Cooperation or Control?
Web 2.0 and the Digital Library

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Abstract

The Web 2.0 trend has placed a renewed emphasis on interoperability and cooperation between systems and people. The digital libraries community is familiar with interoperability through technologies like OAI-PMH, but is disconnected from the general Web 2.0 community. This disconnect prevents the digital library from taking advantage of the rich network of data, services and interfaces offered by that community. This paper presents a case study of a collection within the Texas A&M Repository that was improved by adopting the principles of cooperation embodied by the term Web 2.0.

1. Introduction

Web 2.0 is an ambiguous label, but whatever else is conveyed by the term, it most certainly includes the concepts of interoperability and cooperation [35]. Digital libraries have experience with these concepts, having taken early steps toward interoperability in repositories [16][28][33]. Metadata harvesting and federated collections are furthered by protocols and standards such as OAI-PMH and DIDL [32]. However, in the Web 2.0 vision, the concept of collaboration is elevated to a critical piece of the system architecture [20]. In comparison, the type of interoperability currently practiced in the digital library community seems narrow and limiting.

To engage in the larger Web 2.0 ecosystem, digital libraries must adopt a broader concept of interoperability: one that embraces openness and radical cooperation. In his seminal article defining the concepts behind Web 2.0, Tim O'Reilly summarized this idea as "Cooperate, don't control":

> Web 2.0 applications are built of a network of cooperating data services. *Therefore*: Offer web services interfaces and content syndication, and re-use the data services of others. Support lightweight programming models that allow for loosely-coupled systems [20].

Historically, digital libraries have been hesitant to depend on third-party data providers like Yahoo! or Google. When constructing interfaces into their content, libraries have been more likely to maintain control than embrace cooperation. However, the benefits of making this ideological shift include access to a rich mesh of data and services that can add enormous value to collections [25].

This article discusses a case study of implementing these concepts in a digital library. Specifically, it examines the changes made to a map collection housed in the Texas A&M

Repository [8]. A rich user interface was added that integrates the mapping services offered by Yahoo! and Google. Furthermore, the collection's metadata was repackaged and syndicated using an open format to encourage re-use. This experiment in Web 2.0 interfaces in a digital library may prove useful to others making similar transitions.

2. Background

Tim Berners-Lee has expressed doubt regarding the usefuleness of the term "Web 2.0", saying, "that was what the Web was supposed to be all along" [14]. However, when used to describe a concrete set of trends and practices, Web 2.0 can be a useful abstraction.

The term appeared in common usage in late 2004 following the first Web 2.0 Conference sponsored by O'Reilly Media [36]. Tim O'Reilly has outlined several key concepts that he claims define the Web 2.0 philosophy [20]. While not presenting an exhaustive list, some of these concepts are particularly relevant:

- **The Web as a Platform:** Offering a service through HTTP certainly pre-dates the Web 2.0 movement, but a central trend among Web 2.0 applications is the emphasis on exposing their content through web services. Protocols such as SOAP and REST have become common design patterns in web-based software engineering. In addition, re-use and data re-combination have become so commonplace that a new term found its way into the IT vocabulary: *mashup* [17]. Most recently, service providers like Yahoo! and Google have released applications that automate the creation of these mashups [10][37].

  A consequence of this trend is the availability of a wide range of data services and content that were previously inaccessible or cost prohibitive. This is the hypothesis behind O'Reilly's dictum to "cooperate, don't control"—the Web 2.0 infrastructure is composed of a network of cooperating data services [20]. To maintain and extend this network, applications must offer access to their data through web services interfaces and content syndication, and actively re-use the data offered by others. Our case study shows a digital library collection becoming an active participant in this cooperative network.

- **Harnessing Collective Intelligence:** The emphasis on active collaboration between people is probably one of the most recognizable aspects of a Web 2.0 application. Opening an application to include the customer in a participatory manner shifts the boundary between content providers and producers, and allows an application to leverage the collective knowledge of its entire (potentially large) user base [29]. Commonly cited examples include Wikipedia's open editing policy, or the dialogue created on a blog through reader comments and feedback. Although our collection did not yield itself to this aspect of Web 2.0, other projects have succesfully harnessed this "crowd wisdom" to great effect [25].

- **Lightweight Programming Models:** One consequence of web services interfaces is the separation of data from its original representation. This has allowed the development of a rich mesh of open data providers. Significantly, one of the most common ways for data to be interchanged does not involve complex SOAP interfaces, but lightweight syndication models like RSS and REST. The differences between these two appraoches relate to the idea of *control*—lightweight interfaces are concerned with providing structured data feeds *out* of the application, not controlling what happens to the data on the other end. This maintains the loosely-coupled nature of the Internet that has been one of its strengths since the beginning [7].

One reason for the rapid expansion of the web was reliance on open, human-accessible formats—formats that were open to exploration and adaptation [7]. Technologies such as HTML and XML create a low barrier to entry, allowing the protocols to be quickly acquired and reused. This is also true of many of the domain-specific languages pervasive in the web today, such as Google's KML or GeoRSS [12][9]. Leveraging open, lightweight models allowed us to accomplish this task with the limited resources often available to digital library projects.

- **Rich User Experiences:** The recent convergence of browser capabilities, web standards, and available bandwidth has allowed the emergence of *rich Internet applications.* These typically involve technologies such as DHTML, Flash and JavaScript to emulate native client-like behavior across the web. When these trends are paired with the programming models discussed above, the result is a suite of interface components made available through open APIs. At the time of writing, Google offered no less than 21 distinct APIs on their developer resources website [11]. The interface changes made to our collection were possible because of the availability of APIs such as these.

Certainly other concepts associated with Web 2.0 exist—the perpetual beta, radical decentralization, et cetera—but in many ways, all of these ideas share the common theme of interoperability and collaboration. Most significant to the authors is the *result* of Web 2.0: a rich, inter-connected mesh of web applications and data providers, "tied together by a set of protocols, open standards and agreements for cooperation" [20]. Each member of the Web 2.0 ecosystem is made more valuable because of this culture of openess and cooperation. If digital libraries are to take advantage of this significant resource, then the creators of those libraries and repositories must begin to adopt Web 2.0 principles [3].

3. The Collection

The Geologic Atlas of the United States is an archetypal collection in the Texas A&M University Libraries—the product of digitizing a unique physical collection to aid in access and preservation. As a centerpiece of the digital library, the university's institutional repository addresses both of these concerns, and places the collection in a position to explore Web 2.0 concepts in a production environment.

3.1 Geologic Atlas of the United States

Soon after its inception in 1879, the United States Geological Survey (USGS) began to work on a uniform series of geologic maps, beginning with the *Geologic Atlas of the United States*. The atlas was expected to "consist of a series of folios in a standard format, each containing topographic, geologic, and other maps and illustrations and text describing the geology of a particular quadrangle" [27]. The folios were published from 1894 until 1945, when the program was discontinued. Only 227 folios were ultimately produced, so the coverage area is limited.

Consisting of mixed content of text, maps and photographs, the collection is a valuable resource to geologists, researchers, environmentalists and educators. Since some of the original fieldwork was conducted following a period of largescale de-forestation, these surveys represent the best current information on the surface geology for those coverage areas that are now reforested [34].

The Texas A&M University (TAMU) Libraries own a complete set of the folios, and starting in 2001, the Maps/GIS department began the process of digitizing the collection. Other libraries have scanned portions of the set—usually focusing on the maps in their own state or coverage area—but no complete digitized copy existed. It was the Library's position that this collection has scientific and historical significance, and that digitization would accomplish two goals: aid in the *preservation* of the collection [1], and greatly increase *access* to the resource [15].

3.2 Institutional Repository

Near the end of the scanning project, Maps/GIS approached the Digital Initiatives group within the Library for assistance in depositing the digitized folios into the univeristy's institutional repository (IR). The Library has situated the IR as a central component within a suite of digital library services offered to the university community [22][30]. The repository's stated purpose is to "collect, preserve, and distribute the scholarly output of the university" [31].

Since 2004, the Texas A&M Repository has been built on the DSpace digital repository software platform [31]. Since April 2008, this has included Manakin, the new XML-based UI framework bundled with DSpace 1.5 [22], in addition to previously available interfaces such as OAI-PMH and HTML [28].

To ensure that the unique geospatial properties of the collection were adequately captured in the repository, the Digital Initiatives group and Maps/GIS created a metadata profile for the collection. New elements were added to the metadata mappings within DSpace to accommodate the latitude and longitude values associated with each folio in the collection [34].

Structurally, each folio was represented in DSpace as a single item with multiple files (bitstreams). One bitstream was included for each scanned page of the folio, and then all the pages were stitched together using Photoshop into a single lower-resolution PDF document optimized for screen viewing. This provided a rudimentary book-like interface to the folio, eliminating the need to download 10 to 40 individual files in order to flip through the folio.

3.3 Interface Challenges

When the folio collection was added to the repository, a standard DSpace collection was created to house the items [8]. However, the standard DSpace web interface is not optimized to handle image-based collections, complex items, or geospatial metadata. The usability challenges this created soon became evident.

The default item view in DSpace consists of a simple list of files available in the item, showing the file's name, size, and time. The folios were scanned using standards adopted by the Library of Congress and the National Archives. Since the physical size of the folio pages is non-standard, this resulted in file sizes that were very large. Browsing the resulting pages in a particular folio was a cumbersome process involving uninformative lists and large files (see Figure 1). Particularly on slower Internet collections, the large file sizes of each page resulted in a frustrating user experience.

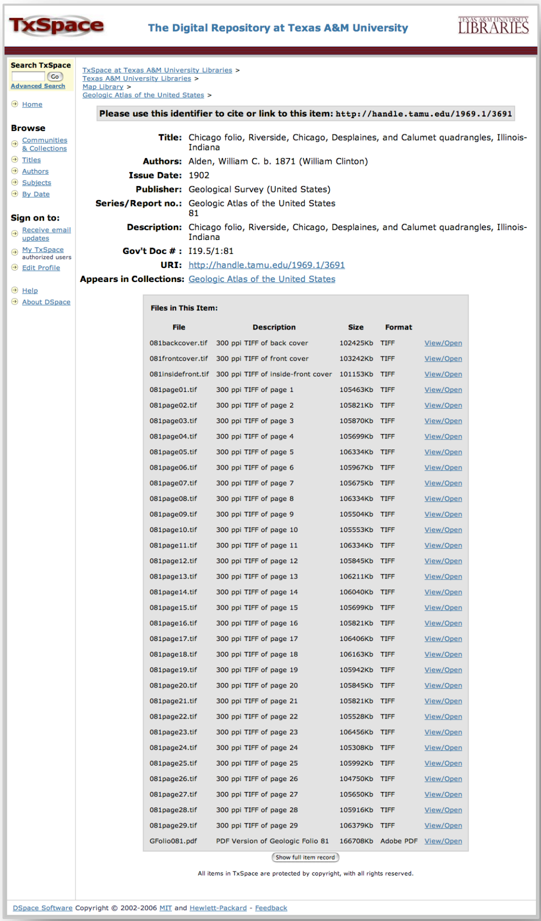

Figure 1: Screen capture of the default DSpace item view.

Similarly, the rich geographic metadata embedded in the collection was wasted. Although the folios used the geographic coverage region in the title, these names are frequently obscure, and textual lists do not provide geographic and spatial context. The options for browsing through the items in a collection included title, author, and date. Sorting or rendering the collection based upon a different metadata field was not possible. The same interface restrictions applied to the search results. Any folios that were returned as a query result were disconnected from their geographic context.

It was clear that the interface provided by the default front-end in the repository failed to leverage the unique properties of the folio collection. The digital library was providing valuable data, but the degraded experience offered through the user interface reduced the collection's impact and usability [19].

4. Approach

To address these shortcomings, we determined that a map-based approach for browsing and searching would improve the collection by providing a superior interface to the traditional browse lists provided by DSpace. Offering an interactive map of the entire collection would enable a user to visually determine the coverage area of a particular folio, as well as place the title in its proper geographic context.

4.1 Centralized Approach

Our initial approach was to maintain the centralized nature of the repository and implement an in-house solution based on open standards. This led us to the Scalable Vector Graphics (SVG) standard, an XML-based graphics format that could be used to efficiently render the collection's contents. The geospatial metadata associated with items would be used to draw corresponding vector shapes on a map of the United States, one for each folio. Clicking on the shape would take the user to that item, while clicking on a state could display a list of all folios in that state (see Figure 2).

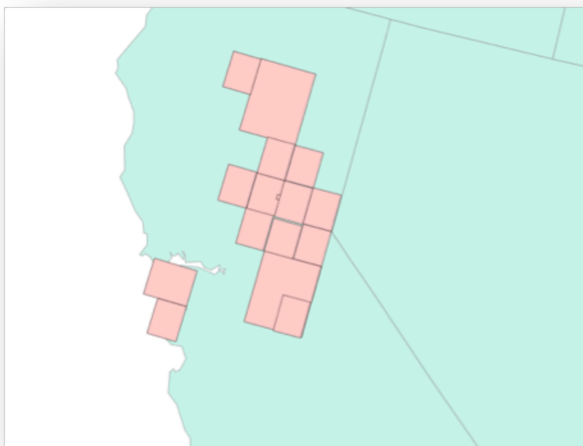

Figure 2: Screen capture of the prototype SVG interface. (image source: Steven Bereyso)

However, even though SVG was already a mature standard at the time, widespread browser support had not yet materialized, making it an unfavorable option. Lacking native SVG support in their browser, users would experience a greatly diminished interface. The alternative requires installation of a third-party plug-in, largely eliminating the primary benefit of a completely web-based solution.

4.2 Cooperative Approach

Once SVG was determined to be impractical, we were forced to reconsider our underlying assumptions and look toward a more cooperative model. Several service providers offered mapping APIs that could quickly and easily generate maps to be embedded in external sites. The leading contenders were the APIs from Yahoo! and Google. We chose the Yahoo! Maps interface because in early 2006, the satellite imagery and interface customization included with the Yahoo! solution was aesthetically superior.

Using the geospatial metadata stored in the repository, each item was plotted as a marker on the map. The marker expands to reveal additional information about the folio, such as its title, latitude and longitude. The marker information also provides a link directly to the detailed view of the item. The search results were similarly customized and the repository was modified (using the Manakin framework) to dynamically generate a map that included only the items returned for a particular query. Although the Yahoo! API provided functionality for geocoding and place name resolution, these features were unnecessary for this collection because of the availability of native geospatial metadata. A screen capture of the finished interface can be seen in Figure 3.

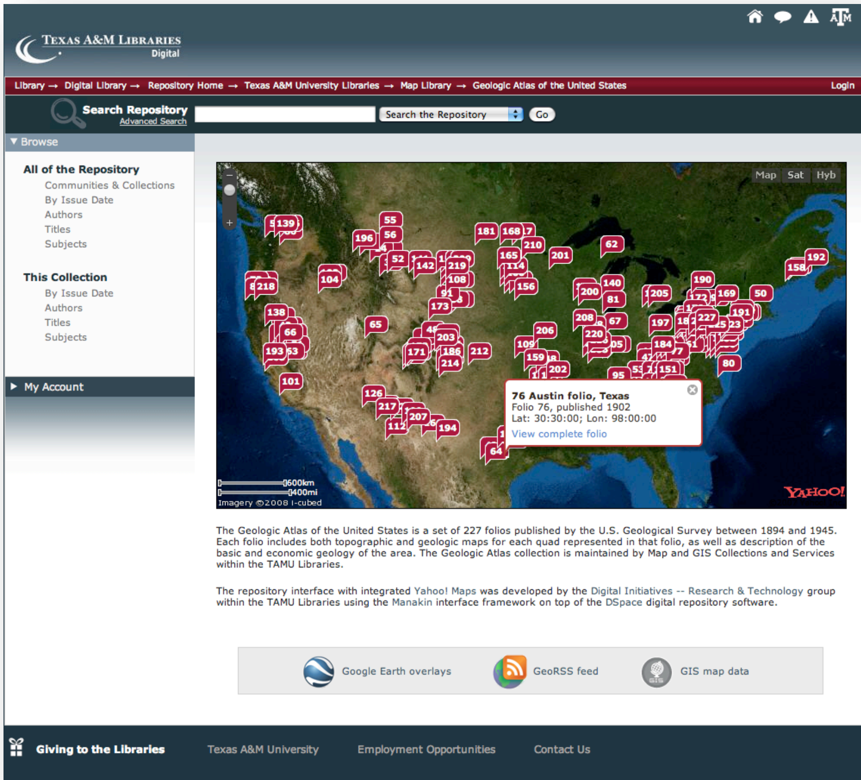

Figure 3: Screen capture of the collection overview with integrated Yahoo! maps interface.

To address the interface challenges related to the complex items in this collection, the detail view of the item was also customized. Since each item consists of a set of images to represent the pages in the folio, an image gallery-style viewing interface was adopted (see Figure 4). Lower-resolution thumbnails provided surrogates for the larger images, while keeping the full, archival-quality TIFF for preservation purposes. The open source Javascript library Lightbox provided a user-friendly way to maintain context while viewing a more detailed image [5]. These changes can be compared to the detail view from the original interface as seen in Figure 1.

By integrating our repository with external APIs we significantly improved the interface to one of the Library's unique collections. The collection's visibility was enhanced, and the overall user experience of the repository was strengthened. Adopting the Web 2.0 philosophy of cooperation allowed us to integrate with a robust data service offered by Yahoo!—a service that addressed the specific properties of the collection and the needs of our users.

4.3 Content syndication

Digital libraries and repositories are well equipped to be data providers: their content is often unique and of high quality, the accompanying metadata is rich and complete, and integration with identifier mechanisms like HDL and DOI ensures some degree of URI persistence. Most DSpace repositories, such as The Texas A&M Repository, have provided access to metadata through OAI-PMH for several years.

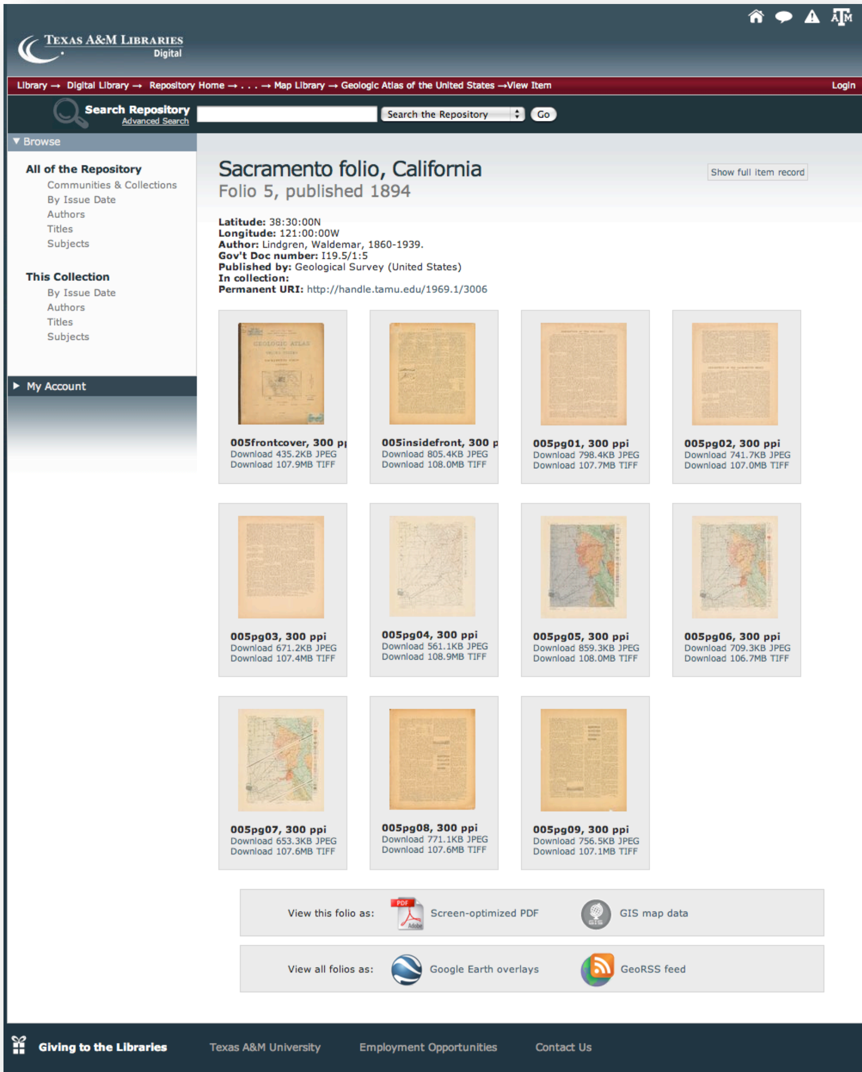

Figure 4: Screen capture of the item detail page with thumbnail surrogates (cf. Figure 1).

While openly available metadata is beneficial, the OAI protocol is relatively unknown outside the digital library community, limiting the audience that might repurpose the data for novel applications. In addition to any existing delivery methods, we wanted to provide new views into the collection that were based on open and clear web standards in common use today.

- **GeoRSS:** RSS and Atom are the dominant protocols used to syndicate content across the web. One of the most common ways of embedding geographic location inside those formats is the GeoRSS XML schema [26]. By offering the collection as a feed, we increase the visibility and appeal of the collection's data to the broader web community. Leveraging this format instantly connects our content with a wide array of tools that understand, aggregate and manipulate these files.

  The GeoRSS feed we provide includes a subset of the descriptive metadata for each item, location information, and a link to the item's representation in DSpace. An example of a simple application of GeoRSS involves passing the XML feed as a parameter to Google Maps, which will plot the location of each folio, and provide basic information about the item.

- **METS representation:** Also encoded in the Atom feed is the URI of a METS representation of each item [12]. The XML-driven interface used by the Texas A&M Repository separates the metadata, presentation and structure of its object, making each part individually accessible [23][21]. Thus, an item's metadata—encoded as a METS object—is available as a stand-alone resouce through its persistent URI.

  The METS schema encapsulates both descriptive metadata and structural relationships within the item, providing URIs to all of its component resources. The addition of METS to the Atom feed provides an alternate view of the complete collection in a RESTful manner [6].

- **Specialized formats:** RSS syndication represents an attempt to broaden access to the collection; however, there are advantages to specialized applicaion interfaces. The GIS community has worked with geographic data for many years, and has developed a rich toolset to aid in this task. KML is an XML-based format that is part of the OpenGIS standard, and is used by Google Earth, a popular virtual globe application [12].

  To capitalize on the program's capabilities, we created additional surrogates for each map image that were optimized for the overlay mechanism used by Google Earth. Along with links to the item detail pages, these surrogates are referenced in a KML file distributed with the collection, providing an alternate browsing mechanism. GeoTIFF metadata is also provided for each folio, usable by specialized software such as the ArcGIS suite of applications.

The benefits of content syndication are often not seen in the short-term; by opening access to a collection's data, a framework is provided for others to re-use that content in innovative ways. Early traffic analysis across the collection indicates these formats are beginning to be used by the user community. A more rigorous statistical analysis could be conducted once the interface has matured through wider exposure.

5. Conclusion

The Geologic Atlas of the United States in the Texas A&M Repository was an example of great content locked in a generic interface. The default repository interface was not equipped to handle the unique challenges associated with the folio's complex item structure, and geospatial metadata was being ignored entirely. As improvements were considered, we were faced with a choice: cooperate with the external Web 2.0 community, or maintain control of our data and interface and remain closed. We chose to cooperate.

Tim O'Reilly offered two criteria for interoperation with the Web 2.0 network of data services: publish content through syndication, and re-use the data services of others [20]. Content syndication through GeoRSS and METS provides a RESTful mechanism to obtain the collection's data, and domain-specific formats like KML and GeoTIFF allow users to browse the collection with specialized tools. Open APIs were used to create a rich, mapcentered interface for the collection, and manage the complex item structure through thumbnail surrogates and context-sensitive image previews.

Responses from the user community have been positive. Comments focused on the usability enhancements to the interface, particularly the ability to browse items in their geographic context. The interface was cited as an "Editor's Pick" by the Yahoo! Developer's Network for its use of their maps API (see Figure 5). Similarly, Google highlighted the KML data feed in its KML Gallery Gadget available on its customized homepage (see Figure 6).

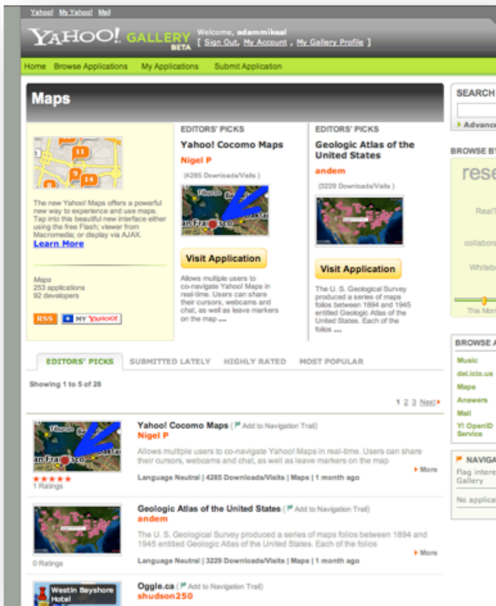

Figure 5: Yahoo! Developer's Network application gallery

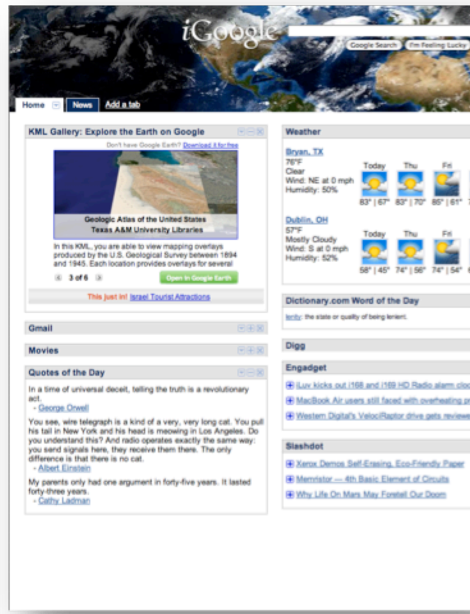

Figure 6: Google's KML Gallery web gadget

To reinforce this qualitative feedback with quantitative results, a formal usability study should be conducted with respect to the changes introduced by the new interface [24]. Basic usability factors such as ease of use, efficiency, and learnability can be quantitatively measured, and together with aggregate traffic analysis can be used to identify beneficial changes to the interface.

Engagement in the Web 2.0 ecosystem can provide significant benefits to the digital library. There is a rich mesh of freely available services that offer much to gain in interface design and syndicated content. Likewise, digital libraries and institutional repositories have much to contribute to that ecosystem as well—a large amount of valuable content not available anywhere else. When cooperation is fostered between these two communities, everyone wins.

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