary report of the survey findings, *Evaluation of Project Outcome: User Satisfaction Report*, is available on the project website: http://iogene.library.unt.edu/?page_id=87

There is no question that we need to better estimate resources and completion dates. We have learned the importance of including estimates for the time and resources required for implementing backend infrastructure components. However, while we need to set goals and timeframes realistically, we should also be optimistic. Reflecting on the success of this project from a system development perspective, the constraints of the legacy digital library system have been alleviated with implementation of the rapid development framework, and the complementary specifications for digital objects as well as an underlying commitment to proven technology solutions and open source tools.

Indeed, a great amount of impressive work was done in this project and the Libraries’ Digital Library System is now positioned for growth, uniquely so among many institutions. The technical infrastructure implemented in conjunction with this project has proved robust at handling an ever-increasing numbers of visitors, as attested by the 59% increase in the number of Portal visits per month from June 2009 to January 2010 (Figure 5). The infrastructure handled this increase in visitors with ease and user satisfaction improved!



Data Source: Google Analytics

Figure 5. Portal Visits

As a result of this project and its application development model, project team members have solidified two shared values that bode well for future work: the importance of user studies and the inclusion of partners and external stakeholders. We suggest that the future success of our application development model at UNT Libraries and other institutions is predicated on those values as well as on organizational willingness to re-engineer existing processes, the championship of senior management within the digital library’s organization, and the allocation of adequate resources for infrastructure and technical staff.

Appendix A. Existing and New Functions

EXISTING FUNCTIONS

Search [SCH]

All users are allowed to search the contents of the Portal using both basic and advanced search features.

Basic Search [SCH-B]

Basic searches can currently be limited to fulltext, metadata, title, subject, and creator.

Advanced Search [SCH-A]

Advanced search options currently include Boolean operations (AND, OR, NOT) and exact phrases. Users can also specify an institution, a collection, a language, an object type, and a date range, as well as limit their search to source materials.

Browse [BRW]

All users are allowed to browse the contents of the Portal based on predefined categories that currently include: subject, collection, contributor, era, and county. Users can currently search Portal contents within two browse categories: collection and contributor.

Search Results [RST]

Search results can be displayed in either a list or grid format.

List View [RST-L]

Metadata displayed with objects in the list view includes: title, date, creator, and description. When date and creator are not specified in metadata records, the fields are left blank. Each object in search results include as a 'more info' link that displays a page containing: the descriptive metadata record, a clickable thumbnail of the object, an 'about the publisher' link, a 'comment on this entry' link that opens a form for users to enter and submit comments, and a Creative Commons license designation that links to an explanation of the appropriate license. Some objects in the search results also include a link, 'Hits in text', which displays a page containing just the pages in a multi-page object that contain hits.

Grid View [RST-G]

Metadata displayed with objects in the grid view includes: title, year, and creator. When date and creator are not specified in metadata records, the fields are not included in the display. Search results all include a 'more info' link that leads to the page described in the List View. 'Hits in text' are not indicated for objects in this view.

Metadata [MDT]

Descriptive metadata records for objects are based on the 15 Dublin core elements. The elements are: title, publisher name, place of publication, original creation date, coverage, description, physical description, language, subject(s), keyword(s), contributor (donor), institution, collection, identifier, resource type, format, and permalink. Some fields are optional and many fields are repeatable. At least one subject/keyword must come from the University of North Texas Libraries Browse Subject vocabulary.

Object Navigation [NAV]

The Portal is comprised of several object types including: maps, books, manuscripts, diaries, photographs, and letters. Most books, manuscripts, diaries, and letters are multi-page documents. In terms of navigational controls, object displays include:

- a title
- a 'view the description' link that displays the same page as the 'more info' link described in List View
- a 'view all pages' link that displays a thumbnail and associated sequence number for all pages contained in an object
- a magnifying glass icon that toggles between two image sizes
- three types of navigation for multi-page objects:
 - sequence drop-down menu
 - previous/next arrows above and below images
 - previous/next navigation from left and right sides of images

Help [HLP]

Help is accessible on all Portal pages from both the header and the footer. This 'help' is an FAQ of nine questions and answers. Help with formulating search queries is available from both basic and advanced search pages. This 'help' provides guidance in regard to capitalization, automatic 'and' queries, stemming, phrase searches, negative terms, and diacritic characters.

NEW FUNCTIONS

Obtain [OBT]

This function would allow users to download and print objects, along with their citations and metadata. Optionally users could select to download, print, or save search results, metadata records, citations, or objects. Users would also be able to order high resolution prints of images.

Comment [CMT]

This would allow users to submit error reports and comments. Only registered users could add comments, view others' comments and communicate with other registered users.

Register [REG]

This would be a simple registration process required of users if they wish to add comments, view others' comments, communicate with other registered users, or create lists.

Create Lists [LST]

This would allow registered users to create and merge search result list(s) and/or lists of selected objects.

View Map [MAP]

This would allow users to view search results on a map of Texas counties. The map would visually indicate the variance in the number of hits for each county. Additionally, users could submit a request to locate a particular county on a Texas map or to locate counties in which a given city name is located.

View Timeline [TML]

This would allow users to view search results on a timeline. The default time interval would be a function of the date range of the objects in a search result set. Optionally, users could modify the time interval as well as specify the interval for grouping results, such as by month, year, decade, etc.

Rate Historical Significance [SIG]

This would allow users to rate the historical significance of objects in the Portal.

NOTE: This function was not desired by participants, hence no requirements are provided.

Appendix B. Client Survey Summary

Portal of Texas History Site Interface Redesign

Total Response: 11

ON DESIGN

General:

- Most staff thought that the look of the site, especially the splash page, is old fashioned, static and dated
- User interface is lacking
- better user of space to have more effective layout in display information

Title:

The Portal to Texas HistorySM

Consensus gathered from the meeting:

The title need to be remained exactly the same, but font/style could be different.

Branding:

Point added from the meeting: Interesting point for the meeting, people from outside the Texas state might not know the look of the Texas flag, more people probably will recognize the shape of the Texas.

Consensus gathered from the meeting:

- No UNT green, no
- Need to find out from URCM, whether this site need to use new UNT stacked branding word mark, <http://www.unt.edu/identityguide/webuse.htm>
- Will use Texas white red and blue colors, but in moderate amount.
- Keep the Texas flag could be a good idea

Color:

- Majority of the staff thought that the color is too much in red and blue, and too bold.
- Better use of color combination for browsing and online reading

Font:

Almost everybody disliked the font, or thought there are too many type of fonts

Consensus gathered from the meeting: no more old-school font style, new font style should be simply and consistent.

Logos:

Consensus gathered from the meeting: will leave it to the designers to see what will be the best to add to the graphical heading/branding area. Open to new ideas, but want to keep it simple.

Audience:

Researchers, Historians, Genealogists, Educators/Teachers, K-12 students, Lifelong Learners, Family History, Enthusiast, General Public

Consensus gathered from the meeting: the Portal of Texas History is dedicated to serve all of the above audience groups. However when tough decisions have to be made in implementing design/function/IA, the development group will weigh in more opinions gathered from the experts such as researchers, historians and genealogists to make the decisions.

Future Style Perception:

- Clean, simply, less-crowded
- Rich in content, Informative
- Professional/Respectful/Academic/Research-based/Prestigious/Authoritative
- Innovative/forward-thinking/cutting edge
- Accessible, user-centered, friendly, Intuitive
- Use of photos

Consensus gathered from the meeting: Good Luck 😊

ON FUNCTIONS

Like or would like to see:

- Faceted search
- Advanced search
- Quick search access throughout the site
- Ability to sort search results by a variety of parameters
- Ability to display search results as list or grid
- Highlighting of search terms in text
- “Zoomification” of large format items page turner
- commenting
- Create citation
- Resize the images
- News/updates blog/feed etc?
- Browse by county map, Heat map perhaps
- Different types of metadata display, dominant/simple view vs full metadata
- Better user experiences

Point added from the meeting:

- *Similar or related items?*
- *Customizable user interface for the future design?*

- *How about faceted browse?*

ON IA/CONTENT

Like or would like to see:

- Better site navigation
- Having contextual definitions
- Help and explanations on functions and how to use and *download resources from Portal to Texas History*
- Easy and prominent access to “News”, “About” section
- More browsing options
- Prioritize the browsing options; mostly used one shall be the default option for browse
- As PR or user education, statics data about the collections and their size could be helpful
- Contact information to be up to date
- Standardize the use of “Home” link
- Better user experiences

LEARN FROM OTHERS, LIKE AND DISLIKE

At this meeting, everybody could pick one or two of your favorite sites that you have listed in the survey, and discuss with the group about why you like the design, information organization or functionality of those sites.

Consensus gathered from the meeting: Will utilize basecamp portal redesign project message board to voice in more opinions/suggestions on how to improve the Portal to Texas History site.

Appendix C. System Framework and Applications

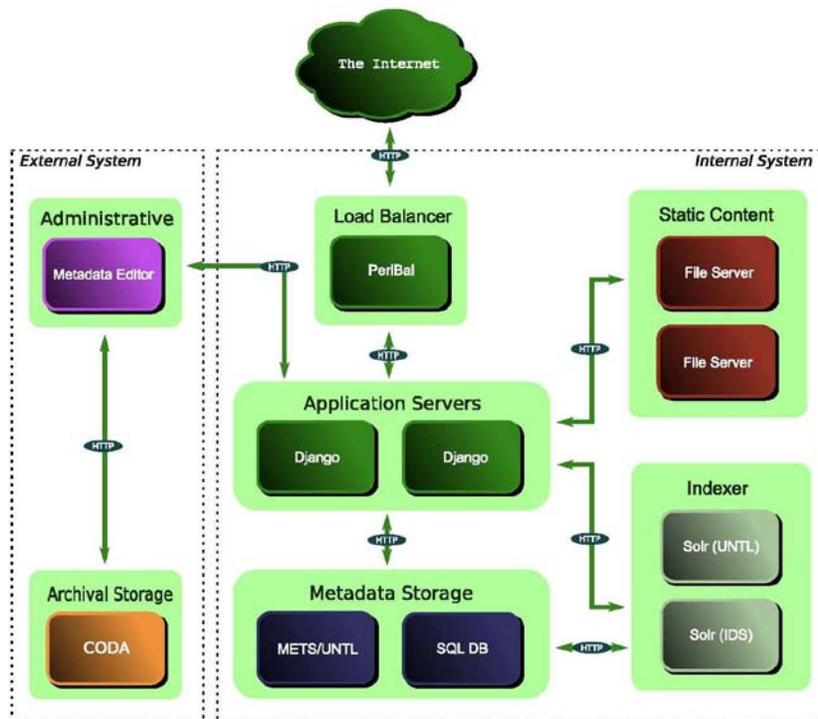


Figure C1. System Framework

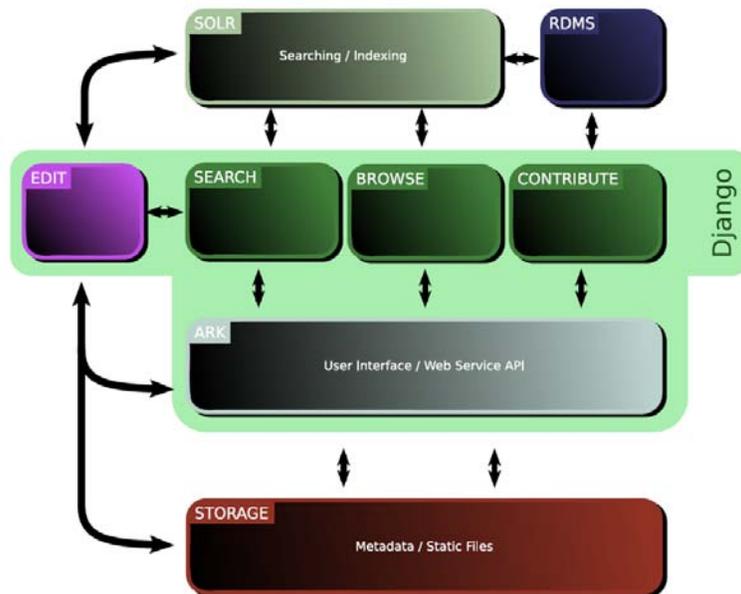


Figure C2. Applications & System Interfaces

Appendix D. User Interface Prototypes

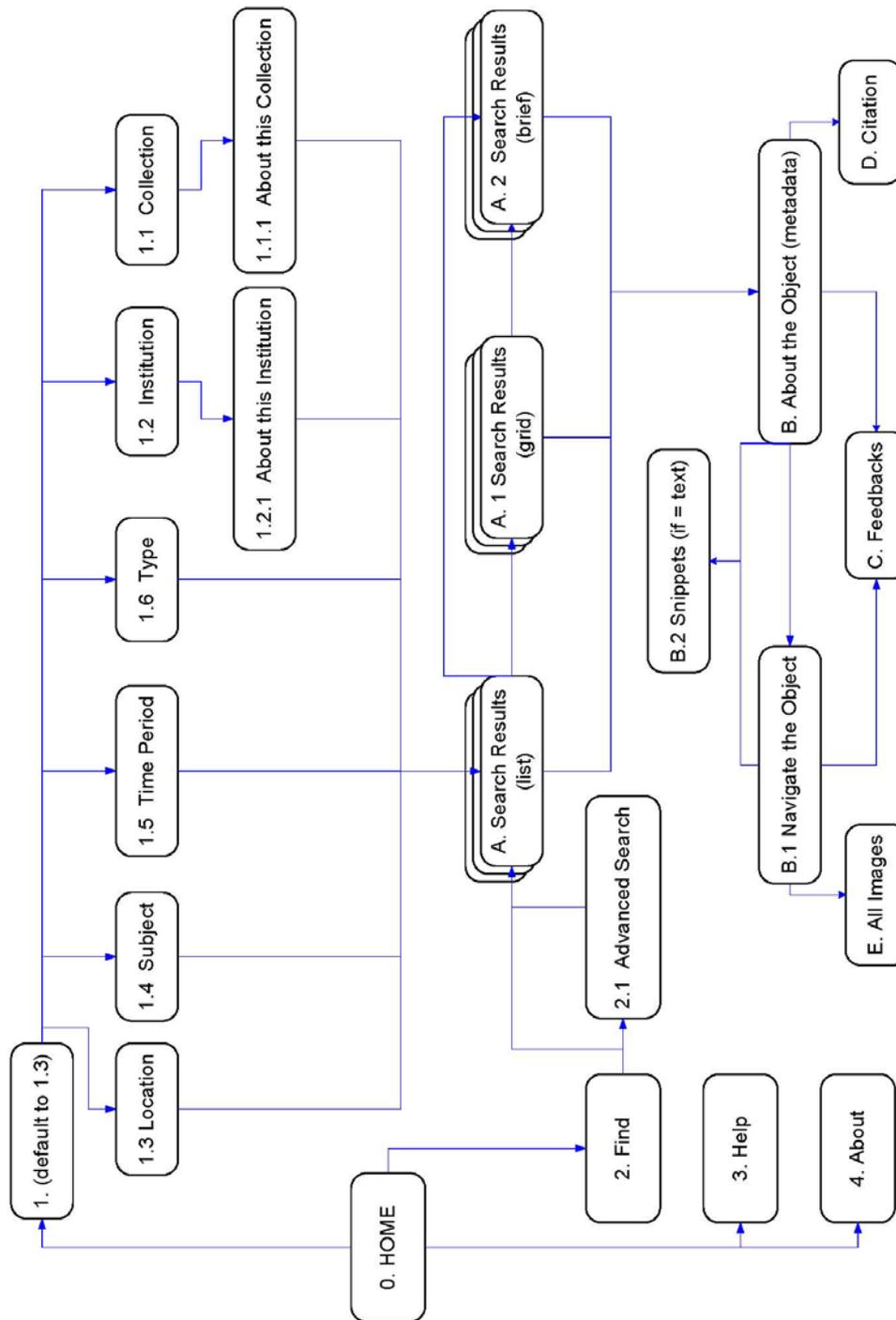


Figure D1. Navigation Prototype



Figure D2. Example of Page Layout Prototype