Integrating Licensed Library Resources with Sakai

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Introduction and Background

The Andrew W. Mellon Foundation awarded a grant to Indiana University in December 2005, with the University of Michigan as subcontractor, for the project Integrating Licensed Library Resources with Sakai. The goal of this project, now known as Sakaibrary, has been to develop new software tools and enhancing existing tools within the Sakai collaboration and learning environment to provide easy access to licensed library electronic full text resources for faculty, students, and librarians.

This project was motivated by the observation that while teaching and learning activities in colleges and universities were increasingly moving online into course management systems such as Sakai, Blackboard, WebCT, and Angel (either in place of or as a supplement to traditional classroom instruction), and academic libraries were offering an increasing array of online content (both locally-created and licensed from commercial or nonprofit providers), it was not easy for faculty, students, and librarians to discover and make use of this online library content from within the CMS. The open source nature of Sakai made it possible for libraries to think about addressing this problem directly by developing enhancements to the Sakai software to enable easier use of library resources within the course management environment.

The genesis of the Sakaibrary project came from a meeting hosted by the Mellon Foundation in New York in January 2005 to discuss library-Sakai integration issues, which involved representatives of the Sakai project and university librarians and library staff from the four original Sakai partner institutions: Indiana, Michigan, Stanford, and MIT. The New York meeting was followed by a larger Mellon-supported meeting at Stanford in March 2005. At this meeting, a number of different usage scenarios were developed by the participants, involving use of diverse content types such as digital art images, audio, video, and statistical data.\(^1\) At the recommendation of Mellon staff, the focus of an initial development project was narrowed down to look at supporting use of licensed full text databases, perhaps the most commonly used form of online library content in teaching and learning.

\(^1\) Report available at [http://confluence.sakaiproject.org/confluence/x/-wF1Ag](http://confluence.sakaiproject.org/confluence/x/-wF1Ag)
The goal of the Sakaibrary project has been to develop new functionality for Sakai to support use of licensed resources, in the form of Citations Helper and the Subject Research Guide prototype, that is not only applicable to the library, teaching, and technology environments at Indiana University (IU) and the University of Michigan (UM), but at any institution implementing Sakai as a course management system. To help ensure broad applicability, the Sakaibrary project team invited five additional institutions interested in Sakai-library integration issues to participate as project partners: Johns Hopkins University, Northwestern University, Stanford University, and the University of California – Berkeley. These partners have provided input and feedback on requirements, designs, and implementations throughout the project.

Project Accomplishments

Usage Scenarios and Requirements
In March 2006, the University of Michigan hosted a project kickoff meeting in Ann Arbor, with librarians and technologists from IU, UM, and the five additional project partners. At this meeting, each institution presented several usage scenarios outlining potential faculty, student, and librarian use of Sakai for discovering and working with library content and services. From these usage scenarios, IU and UM staff developed a set of requirements to guide design and development of the Sakaibrary project tools and selected a subset of these requirements on which to focus the first phase of development.

Citations Helper
The principal accomplishment of the project has been the development of Citations Helper, a new feature for Sakai that supports the creation and dissemination of citation lists or reading lists, through searching of library licensed full text databases and indexes.

The primary project goals served as a guide for the development of Citations Helper, including: enhancing the teaching and learning experience by building tools to provide seamless integration of content from licensed library databases within Sakai; leveraging of existing and emerging library technology infrastructure and existing preliminary work on Sakai integration as much as possible in developing these tools; engaging librarians, students, and faculty in the design and testing of tools for integration of library content and services; and collaborating with the Sakai community to optimize development for usefulness in multiple settings and to promote seamless integration within the Sakai software platform.

The Citations Helper is integrated within the Sakai Resources tool, which is the primary place for faculty to present and students to access digital content to support course work. Developed by an interdisciplinary team of software developers, public service librarians, digital library experts, and an interface and usability specialist, the Citations Helper allows instructors to search for citations in library licensed databases and make stable links to full-text content for use by students enrolled in a particular course. Citations Helper leverages existing library technologies—including metasearch.

2 Available at http://confluence.sakaiproject.org/confluence/x/_QF1Ag
3 Available at http://confluence.sakaiproject.org/confluence/x/wz4
engines, Google Scholar, and OpenURL link resolvers—to provide access to the rich array of resources in library subscription databases such as full-text articles from journals and other periodicals, large commercial aggregation services such as ProQuest and Ebsco, and non-profit databases such as JSTOR, developed with support from the Andrew W. Mellon Foundation. The Repository OSID (Open Service Interface Definition) from the Mellon-funded Open Knowledge Initiative project was used to implement a standard programming interface to metasearch engines, with implementations developed for SirsiDynix SingleSearch and Ex Libris MetaLib.

During the iterative design process, the project team engaged faculty, librarians, and students in the development of the functional requirements and interface design for Citations Helper, through informal demonstrations and discussions and more formal usability testing. Project partners from University of California at Berkeley, Stanford, Yale, Johns Hopkins, and Northwestern provided ongoing feedback and ideas for how to make the Citations Helper more usable and tightly integrated with Sakai. Through participation in Sakai conferences and ongoing communication with and participation in the wider Sakai community, the project team contributed to overall discussions of Sakai’s direction, while integrating with Sakai as seamlessly as possible in its present form. An initial public version of Citations Helper was released as part of Sakai 2.4 in the spring of 2007, and a new version offering improved local configurability and additional features—including the ability to import existing citations from a variety of tools and the ability to search for and embed
citations within the rich text editor used in many Sakai tools—was released as part of Sakai 2.5 in the spring of 2008.

**Subject Research Guides Prototype**

The second major software development goal for the Sakaibrary project is to prototype functionality in Sakai that will allow librarians to produce—and instructors to incorporate—subject research guides consisting of links to Web resources, links to library databases, search boxes constrained to search relevant sources, and expository material.

Many academic libraries, including those at Indiana and Michigan, currently offer librarian-created Web pages that bring together library resources, Web resources, and research tips relevant to a particular course, discipline, or research topic. These pages are typically created either through a simple forms-based web interface or by direct editing of HTML and are usually made available via the library’s Web site. Tools developed for creating and maintaining such guides are often very specific to a local institution’s library technology environment, including web content management system, electronic resources management system (ERMS), metasearch tool, and link resolver, and are not easily reused across institutions. The goal of the work on subject research guides in the Sakaibrary project is to make it easier both for librarians to create and maintain these guides and for faculty and students to access them within the context of a particular course in Sakai, and to build a tool environment as part of Sakai that can be portable across institutions. This is accomplished by leveraging the work that has already been completed for Citations Helper to provide generic interfaces to an institution’s metasearch system and library database information.

The project team developed an initial list of requirements based on the usage scenarios and high level requirements created at the beginning of the project, the experience of librarians at IU and UM in creating and maintaining course and subject pages, and additional feedback from librarians at the project’s partner institutions. From this set of requirements, the project team began to focus on the need for an authoring user interface that is more flexible than simple forms-based templates yet easier to use than direct HTML editing, and which can easily tie into various other data sources. A variety of existing tools, including Springshare LibGuides, Google Notebook, and various Wiki tools were reviewed before the decision was made to build an interactive authoring interface based on AJAX and dynamic HTML technologies.

The initial prototype of the Research Guide tool supports the creation and editing of guides containing free text, Web links, and embedded or linked citation lists. The project team is currently working on a second prototype, with the assistance of short term bridge funding from IU and UM, which adds the ability to link to library databases and embed a database search box, and offers an improved interface for incorporating citation lists into a guide.

The project team is also looking at the requirements for organizing, sharing, discovering, linking to and reusing subject research guides within Sakai. In the current prototype, guides are created and accessed within the context of a specific course site in Sakai, but future plans are to also support a

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4 [http://confluence.sakaiproject.org/confluence/display/SLIB/SRG+Requirements+3.6.07](http://confluence.sakaiproject.org/confluence/display/SLIB/SRG+Requirements+3.6.07)

5 Available for demonstration use at [http://www.dlib.indiana.edu/projects/sakai/demo/](http://www.dlib.indiana.edu/projects/sakai/demo/)
model in which guides that are reused across multiple course sections or semesters may be created by librarians in a generic Sakai project site managed by the library and then made available to relevant course sites by the faculty member or librarian.

Figure 2. Research Guide tool prototype authoring interface

Usability Testing
Two usability tests were completed as part of the Sakaibrary project development process. The project team tested a preliminary version of the Citations Helper in November 2006, and in June 2008 the team contracted with the Indiana University User Experience Group to conduct a test of the version of Citations Helper released with Sakai 2.5 and the Subject Research Guide prototype.

The purpose of the first study was to evaluate the usability of the Citations Helper to make design recommendations as well as to assess the value of such a tool. Eleven participants (four librarians, three instructors, and four undergraduate students) were tested and several interface changes were made as a result of the findings of the test. User interface changes included replacing checkboxes with buttons, changing language on some screens, and making the abstracts of articles viewable.

The purpose of the second study was to learn if users are able to easily navigate and accomplish basic tasks using the Citations Helper and Research Guide prototype tool. Eleven participants (one
faculty, four librarians, four graduate students, and four undergraduate students) were tested on thirteen tasks. Currently, the project team is conducting complete analysis of the findings and recommendations.

The usability testing reveals overall satisfaction with the tools as well as some areas for improvement to the user interface. Both tests show that experienced Sakai users were able to complete more tasks in less time than first-time users. Complete reports of the findings and recommendations are available on the project Wiki.6

**Other areas**

In addition to the development work described above, the project team released a white paper titled *Providing Library Reserves to Sakai using RSS.*7 As more and more data and metadata at libraries becomes available in electronic form, librarians are presented opportunities to expand not only the types of services they offer, but the contexts within which the services are framed. This paper provides an overview of one such reframing: the automated publishing of course reserves data to the course management system Sakai. It briefly looks at the electronic infrastructure on college and university campuses that allows this sort of expansion of library services and then discusses in more detail the technical underpinnings of this particular service as offered through the Library Reserves tool in CTools, the Sakai instance at the University of Michigan. This paper is provided to the Sakai community (and beyond) to encourage librarians and academic technologists to consider utilizing similar technologies to provide access to library reserves or other library content.

**Outreach**

The project team has participated extensively in all Sakai conferences since 2006. In addition to general updates on project progress, the project team has offered tool walkthrough sessions, technical demonstrations, and open discussion (Birds of a Feather) sessions. Participants in these sessions have included librarians, technologists, administrators, and developers from the Sakai community. Communication with the Sakai community through these sessions has been imperative for gaining input and encouraging trial and adoption of the Citations Helper. It has also been important in raising awareness about the importance of integrating library content and services with the course management system. The project team maintains a space on the Sakai project’s Wiki documenting the project8 and a project website9, as well as a public test instance of Sakai with the Citations Helper and Research Guide tools enabled.10

In addition to promoting the project within in the Sakai community, the project team has promoted the project to wider audiences through presentations at other library conferences:

6 [http://confluence.sakaiproject.org/confluence/display/SLIB/Usability+Testing](http://confluence.sakaiproject.org/confluence/display/SLIB/Usability+Testing)
8 [http://confluence.sakaiproject.org/confluence/display/SLIB/](http://confluence.sakaiproject.org/confluence/display/SLIB/)
10 [http://www.dlib.indiana.edu/projects/sakai/demo/](http://www.dlib.indiana.edu/projects/sakai/demo/)


• Overview of Sakailibrary for the Georgia Virtual Library Project Group, University of Georgia System, Virtual Presentation, November 28, 2007.


Google Scholar

Early on in the project, the Sakailibrary project team contacted the team at Google responsible for Google Scholar to explore potential points of integration between Google Scholar and Sakailibrary. Google was aware of Sakai and very interested in implementing the ability to import citations found through Google Scholar into citation lists in Sakai, in much the same way that Google Scholar
already supported importing citations into the RefWorks web-based reference management tool. Sakaibrary project members worked with Google to specify the mechanisms through which Citations Helper and Google Scholar would communicate. In the resulting implementation, a user can invoke Google Scholar when creating or editing a citation list, and Google Scholar displays and “Import into Sakai” link under each search result, where the word “Sakai” is replaced by the local name of the institution’s Sakai instance, e.g. “Oncourse” at IU or “CTools” at UM.

Adoption

Indiana University

During the spring semester of 2007, Indiana University tested an early version of Citations Helper on the Bloomington campus with a graduate level course in the School of Library and Information Science. For this course, each of the 12 students created a citation list for a class assignment, using a test instance of Sakai hosted by the library. Overall satisfaction with the tool was fair. Most users agreed that it was ideal for creating reading lists for students. Some recommended that expanding the tool to allow students to create a bibliography for a course assignment should be explored.

In August 2007, members of the IU Sakaibrary project team met with a small group of IU Bloomington faculty who had received fellowships to explore innovative ways of using technology in teaching. These Fellows expressed interest in the Citations Helper and seemed very open to using the tool in their writing intensive and upper level courses. Citations Helper was deployed in IU’s production Sakai 2.4 instance, known as Oncourse CL, in time for the start of the 2007 fall semester. The feature was available to users at all eight IU campuses, but the Search Library Resources feature was enabled only for users at IU Bloomington, using the IU Bloomington Libraries’ SirsiDynix SingleSearch metasearch engine. Despite being disabled by default and not highly publicized, the instructors of 51 courses elected to use Citations Helper during the fall 2007 semester, and 49 used it during the spring 2008 semester, when the Search Library Resources feature was also enabled for the Indianapolis campus’ ExLibris MetaLib metasearch engine. In addition, 42 project sites have enabled the feature, and 30 users have enabled Citations Helper in their personal Oncourse workspaces.

In spring 2008, a special training workshop was developed by the IUB Libraries and offered through the Teaching and Learning Technology Center (TLTC), which is responsible for faculty and instructor Oncourse training and support on the Bloomington campus. Eight instructors attended the workshop and expressed enthusiasm for the tool. Evaluations of the session revealed that attendees expected to implement it in future classes. The workshop will be offered regularly each semester.

Considering the quiet launch of the Citations Helper tool in Oncourse, the adoption rate is promising. The voluntary exploration of Oncourse features is not a common practice among IU faculty. The use statistics above show that a small number of faculty or instructors willingly incorporated a new Oncourse tool into a course with minimal training or support.
Starting either in fall of 2008 or spring of 2009, Citations Helper will be enabled by default within new Oncourse sites, and because of this, along with additional training opportunities and publicity, it is expected that the number of courses using the tool will increase significantly. In addition, the IU Bloomington Libraries will offer a librarian-specific training session for Oncourse designed to increase awareness of all Oncourse features, including Citations Helper. The intent is to increase understanding of Oncourse among librarians so they are able to support faculty and instructors in using the tool to its full advantage.

University of Michigan

Citations Helper was put into production in the University of Michigan CTools environment for the fall 2007 semester. Awaiting the completion of load testing, the Michigan project team decided to do a “soft” rollout without a great deal of publicity. Thus, as at IU, Citations Helper is an option that instructors and other site owners must activate within their own workspace, course site, or project site. After completion of load testing in August 2008, it is expected that the Citations Helper will be enabled in all sites by default. Outreach will increase over the next year to build awareness of Citations Helper and will include instruction sessions and publicity to academic departments. Outreach thus far has included faculty workshops and promotion through subject librarians.

In the fall 2007 semester, the instructors of 45 courses enabled the Citations Helper feature, and in the winter 2008 semester, the instructors of 30 courses enabled the feature. In addition, the owners of 68 project sites have enabled Citations Helper, and 95 individual users have enabled it in their personal workspaces.

A user survey on Citations Helper use at UM will be conducted during the 2008-2009 academic year to obtain more feedback on usage patterns and usability issues to inform future development work.

Other members of the Sakai community

There has been significant adoption of Citations Helper in the Sakai community beyond IU and UM, both in production and testing environments. Institutions have the option to enable one or all four of the Citations Helper functionality options, including Search Library Resources (utilizing metasearch tools), Google Scholar, manually entering citations, and/or importing citations from bibliographic software programs such as Endnote, RefWorks, or Zotero.

Based on discussions at Sakai Conferences and responses to a survey sent to a number of Sakai project e-mail lists in July 2008, the Sakaibrary project team is aware of the following institutions that have implemented Citations Helper within their Sakai installations:

Institutions using Citations Helper in production as of August 2008:

- Columbia University
- Indiana University (available at all seven campuses)
- University of California Berkeley
- University of California Davis
- University of Michigan
- University of Virginia
Technical Implementation

Citations Helper
As noted earlier, in developing Citations Helper, capabilities were added to Sakai’s Resources tool, making it possible for Sakai users to create citation lists and populate them with citations taken from results of searches using their library’s metasearch tools and/or Google Scholar, or imported in RIS format from other reference management tools. This functionality is enabled by several developments, including creation of a Search Manager that interacts with external metasearch engines, a Citation Service that handles persistence of user-selected citations, a Citations Helper to manage the user interactions and communicate with the underlying technology, a Google-search servlet to handle interactions with Google Scholar, changes to the Resources tool itself to support integration of specialized resource types such as citation lists, and a Configuration Manager to handle customization of the way these elements work in a particular Sakai instance.

The Search Manager handles interactions with proprietary external metasearch engines through an implementation of the Open Knowledge Initiative's Open Service Interface Definition (OSID) for Data Repositories. The Search Manager converts users' entries in web-based search forms into queries in a standard internal format, based on version 1.1 of the Common Query Language (CQL). The OSID implementation for a particular metasearch engine then translates the query into the non-standard format specific to that metasearch vendor. The query is conveyed to the metasearch engine via an HTTP request, and the engine returns a message containing results and/or status information in whatever format the vendor provides. The OSID implementation translates the query results into a generic format that can be returned to the Search Manager. Finally the Search Manager converts these results into a format that can be displayed to users. This project created two reference implementations of the Data Repository OSID: one for SirsiDynix SingleSearch (based
on the MuseGlobal Web2 Bridge gateway) and one for Ex Libris MetaLib. Both were designed so they could be used as the basis for additional implementations by removing portions of the code specific to the target vendor and replacing them with code that would handle interactions with a new metasearch engine.

The Citation Service is responsible for persistence of citations and collections of citations when a user ends a session and recovery of those citations for the user in subsequent sessions. The service uses Sakai’s SQL Service to make a database connection whenever necessary to save or retrieve citations. In the persistence layer, citations are modeled as sets of RDF (Resource Description Framework) triples, where the "subject" is an identifier for the citation, the predicate is an identifier for a particular attribute (such as “title” or “author”) and the object is a value (such as the actual title of a journal article or the name of its author). The Citation Service is designed to efficiently store or retrieve all relevant triples for a particular citation or collection of citations. It also converts between these sets of triples and the Java objects that are used to represent citations elsewhere in the application. As with other global services in Sakai, a single instance of the Citation Service is created when Sakai starts up and handles all access to the citation information in the database. The service also manages schema definitions for various types of citations (e.g. books, journal articles, chapters).

The Citations Helper provides a graphical user interface through which Sakai users are able to create citation lists, initiate searches, manually create citations, etc. This functionality is provided in the context of Sakai's Resources tool. The Resources tool invokes the Citations Helper whenever a user elects to create a new citation list or revise an existing one. The helper renders the user interface as web pages using the Velocity Rendering Engine within Sakai. Mouse and keyboard inputs within those web pages result in HTTP requests to the helper to start new searches, add search results to a citation list, set attributes for a citation list, change values within a citation, etc. The helper responds to such inputs by invoking appropriate methods in the Search Manager, Citation Service, or Resources tool.

The helper also introduced the use of OpenURLs to Sakai. Essentially, an OpenURL describes a desired resource: this is sent to an institution-specific link resolver, which responds with links to resources available locally. OpenURLs are used in lieu of vendor specific links to provide “durable”
access to resources. As library holdings change over time, the link resolver can reflect that and continue to provide access to the best available resources.

A special servlet manages interactions initiated by users reviewing search results from Google Scholar. The Citations Helper displays a button that allows users to search Google Scholar as a way of finding citations to add to a Citation List. Clicking that button launches a pop-up window showing a search form for Google Scholar. Results returned by Google in this context include special links allowing the user to import individual citations from their Google Scholar search results into the citation list currently being created or revised. Clicking the link invokes a method in the servlet which imports the citation and displays a message to the user.

![Figure 5. Sakai - Google Scholar Interaction](image)

The Citations Configuration Service enables customization of the behavior of the Citations Helper and the functionality related to it. It can be configured to use different OSID implementations and/or metasearch engines for different users. It can also customize the set of databases that are made available for searching by a particular user. The Configuration Service provides a subject-category hierarchy that is displayed in the Citations Helper search pages. This allows the user to choose which databases will be targeted in a particular search from all databases related to particular categories and subcategories (which may be configured to correspond to academic disciplines and subdisciplines).

Development of citation lists within the Resources tool made it easier to make the capabilities available in various Sakai contexts, but making citation lists available through the Resources tool required changes to the Resources tool itself. The need for those changes paralleled a similar need within the Open Source Portfolio (OSP) project for a separate web application within Sakai to define behaviors that would appear to users to occur within the Resources tool. The Resource Type Registry was added to Sakai to allow Sakaibrary, OSP and others to register new types of resources and the actions and/or behaviors associated with them. This was accomplished through a significant refactoring of the Resources tool which moved much of the user interface rendering to helpers and established a simple way to define new functionality in the Resources tool.
Subject Research Guides Prototype

The Research Guide tool developed as a prototype for subject research guides (SRG) supports two modes: access and author. The access mode enables read-only views of existing research guides. The author mode enables creation and revision of research guides using an edit-in-place design pattern. The edit-in-place design pattern allows users with adequate permissions to select part of a document for editing, make revisions on that item and save the changes by deselecting the item, all without leaving the context in which the item appears.

SRG is a web application written using the Reasonable Server Faces framework (RSF) that exposes itself in Sakai as a new “Research Guide” tool. The application makes use of the cross platform JQuery Javascript library and persists its data using Hibernate. In addition, SRG makes use of user interface widgets developed by the Mellon-supported Fluid Project\(^\text{11}\), including the Reorderer for drag-and-drop reordering of document sections.

A research guide is essentially a container for content items. Four types of content items are supported and others are planned. The four types currently supported are title, text, link and citation list. As with any RSF project, rendering a research guide requires construction of a component tree. Using RSF’s UJointContainer mechanism allows a modular approach in which the rendering of each type of content item can be defined separately from the rendering of the page as a whole. A renderer for an individual content item may render one or more views of the content item depending on the mode of the research guide being rendered and the current state of the interaction with respect to the content item. For example, in author mode, two views of a text item might be rendered—one as a static view of the item and the other to be used in revising the content if the user chooses to make changes. In that case, only the static view would be shown initially, but that view would be hidden and the other shown if the user selects it for revision. JavaScript is used when the page loads in author mode to enable transitions between the static views and revision views.

When a user signals completion of changes to a content item in author mode, the changes must be saved on the server and the browser-side representation of the content item must be returned to its static view. That is accomplished using a form of Asynchronous JavaScript and XML (AJAX), which is a framework for updating web pages dynamically using JavaScript. The special form of AJAX used in the SRG prototype is known as Asynchronous HTML and HTTP (AHAH). In AHAH, a browser request returns a chunk of HTML that replaces the element from which the request originated. A JavaScript function is called to dynamically update one portion of the document in a Web 2.0 way to create a more interactive environment by avoiding complete page reloads.

AHAH is also used to enable insertion of new content items at arbitrary locations within the research guide. Sakaiibrary project developers worked with the authors of RSF to improve RSF’s ability to handle insertions throughout a document coherently.

SRG submissions are handled by backing beans. In RSF terms, a backing bean is the target of HTML form submissions. By assigning submit buttons to different methods in the backing beans (as well

\[^{11}\text{http://fluidproject.org/}\]
as form elements to member variables of the backing bean) this is how the application is able to navigate to different pages.

jQuery has a powerful selection mechanism that uses CSS, XPath and custom selectors. This ability allows us to leverage element id and CSS assigned classes to elements in the DOM (Document Object Model) to select or find dynamic content. By following rules for assigning element ids and classes, it is easy to control and navigate through the constantly changing DOM.

Challenges

Existing Library Technologies and Metasearch
One of the main tenets of the project has been to leverage existing technologies implemented in libraries rather than trying to reinvent the wheel. However, the use of existing metasearch technologies has proven to be both a help and a hindrance to the objective of creating a seamless way for faculty to find and link articles within their courses. Both of the metasearch technologies that were used in this project were somewhat problematic in terms of performance, reliability, and quality of data returned. Many of these problems are not the fault of the systems' vendors but are inherent in attempting to implement federated searching of disparate databases using different underlying data formats, query semantics, and ranking algorithms.

The project team also encountered problems with varying degrees of data normalization across sources that most normal users of metasearch would not encounter due to the need to construct OpenURLs for each item based on its fielded metadata. Citations Helper constructed and used OpenURLs because the metasearch engines could not necessarily be relied upon to return durable URLs for each item that would persist beyond the user's current session. However, based on recent discussions with libraries implementing metasearch services, the project team is planning to take a second look at this issue to see if a more reliable full text article link can be provided in some cases by using the direct URL returned by the metasearch engine for an item rather than an OpenURL.

The Google Scholar approach of harvesting and indexing metadata and full text in a central location seems to be more promising in terms of usability, but Google Scholar itself is more useful for some disciplines—particularly engineering, medicine, and the sciences—than for others, due to its coverage and rate of ingest. In addition, as a free product offered by a commercial vendor, libraries and academic institutions do not have much ability to influence its functionality and direction.

Changing Models of Library Service
The transition to a Web 2.0 world presents challenges for provision of library services. The library and its staff need to be in multiple virtual spaces at one time, ranging from library websites to social networking tools. The course management system is another of these tools, and establishing best practices for resources and services in such an environment is evolving. Motivating library staff to experiment with new technologies and services is an ongoing challenge, as they often already have a full workload. The project team found that working with library staff in the design and implementation process helps motivate them to try new tools, and this has been integral to the work of the Sakaibrary project.
Integrating with Sakai

Thanks to the open source nature of Sakai, there are many projects working, like Sakaibrary, to develop new functionality for Sakai, and this typically takes the form of developing a new Sakai “tool” that can be enabled by an instructor or by default for a course. In the Sakaibrary project, rather than simply creating additional tools, the project team wanted to fit their work into the contexts in Sakai in which faculty and students are already working, such as the Resources tool for creating and managing content. This was possible for us to do because of the invaluable involvement of a longtime core Sakai developer at UM on the project team, but this remains a challenge for other projects and for the Sakai development process as a whole, and leads to further proliferation of tools with overlapping functionality.

In fitting properly into Sakai, the Sakaibrary project’s extensions also inherit user interface conventions that are part of the Sakai framework. However, these conventions are not necessarily intuitive to users. In the most recent usability testing of both Citations Helper and the Subject Research Guides prototype with librarians and students at IU, discussed earlier, many of the problems and recommendations reported by the testing team had to do with general Sakai navigation and user interface rather than this project’s extensions.

Fortunately, work is underway now in the Sakai project on addressing these issues, particularly through the User Experience Initiative funded by the Sakai Foundation. In addition, a new focus on content authoring has emerged within the community, which will bring together developers of tools that support content creation and authoring to discuss common requirements, user interface needs, frameworks, and toolsets.

Web Development

Software development on this project, especially to create the dynamic, interactive authoring interface required for the Subject Research Guides prototype, has involved the use of a number of new and emerging technologies, including the Reasonable Server Faces (RSF) Java web application framework and the Fluid Infusion user interface component toolkit developed by the Mellon-funded Fluid Project. While use of these technologies improved the overall architecture and functionality of the product, both are still evolving (as is Sakai) in terms of their functionality and developer documentation. This is positive in that the developers of these technologies were able to fold some of this project’s requirements into their ongoing work, but it slowed development down at some unexpected points. Managing a software development project that depends on other technologies that are themselves still under development requires an agile process, and the project team found that it needed to change its priorities, goals, and schedule expectations from week to week.

Sustainability

As noted earlier, the Citations Helper has been implemented in production at IU, UM, and a number of other Sakai institutions, and is a core component of the Sakai software distribution. The libraries at IU and UM are committed to working with others in the Sakai community to continue to improve the tool and ensure that it continues to function in future Sakai releases. The Research Guide tool
Future Directions

The Sakaibrary project has only just begun to address the use of library-provided content and services in online teaching and learning. As noted in the introduction, initial Mellon-funded discussions amongst members of the academic library and Sakai communities in 2004 resulted in usage scenarios involving not only licensed article databases and subject research guides, but also image, audio, video, data, and e-book collections.

While licensed databases of articles and other resources represent a significant source of content from college and university libraries used to support teaching and learning, libraries have also made substantial investments in local or collaborative/consortial digitization of analog resources including books, manuscripts, art images, photographs, musical scores, audio, and video. To enable their greatest use, these rich sources of pedagogical material should also be made easily available through online learning and course management systems such as Sakai. Beyond the simple benefit of easier access, having these materials available online through Sakai enables new forms of teaching and learning, including the ability to support direct annotation and markup of text, images, audio and video by students and instructors for classroom presentations and assignments.

The project team envisions a potential second phase of the Sakaibrary project to focus on two areas:

- Transforming the Subject Research Guides prototype created in the first phase of the project into a functional, usable, production-quality tool that can be deployed in a wide range of Sakai institutions.

- Implementing capabilities in Sakai that allow students and instructors to discover rich digitized content from digital library repositories, both local and remote, and then make use of this content within a variety of value-added pedagogical tools in Sakai, including tools for annotation and markup of digital media and for testing/quizzing using digital media.

The latter work would build upon the previous work of the Sakaibrary project and preliminary work done by IU as part of the Mellon-funded DLF Aquifer American Social History Online project,12 to implement support for searching of digital library repositories, institutional repositories, and digital library metadata aggregators from within Sakai. The team would expect to support searching of DSpace, Fedora, ContentDM, OAIster, HathiTrust, and other sources that support the SRU (Search and Retrieve via URL) protocol as a target.

In addition, building upon the previous work of DLF Aquifer on asset actions and the recently released OAI-ORE (Open Archives Initiative Object Reuse and Exchange) standard13, the team would also implement support for complex digital objects within Sakai so that objects in digital

library repositories such as electronic books, architectural image sets, manuscripts, audio, and video recordings can be referenced from or stored within Sakai and used by a variety of Sakai tools in a standard manner. Based on real-world use cases developed from demonstrated faculty and student needs, the team would implement or extend various Sakai tools, supporting such activities as annotation and testing/quizzing, to be able to consume and work with these objects.