



McMaster eBusiness Research Centre

**FOSTERING ROBUST LIBRARY PORTALS:
AN ASSESSMENT OF THE
MCMASTER UNIVERSITY LIBRARY GATEWAY**

By

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Wuping Zheng, Eric Fu, Tao Jiang and Demos Syros**

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**McMaster eBusiness Research Centre (MeRC)
Michael G. DeGroote School of Business**

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ABSTRACT

Library portals are important vehicles by which to support the information needs and uses of library patrons. These systems provide users with convenient, personalized Web-based access to a comprehensive collection of information resources of relevance and authority. Moreover, library portals support a broad range of information seeking activity from browsing to search, provide mechanisms for communication and collaboration, and facilitate knowledge creation and sharing – all through a usable, intuitive interface.

This report proposes an evaluation framework for library portals that assesses the overall robustness of library portals on five dimensions: (1) the usability of the system interface; (2) the ability of the portal to support a wide spectrum of information seeking activity; (3) the personalization of the interface in ways that match individual user needs; (4) the extent to which the portal fosters knowledge work; and (5) the degree to which intelligent agents are employed.

To test the viability of the framework, a real-life library portal, the McMaster University Library Gateway, is assessed. Overall, the system is found to exhibit some good characteristics, however recommendations are suggested to improve the overall robustness of this specific library portal's design. *Immediate recommendations* include the need: (1) to improve the terminology used on the library portal interface to limit or reduce library jargon; (2) to fix inconsistencies in the screen design; and (3) to clean-up some navigation problems. *Short term recommendations* include the need: (1) to provide an integrated library portal site design that does not mimic the physical structure of individual libraries; (2) to make the distinction between the library catalogue and other electronic resources transparent to users; and (3) to provide better Web log tracking metrics. *Long term recommendations* concentrate on: (1) personalizing the site to individual user needs; (2) offering communication and collaboration areas; (3) providing a single browse/search function that is immediately accessible from the portal's homepage and does comprehensive searching across the entire library's resource collection; and (4) leveraging the use of intelligent agents.

As such, the proposed evaluation framework proves to be an effective tool by which to assess the robustness of library portals and to elicit recommendations for enhancements and modifications.

KEYWORDS

library portals, gateways, Web interface design, information seeking, information needs and uses, knowledge work, intelligent agents

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1. INTRODUCTION

The purpose of this report is twofold. The first is to propose a framework by which to evaluate the robustness of library portals. The second is to apply the framework to a real-life library portal initiative as a means of testing the viability of the framework in providing useful and salient recommendations concerning future enhancements to the portal system.

The initial framework was devised in December 2002 as part of an MBA project assignment for a course entitled *K726: Information Retrieval and Intelligent Agents* taught at the Michael G. DeGroote School of Business. In this course, students were introduced to the design and structure of different types of intelligent agents and Web information retrieval systems, such as portals and search engines, in support of electronic business and knowledge management. The idea to utilize the framework as means to assess the strengths and weaknesses of a real-life library portal, namely the McMaster University Library Gateway, was hoped to be a method by which students could apply ideas and concepts taught in class to a real-life Web-based information retrieval system. The class comprised eight MBA and Ph.D. students. Students were permitted to work individually or in pairs. The final deliverable was a detailed report worth 40% of their final grade. This working paper represents the culmination of the best ideas from these individual reports, as well as some theoretical commentary from the course instructor.

The strength and beauty of this working paper is that it represents and aggregates the honest opinions of eight graduate students whose task was to provide a critical assessment of the McMaster University Library Gateway. In this respect, the opinions are objective and without bias. The report represents the views of real Gateway end-users who, through the K726 course, were well-versed on the fundamental concepts underlying Web-based information retrieval and the application of those fundamentals to portal environments. As such, the accolades, criticisms, and recommendations put forth provide a fairly educated and objective evaluation of the McMaster University Library Gateway as it stood in first quarter 2003.

The authors of the report hope the recommendations suggested inspire change in the design of the McMaster University Library Gateway in ways that: (1) lead to increased perceived usefulness and ease of use of the system; (2) facilitate effective and efficient end-user browsing and search behaviour; (3) better match the information needs and uses of library constituents through personalization of the portal interface; (4) foster knowledge creation, distribution, and use activity; and (5) leverage intelligent agent technologies to the Gateway's advantage. It is also hoped that the framework will serve as a basis for informing and evaluating the design of other library portal initiatives in ways that promote portal use and library patron satisfaction.

In terms of the paper's organization, this report is structured into five further sections. The first offers a description of library portals and their importance, particularly in academic settings. The second presents an overview of a library portal evaluation framework, with special emphasis on the underlying theory on which the framework is grounded. The third provides background information on the McMaster University Library Gateway initiative. The fourth utilizes the framework to assess and evaluate the Gateway, giving both positive and critical commentary on the effectiveness of the Gateway's ability to serve as a robust library portal. The fifth and final section provides a summary of recommendations for the McMaster University Library Gateway and reflects upon the viability of the framework in serving as an effective framework to assess library portals initiatives in general.

2. LIBRARY PORTALS

There has been considerable interest and research activity in library portals in recent years. At the end of 2000, a special issue in *Information Technology and Libraries* (ITAL) journal was devoted to the topic. There, library portals were defined as “user-centered, customizable interfaces to collections of library resources” (Morgan, 2000, p.166). Such a description emphasizes the need to build robust interfaces to library resources – interfaces that address the information needs and uses of patrons through personalization of information content tailored to individual preferences. As libraries create, license, or negotiate access to more and more digital content, the need for such easy-to-use interfaces becomes increasingly important (Pasquinelli, 2002).

The special ITAL issue serves as a good primer on library portals. It raises awareness of certain challenges facing library portal implementations, such as privacy issues, technical barriers, hidden costs, the lack of adequate evaluation metrics, the disintermediation of traditional librarian roles, et cetera. It also details three separate library portal initiatives: the University of Washington’s My Gateway (the personalized component of the University of Washington Libraries’ Information Gateway available at www.lib.washington.edu); Virginia Commonwealth University’s My Library project (available at www.library.vcu.edu/mylibrary); and North Carolina State University Libraries’ personalized library portal (available at <http://my.lib.ncsu.edu>).

So why all the fuss? Foremost is the fact that library portals have the potential to leverage the role of libraries as we know them today. Consider the following description:

“A library Web portal has the potential of changing how libraries are used and how librarians will do their work. These portals have the potential of bringing about real change to our professional and organizational culture. These changes will enable libraries to be customer centered. Systems and processes will be based on dynamically linked and scalable databases that will enable library staff to concentrate on content delivery and teaching. These trends will inevitably enhance the academic library’s ability to deliver positive learning outcomes to customers and stakeholders.” (Lakos and Gray, 2000, p. 169).

Pretty heady stuff. In fact, such grandiose promises have infiltrated the corporate sector as well. There, enterprise portals are the new mantra. These are “applications that enable companies to unlock internally and externally stored information, and provide users a single gateway to personalized information needed to make informed business decisions” (Shilakes & Tylman, 1998). The benefits of enterprise portals are well documented. They provide organizational workers with structured access to information, support a common and personalized view of enterprise information, improve employee productivity, and offer competitive and strategic advantage (Dias, 2001).

However, library portals are slightly different than enterprise portals. Though both provide a path to all-encompassing content and services from one access point (Hagedorn, 2000), library portals serve patrons who may or may not be members of a single organization and, as a result, have a wider range of information needs and a larger distribution of people in terms of their familiarity and comfort with computers. For example, in an academic setting, library portals would serve students, faculty, alumni, community members, as well as the general public. Here, the library portal serves as a gateway by which students and faculty can locate and access information resources in a convenient and efficient manner, as well as a place where teaching and learning can occur (Dowler, 1997). As such, library portals in academic environments bear upon two of

the three keystone principles identified by the Association of Research Libraries:

- (1) libraries are responsible for creating innovative information systems for the dissemination and preservation of information and knowledge regardless of format; and
- (2) the academic library is the intellectual commons for the community where people and ideas interact in both the real and virtual environments to expand learning and facilitate the creation of new knowledge (Deiss, 1999).

There are variations in the literature on the agreement over what constitutes or differentiates a library portal from other library Web initiatives, such as a Web-based front-end to a library catalogue. According to Pasquinelli (2002):

“Library portals typically include an online catalog of materials as well as gateways to collections of digital resources accessible to the user. Broadcast search tools allow library users to search all of these sources simultaneously with a single query. Portals may include electronic reference services (“ask a librarian”), personalization features (“my bookshelf,” custom intelligent searches), and other research tools. Enriched content, such as author biographies and book reviews, tables of contents, and jacket images can be provided to supplement the online catalog. Some libraries have built interactive features into their portals, allowing development of virtual communities.” (Pasquinelli, 2002, p. 24)

As such, library portals are more than Web-based front-ends. They are environments where users personalize and interact with library resources, using them not only to access information content, but also to communicate and collaborate with others. But should libraries be concerned about building such robust systems? According to Noer (2003), they definitely should:

“With the expanding Internet and, particularly, the increasing availability of high bandwidth connections, the age of portals is upon us. Portals are merely aggregations of services on one Web site so the user does not have to hunt in many different sites for the things s/he wants whether these things are information or games or shopping. Portals are really department stores or shopping malls on the Web.

Portals are already becoming specialized and a serious commercial operation. One of the most defined niches is the educational portal where the portal service provides all the computing services a university or school will need via its Web site. Each university using the service has individualized access to the functions and features from student administration to the development and delivery of remote learning courses. This sort of service portal is not yet available in the information [i.e., library] world, but it cannot be far away.

Libraries need to establish their information portals with a broad spectrum of information providing services so they can retain their position as the one stop shop for information in their community. If they don't do this then the community portals (geocities, etc.) will provide local information, the business portals will take that role, the direct delivery shops and sites (amazon.com...) will supply the reading material and the library will be left as a series of meeting rooms and an archive.

Portals may possibly represent the biggest threat to libraries in the medium and long term, but they also offer an opportunity for libraries to regain a position they haven't held

since possibly the middle ages.” (Noer, 2003, p.144)

The message here is that libraries are at a crossroads. Libraries can respond and build robust library Web interfaces that meet user information needs and demands, or take their chances in letting other information intermediaries, such as Web search engines, provide those services. Fortunately, there is evidence of libraries stepping up to the challenge. For instance, in a new paragraph in Noer’s third-edition of his white paper, he notes a trend where:

“Portals are being embraced by libraries and they may be their salvation in the battle against the Web search engines as the place to look for answers. The libraries’ online presence is fighting back with the portals and meta search engines and enriched content and additional services, all from a source the users trust.” (Noer, 2003, p. 144)

This is good news for all of us.

3. A LIBRARY PORTAL EVALUATION FRAMEWORK

This section of the report discusses the workings of a proposed library portal evaluation framework. The purpose of the framework is to provide a guide by which to assess a library portal in terms of its overall robustness on many dimensions. As such, the paper’s framework proposes an evaluation of a library portal in terms of five characteristics which, in the authors’ opinion, are all critical components influencing the overall robustness of a library portal system.

Figure 3-1 below illustrates the framework’s five components. Specifically, these are: usability concerns; (2) the degree to which the full spectrum of end-user information seeking behaviour is supported; (3) the extent to which personalization of the portal interface meets the information needs and uses of library patrons; (4) the ability of the portal to foster knowledge work; and (5) the extent to which intelligent agent technologies are deployed to leverage portal use.

The theory underlying each of the framework’s five characteristics is described in the next subsections.

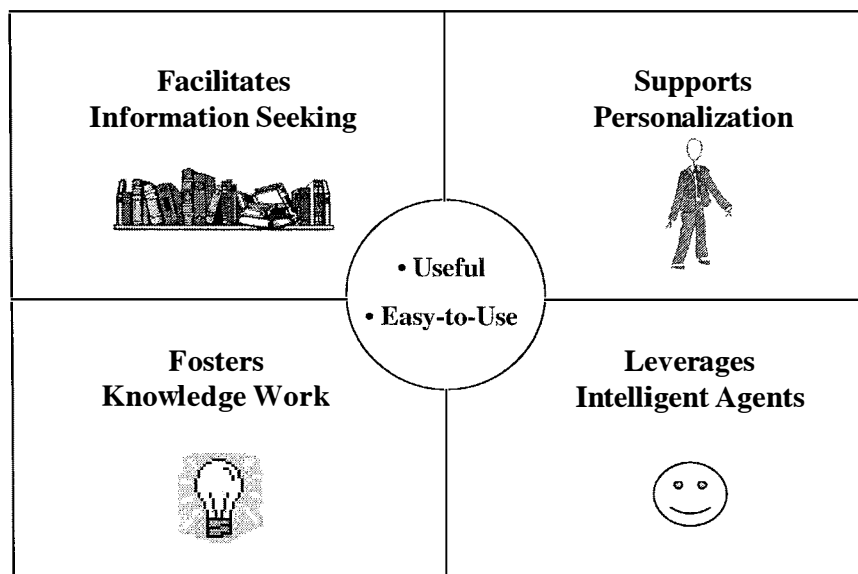


Figure 3-1: Components of a robust library portal

3.1 Useful and Easy-to-Use

A recent article by Thong, Hong, & Tam (2002) in the *International Journal of Human-Computer Studies* provides empirical evidence of a user acceptance model for digital libraries. Their model is relevant to this report in that the model identifies key factors which influence user adoption of such systems. Thong et al. base their model on the well-established Technology Acceptance Model (TAM) devised by Davis and his colleagues (Davis, 1989; Davis, Bagozzi & Warshaw, 1989).

Over the years, TAM has been successfully applied in examining adoption behaviour of various information systems. TAM defines *perceived usefulness* as the extent to which an information system will enhance a user's performance and is proposed to have a direct impact on system adoption since a user would be more willing to use a system if it is perceived to provide valuable functions. TAM defines *perceived ease of use* as the extent to which a person believes a system will be free of effort and is proposed to influence both adoption and perceived usefulness since the easier it is for a user to interact with a system, the more likely the user would find it useful and intend to use it.

In Thong et al.'s model, various factors are identified that have an impact on the perceived usefulness and perceived ease of use of a digital library. These factors consist of three system interface characteristics, three organizational context variables, and three individual differences and are illustrated in Figure 3-2 below. Specifically, organizational context is shown to influence both perceived ease of use and perceived usefulness, while interface characteristics and individual differences are shown to affect the perceived ease of use of digital libraries.

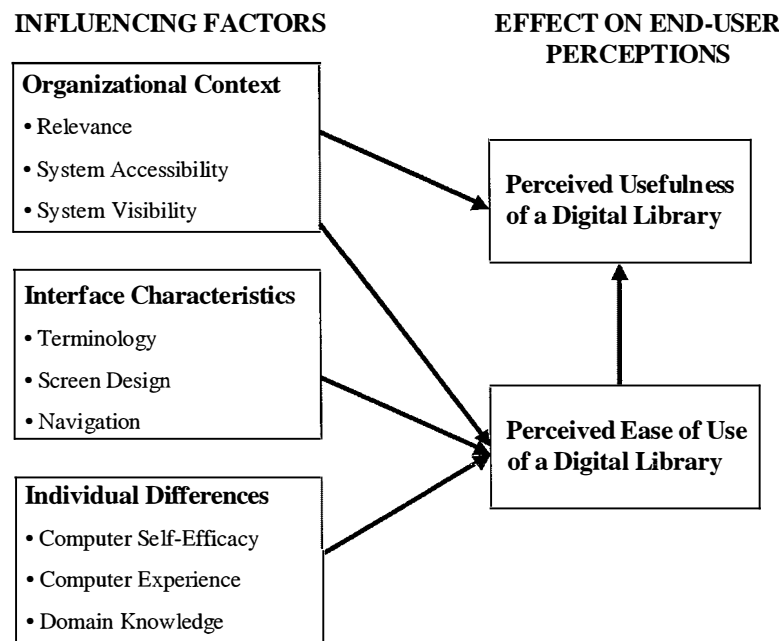


Figure 3-2: Factors affecting perceptions of a digital library (adapted from Thong et al. 2002)

With respect to organizational context, there is relevance, system accessibility, and system visibility. *Relevance* in the digital library context is the match between the system's content and

individual user's needs. The better able the system is to provide relevant documents to users, the greater the increase in users' perception of the digital libraries usefulness and ease of use. *System accessibility* is defined as the ease with which people can locate specific computer systems. The more accessible a digital library is, the greater the positive perceptions users have of its overall usefulness and ease of use. *System visibility* is the extent to which a digital library is visible and its benefits are demonstrable to others. Digital libraries with greater visibility lead to increased perceptions of the system's usefulness.

In terms of interface characteristics, there is terminology, screen design, and navigation. *Terminology* refers to the words, sentences and abbreviations used by a system. The degree to which users interact with a digital library depends on how well users understand the terminology displayed on the system interface. For instance, one major problem with digital libraries is inappropriately used jargons (Talja et al., 1998). Many users of digital libraries do not have the same training or educational background as library staff. Thus, the terminology used in digital libraries should be in layman's terms, rather than in library-speak. Closely aligned terminology between users and a digital library leads to greater perceptions of the ease of use of the system. *Screen design* refers to the way information is presented on the system interface. In the context of the digital library, it matters not only what is displayed but also how that information is presented. For instance, graphical user interfaces were found to foster richer interactions with both information retrieval systems (Hu, Ma, & Chau, 1999) and digital libraries (Liu et al., 2000). Well-presented screen designs lead to greater perceived ease of use in digital libraries. *Navigation* refers to the ease with which user can move around the digital library. Good navigation reduces information and cognitive overload as well as disorientation. Greater navigation clarity in digital libraries positively affects perceived ease of use.

In terms of individual differences, there is computer self-efficacy, computer experience, and domain knowledge. *Computer self-efficacy* is defined as an individual's judgement of one's own capability of using a computer. *Computer experience* refers to an individual's past dealings and usage of computers in general. *Domain knowledge* refers to an individual's knowledge in a particular subject domain. All three of these factors have positive effects on perceived ease of use of digital libraries.

Altogether, the above criteria from Thong et al.'s (2002) framework provide useful metrics by which to evaluate the effectiveness of a digital library in terms of its usability, particularly in its perceived usefulness and ease of use.

3.2 Facilitates Information Seeking

Information seeking is a broad behavioural endeavour. It is "a process in which humans engage to purposefully change their state of knowledge" (Marchionini & Komlodi, 1998, p. 97). In this sense, information seeking is not a restrictive, narrow activity but rather a dynamic process comprising a wide array of tasks ranging from wayward browsing and exploration to specific, goal-directed search (Marchionini, 1995). This report suggests that library portals need to focus not just on the information retrieval aspects of information seeking (i.e., search), but also browsing activity as well. Doing so, it is argued, would help support library patrons in their various on-going modes of information seeking.

According to Weick & Daft (1983), there are four modes of scanning that cover all modes of information seeking activity in which individuals engage, namely undirected viewing, conditioned viewing, informal search and formal search. The first two are browsing in nature; the latter two are searching-related.

In *undirected viewing or browsing*, the overall purpose is to scan broadly. Many and varied sources of information are used, and large amounts of information are screened. The goal of broad scanning implies the use of a large number of different sources and different types of sources. These sources should supply up-to-date news and provide a variety of points of views.

In *conditioned viewing or browsing*, the individual directs viewing to information about selected topics or to certain types of information. The individual has isolated a number of areas of potential concern from undirected viewing, and is now sensitized to assess the significance of developments in those areas. The individual wishes to do this assessment in a cost-effective manner, without having to dedicate substantial time and effort in a formal search. Hence, the individual routinely focuses on browsing through pre-selected sources of interest.

During *informal search*, the individual actively looks for information to deepen the knowledge and understanding of a specific issue. It is informal in that it involves a relatively limited and unstructured effort.

During *formal search*, the individual makes a deliberate or planned effort to obtain specific information or information about a specific issue. Search is formal because it is structured according to some pre-established procedure or methodology.

Table 3-1 below illustrates the various types of tasks in which end-users engage themselves when operating in each of these four modes. It is suggested that a robust library portal would support users in each of these modes of behaviour.

Information Seeking Mode	End-User Task Behaviours
Undirected Browsing	<ul style="list-style-type: none"> • Examination of general areas of interest over a broad number of sources • Visitation of Web pages may indirectly lead to visitation of a specific Web site
Conditioned Browsing	<ul style="list-style-type: none"> • Recognition of areas of interest with a focus on pre-selected sources • Interest is instigated through customized site news and new features that may be specific to a user
Informal Search	<ul style="list-style-type: none"> • Formulation of search queries on convenient and easily accessible information resources • Search queries are usually basic and broad
Formal Search	<ul style="list-style-type: none"> • Characterized by an optimization period entailing a systematic gathering of information • Search queries are usually advanced and specific

Table 3-1: Information seeking modes and task behaviours (adapted from Weick & Daft, 1983)

Choo, Detlor, and Turnbull (2000a, 2000b) offer suggestions on tailoring the design of Web sites, particularly in organizational settings, in ways that support Weick & Daft's four information seeking modes. These suggestions applied to library portal environments are summarized in Table 3-2 below.

Information Seeking Mode	Implications for Library Portals
Undirected Browsing	<ul style="list-style-type: none"> • Introduce search tools or recommendation tools that can identify Web sites or other portal sites that match users' subject areas of interest. • Encourage users with similar subject interests to share URLs of preferred Web sites • Support the wayward, undirected, serendipitous browsing of information
Conditioned Browsing	<ul style="list-style-type: none"> • Train users to evaluate and identify sources of information of high authority • Make it easy for users with similar subject interests to share information via e-mail or online forums • Offer or introduce users to services that allow them to subscribe to and be notified about new content of interest
Informal Search	<ul style="list-style-type: none"> • Pre-select high quality sources and search engines for quick, informal searches • Pre-package good search strategies developed by subject matter experts – allow users to view these strategies and learn from them • Educate users on how to evaluate information provenance and quality
Formal Search	<ul style="list-style-type: none"> • Educate users about the full range of information sources that should be considered for comprehensive searching • Educate users about when to use commercial online databases, the library or other information resource centres, information brokers • Train users on advanced search techniques: narrowing or broadening a search; balancing precision and recall; backward and forward chaining

Table 3-2: Information seeking modes and implications on library portals

Overall, the above discussion raises awareness of the need to support a range of information seeking modes from browse to search. It is suggested that a robust library portal would be one that facilitated such a spectrum of information seeking activity.

3.3 Supports Personalization

Yahoo! was the first major large-scale Web portal to offer a personalized portal service called *MyYahoo!* launched back in 1996. Since then, tailoring what and how information is displayed on a portal to individual users has been lauded as one of the primary benefits of enterprise portal systems (Collins, 2003, Stenmark 2003). To facilitate this tailoring of information display, either the system itself can customize the presentation of information based on predefined user roles or the system can permit users themselves to personalize the information displayed (Strauss, 2002).

Personalizing the display of information to user needs meshes well with the principles of the Library and Information Science discipline – a field dedicated in part with addressing the information needs and uses of people (Julien & Duggan, 2000). The two latest published reviews of the information needs and uses literature by Hewins (1990) and Dervin & Nilan (1986) acknowledge the gap between information needs and uses research and information system practice. As a means to bridge this gap, there have been increased calls for more user-oriented system designs and concentration on building systems which match individual user information needs. The personalization of Web-based information content is one method of by which information systems can better address the information needs of users.

As such, the proposed evaluation framework for library portals suggests that the personalization of information content is a requisite feature robust library portals should support.

3.4 Fosters Knowledge Work

One of the premises of this report is that library portals are in actuality instantiations of knowledge portals. What are knowledge portals? According to Mack, Ravin, & Byrd (2001), a knowledge portal is an information portal used by knowledge workers. In a similar vein, Detlor (forthcoming) defines a knowledge portal to be a specific breed of portal supporting the three main facets of information content storage and retrieval, communication, and group collaboration.

The premise behind Detlor's definition is that portals are information-rich work environments, and not merely simple information dissemination tools. In this light, portals can provide people with a shared information work space to facilitate the creation, exchange, retention, and reuse of knowledge (Detlor, 2000; Choo et al., 2000b). The major components of such a workspace applied to library portals consist of: (1) a content space to facilitate information access and retrieval; (2) a communication space to support the negotiation of collective interpretations and shared meanings; and (3) a coordination space to support cooperative work action.

As an information *content space*, library portals can help facilitate storage and access to relevant information content. In terms of a *communication space*, library portals can help patrons make better sense of the information they receive. This can be accomplished through the provision of rich information channels to help library portal users engage in conversations and negotiations with others library patrons and staff. In this way, new perspectives and innovation can result. As a *coordination space*, library portals can offer patrons with the ability to manage the flow of information necessary for cooperation between various knowledge workers. This necessitates the need for portals to have requisite functionality in their designs to automate workflows, coordinate routines, and manage projects, as well as signal the expertise of others and their availability for

cooperative action.

By providing these three distinct spaces, library portals can offer patrons the benefit of acquiring, distributing, interpreting, storing, and retrieving information in their daily work that promotes knowledge creation, distribution and use. A library portal model that exemplifies the functionality of a knowledge portal is given by Pasquinelli (2002). There the library portal environment is composed of six distinct areas (see Figure 3-3 below): *My Library*, *Local Resources*, *Virtual Reference Desk*, *Remote Resources*, *Library Information*, and *Online Communities*.

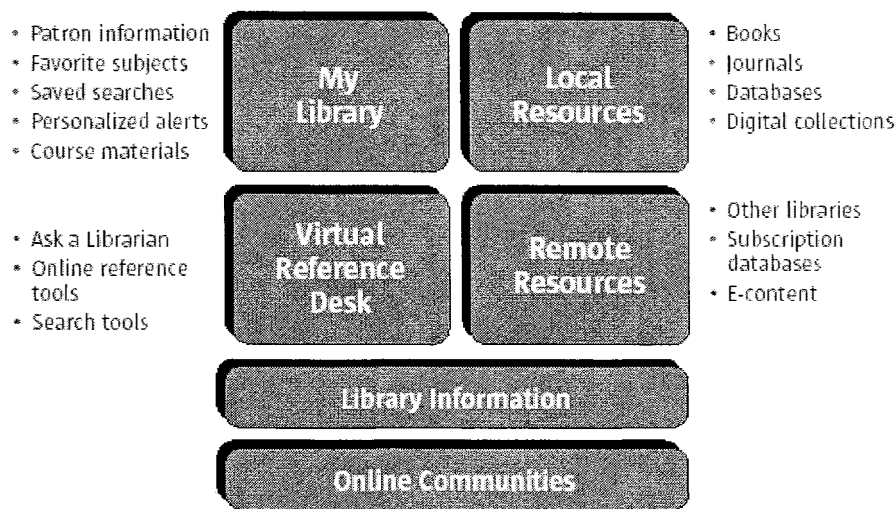


Figure 3-3: A library / knowledge portal (Pasquinelli, 2002, p. 23)

The *My Library* component allows a user to personalize the virtual library experience by creating quick access to content, collaboration and communication tools and features. An example of an *My Library* implementation is Cornell University's *My Library* component which offers two main services: *MyLinks* and *MyUpdates* (Calhoun, 2002). *MyLinks* contains links to Web sites, tools or utilities that are commonly used by a particular user. *MyUpdates* contains updates on specific content that has been requested by a user, such as notices of a new journal publication or an article on a specific topic. Additional services in *My Library* could include outstanding and ongoing information requests.

The *Local Resources* component includes all local content, including databases, digital collections, online books, and online journals that are hosted on a library's computers.

The *Virtual Reference Desk* component enables a user to receive a comparable level of reference service in the virtual environment as the physical environment. The component assists with communication and finding content. For example, it contains functions for finding information such as search engines, online referencing tools, or an 'Ask a Librarian' feature. The ideal search tool would be one that allows for searching through all digital information including external resources. The 'Ask a Librarian' feature could be implemented through interactive chat sessions as more users move towards the sole use of the virtual library.

The *Remote Resources* component provides access to other libraries, subscription databases and other external electronic content. The main feature of this component is to allow access to resources that are external to the library.

The *Library Information* component provides information about the library and its resources such as hours, locations, 'how to' documents, and contact information.

The *Online Communities* component addresses the collaboration facet of a knowledge portal. Site functionality such as chat and discussion rooms that are accessible via inter- and intra-library environments can provide the basis for establishing collaboration through online communities. Furthermore, specific discussion rooms on predefined topics could enhance learning by bringing interested parties together to assist in or discuss new research.

Of relevance is that the elements of the Pasquinelli's library portal model satisfy Detlor's description of a knowledge portal (see Figure 3-4). Specifically, the *Online Communities* component provides the ability for collaboration and communication; the *My Library* and *Virtual Reference Desk* provide the ability for communication and the storage and retrieval of information content; *Local Resources*, *Remote Resources* and *Library Info* provide additional information content features.

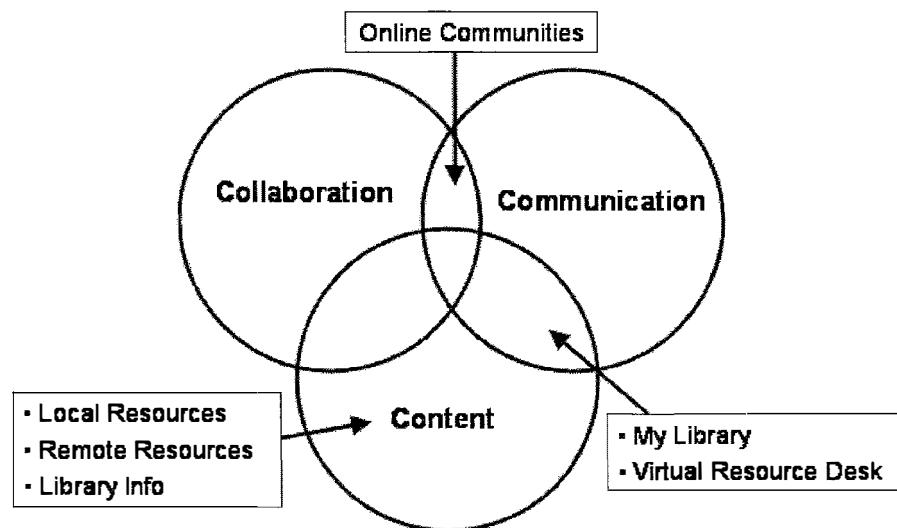


Figure 3-4: A mapping of Pasquinelli's library portal components to Detlor's description of a knowledge portal

The proposed evaluation framework for library portals suggests that the ability to foster knowledge work through the provision of content, communication, and collaboration spaces is an important feature for library portals to address. It is argued that the provision of such functionality and services could lead to more robust designs.

3.5 Leverages Intelligent Agents

An intelligent agent is a software program that acts on behalf of users to find and filter information, negotiate for services, automate complex tasks, and collaborate with other agents to solve complex problems (Agentbuilder, 2000). Due to the vast and rapid growth of electronic information sources available in libraries today and the increased user demand for convenient and quick access to this information, intelligent agents offer promise in helping end-users address information overload and filtering problems, as well as assisting library staff in managing the

acquisition, access, and organization of these information resources. Though certain challenges still prevent the wide adoption and deployment of agent solutions (Nwana & Ndumu, 1999), the challenges are likely to be overcome in the next few years with the advent of the Semantic Web (Berners-Lee, 2003; Berners-Lee, Hendler, & Lassila, 2001; Port 2002). As such, software agents will soon be viable tools by which to assist end-users in their information seeking activities and interactions with digital library resources. Several digital library projects currently underway aim to utilize intelligent agents in their designs (e.g., Derbyshire et al., 1997 ; Wellman, Durfee, & Birmingham, 1996).

Detlor and Arsenault (2002) provide a model which illustrates how various types of agents could work cooperatively together to facilitate information seeking and retrieval across library domains. The model portrays individual library users having a personal *interface agent* that utilizes user profile information to tailor the display of information on the computer interface. The user profile database would contain personal information about the library patron, such as subject areas of interest, favourite library resources, and perhaps a history of previous information requests or feedback information from the user on the relevance of material retrieved from past information searches. The profile would also contain outstanding and on-going information requests. Outstanding requests refer to information queries not yet deemed complete by a user. Ongoing requests would be general topics the user has expressed an interest in gathering more information about or being told of new additions to library collections that pertain to interest areas outlined in his or her profile.

The interface agent would also monitor the user's information seeking and retrieval behaviour and offer help to improve user interaction and engagement with the system. For example, the interface agent would watch how users formulate search queries or go about traversing Web sites, and then based on an analysis of this activity, offer advice or guide the user on how to do these tasks more effectively. This could result in the display of hints to the user about the existence of advanced search functions or the elicitation of suggestions about key portal or individual Web sites that may help users browse for information about specific topic areas.

A key role of the interface agent would be to communicate and coordinate activities with the user's *information agent*. The role of the information agent would be to function as an information intermediary on behalf of the user. This entails scouring library collections to fulfill information browsing and searching requests, as well as monitoring the information landscape for new information items that may be of interest to the user. Working in the background, the information agent would coordinate its actions with *server agents* and *other users' information agents*.

Server agents would service requests to specific library collections from many information agents. It would be the role of the server agent to verify the licensing authority of an information agent to utilize resources in the collection, as well as to retrieve relevant information items from the collection that satisfy an information agent's seeking and retrieval requests. The information agent would decide which server agents to poll for information, as well as the frequency of this polling. For instance, specific information queries may be performed once to satisfy a one-time request for information on behalf of a user wanting immediate feedback in real-time. Meanwhile, other information queries may be made on a continual basis to fulfill a user's outstanding information requests.

Other user information agents would be polled to determine information items of relevance from users with similar profiles. Each information agent would know its own user's interest areas, preferences for certain library collections, and ratings of the relevance of information items

retrieved from past requests. An information agent would know this from its communication with its user's interface agent that has access to the user's profile database. By coordinating and sharing this information among information agents servicing the needs of like-minded individuals, information agents could facilitate collaborative filtering with the goal of identifying retrieval items of higher relevance to users.

There are subtle differences between how the interface and information agents would operate. Interface agents would be in direct communication with users and active only during user sessions. On start-up of a user session with the library system, interface agents would need to "talk" with the user's information agent to retrieve results from outstanding and on-going information requests (if any). In contrast, information agents would not engage in dialogue directly with users and would operate continuously, even when users terminated their sessions with the library system. When users are "away", information agents would be engaged in constant communication with server agents and other users' information agents. This would allow information agents to satisfy ongoing and outstanding information requests on behalf of library patrons.

There would be many benefits of adopting such an approach. For individuals, Detlor & Arsenault (2002) identify three:

- (1) The provision of a '24/7' library reference service tailored to individual needs. Such a service would relieve users from having to re-query the same requests for information on a continual basis to address ongoing information needs.
- (2) The provision of interface agents to assist users with the information search process and better present information on library Web-based interfaces. These agents could improve information seeking and retrieval performance over time by "learning" what information was deemed relevant by the user and how that information should be displayed. The agents could also determine which library collections users prefer, displaying those and blocking out collections the user indicates not to see.
- (3) Access to an extensive yet restrictive offering of local and external library collections. This prevents users from conducting unwieldy searches across the entire World Wide Web where relevant documents are difficult to locate, and in its place, offers a rich, authoritative information space where items are catalogued to standard classification taxonomies leading to more relevant and precise information search results.

For libraries, a major benefit of an agent-based environment would be the relief of reference library staff from trying to service personal information requests for a large number of clients. This is more important nowadays given the budgetary and time constraints facing library institutions attempting to offer individualized service, and the demands of an ever-growing technology-savvy client base who want information needs satisfied in short turn-around times.

From Detlor and Arsenault's (2002) description, agents are a key enabling technology in library portal environment. As such, it is argued that more robust library portal systems would leverage the use of agent technologies as a means of assisting users in their information seeking behaviour and helping library staff manage its online information resources.

3.6 Recap

The purpose of this section was to provide a description of a proposed evaluation framework for library portals. The framework identifies key characteristics that determine the extent to which a library portal is robust. The framework suggests that a robust library portal would be one that:

- 1) offers good usability in terms of both perceived usefulness and ease of use;
- 2) facilitates a range of information seeking activity from browsing to searching of electronic journals, indexes, and online catalogues of holdings;
- 3) supports personalization of the interface in ways that address the information needs and uses of the portal's major constituents;
- 4) fosters knowledge work through the provision of a shared information work space comprised of content, communication, and collaboration areas;
- 5) leverages the use of intelligent agents to improve information seeking and knowledge creation, distribution, and use.

4. THE McMASTER UNIVERSITY LIBRARY GATEWAY

4.1 What is it?

The McMaster University Library Gateway (hereinafter referred to simply as the Gateway) is a Web-based portal to McMaster University's library resources and services. It facilitates virtual access to the University's four libraries and two library systems.

The four libraries are:

1. Mills (Social Sciences & Humanities)
2. Innis (Business)
3. Thode (Science & Engineering)
4. Health Sciences

The two library systems are:

1. Mills, Innis, and Thode which collectively fall under the University Library (UL) system and report to the University Librarian.
2. Health Sciences (HSL) which reports through the Faculty of Health Sciences.

Both UL and HSL share the same online library catalogue and work on large projects together. However they are separate entities with separate budgets, information technology systems & staff, mission statements, and cultures. Historically the two have maintained separate Web sites.

4.2 Why Study the Gateway?

The Gateway was chosen as a site to study for a variety of reasons.

First was the ease of access by which the authors of the report could utilize all components of the Gateway site and ask questions to knowledgeable library staff on the history and workings of the Gateway.

Second was the familiarity the authors had with using the Gateway on a regular basis.

Third was the welcomed encouragement by various members of the McMaster University library staff for the authors to provide feedback and recommendations on how to improve the Gateway site. The library staff at McMaster University continually poll the effectiveness and usability of the Gateway site and its subcomponents through mechanisms such as usability studies and analysis of Gateway usage statistics. As such, this assessment was encouraged by library staff as yet another means by which to measure the site's effectiveness and to gain insight on ways of making the Gateway as robust as possible.

Fourth was the vision of the Gateway. Historically, the original concept of the gateway was built around the library catalogue. Rapid advances in Web-based technology quickly encouraged this vision to be expanded to all library resources. In 1996, Web sites for both UL and HSL were created. Neither contained a search engine although both provided manually maintained lists of electronic resources. In 1999, an ad hoc group reviewed the two Web sites. From this review

emanated several recommendations in terms of the sites' appearance, organization, content, and maintenance routines. These included the standardization of colour and layouts, the re-organization of content, and the use of short sentences and bullets.

In March 2000, the University Librarian proposed a new vision for the Gateway:

"In planning for the future, the burgeoning website should be placed at the centre of an integrated information access plan... Thus, the Gateway would no longer be a tangible suite of software and associated hardware, but rather signify the Library's presence on the web." (Hill, 2000).

The objectives of the Gateway are to provide a unified, virtual environment for the library system and deliver selected electronic services while meeting the current needs of users, providing the capability to respond to future needs, and having flexibility to use new technologies as they emerge. As such, the Gateway seemed like an ideal candidate system to study in terms of its vision. Though the Gateway did not intentionally start out as a library portal (as per this working paper's definition), its new vision suggests that it is moving in that direction.

4.3 Overview of the Gateway

The Gateway primarily includes three components:

1. MORRIS (McMaster Online Resource Retrieval Information System) which is the university's library catalogue of holdings;
2. the ERD (Electronic Resources Database) which is a collection of electronic-based indexes, journals, and reference tools;
3. information pages pertaining to the hours and services of McMaster University's four libraries.

Public access to the Gateway is available through <http://library.mcmaster.ca>, though only authorized McMaster University students, faculty and staff have access rights to some of the licensed contents of the ERD.

Figure 4-1 illustrates the main home page of the McMaster University Libraries home page. Individual library home pages closely mimic the look and feel of the McMaster University Libraries home page, however some of the information content posted on these individual library sites is tailored to each individual library. Figure 4-2 illustrates the home page of the Innis library site.

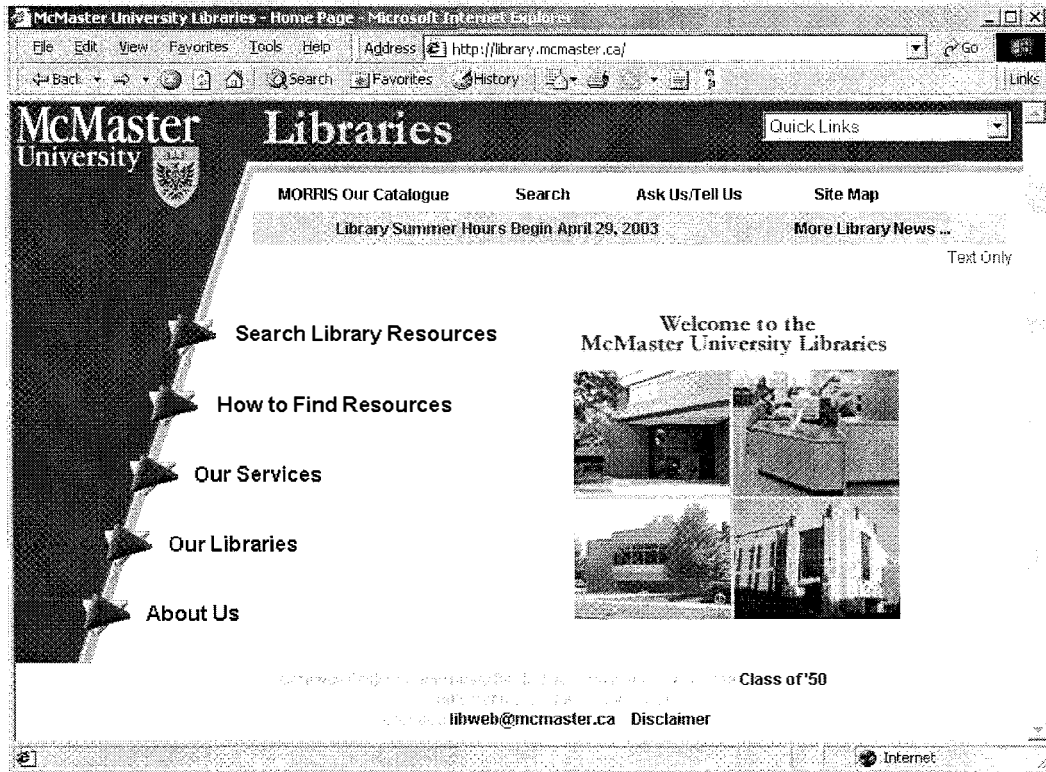


Figure 4-1: The McMaster University Libraries home page

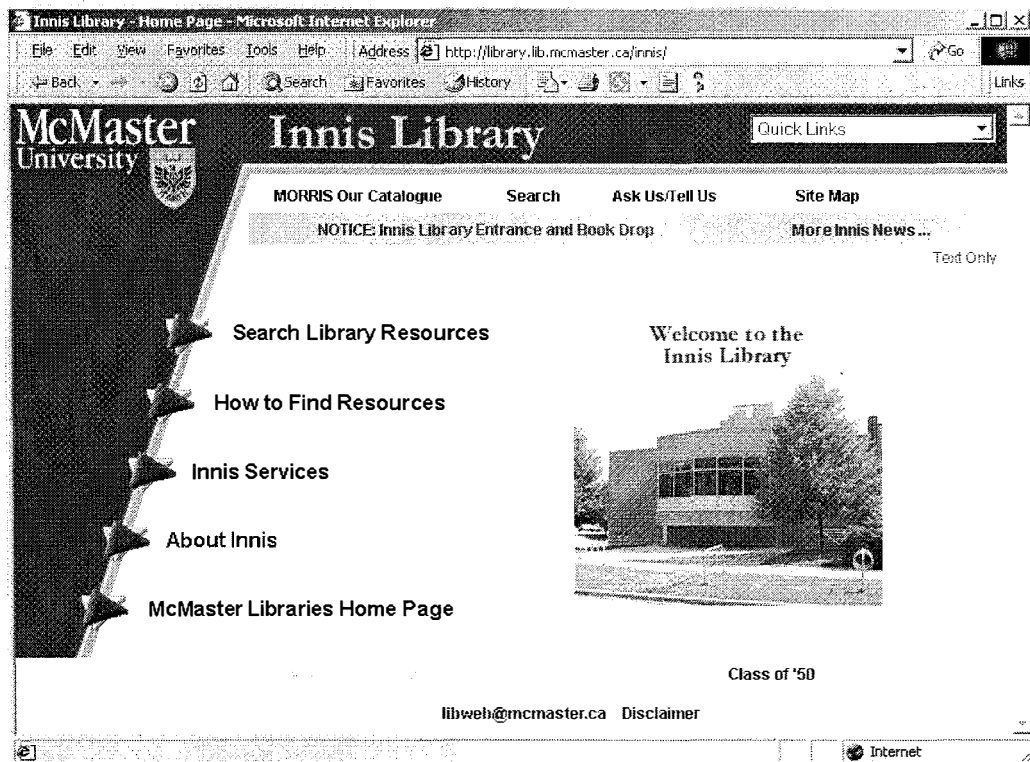


Figure 4-2: The Innis Library home page

5. ASSESSMENT OF THE McMASTER UNIVERSITY LIBRARY GATEWAY

The evaluation framework presented earlier was used as a guide by which to assess the Gateway. Recall that the purpose of the framework was to serve as a roadmap for conducting an effective and thorough analysis of a library portal's robustness in terms of a variety of factors, namely: usefulness and ease of use; information seeking, personalization, knowledge work, and intelligent agents.

Each of these factors, as they pertain to the Gateway, are described in turn. Both positive and negative aspects are discussed. Where appropriate, recommendations are made. A summary of recommendations is made in the Summary and Conclusions section.

Note that it is recognized that MORRIS is a commercial software product and, as such, is difficult to modify. However, recommendations are made to the MORRIS interface anyways as a means of raising awareness of the need to address interface design issues with the online catalogue.

5.1 Usefulness and Ease of Use

Recall that in terms of a usable library portal interface, certain factors influence the extent to which a digital library is perceived to be useful and easy-to-use. These factors are organizational context, interface characteristics, and individual differences.

5.1.1 Organizational Context

Overall, the Gateway scores quite well along this dimension.

With respect to **relevance**, the Gateway is relevant to two broad types of users. The first are users who want to find information about library services. These people can either search the information available on the Gateway or contact a librarian via an online form or e-mail. The second are users who want to search or browse the Gateway for information content pertaining to subject areas of interest. Both groups of people are well provided for in the Gateway's design.

In terms of **system accessibility**, the Gateway is easily accessible. The Gateway home page and its electronic resources (both the library catalogue and electronic collections) are widely accessible to the McMaster community from any computer on campus that connects to the Internet and any outside computer where a user can setup proxy settings on his or her workstation. In fact, any one in the world with an Internet-enabled computer can access the Gateway. It is just specific licensed content that is restricted to authorized McMaster students, faculty and staff via the proxy server.

With respect to **system visibility**, the Gateway is quite visible to all users who have physically visited one of the libraries, as access to work stations exist at most locations in close proximity to the entrances of the libraries. Virtually speaking, the system is also highly visible on the Internet via links from the McMaster University home (see Figure 5-1) and some departmental home pages (see Figure 5-2).

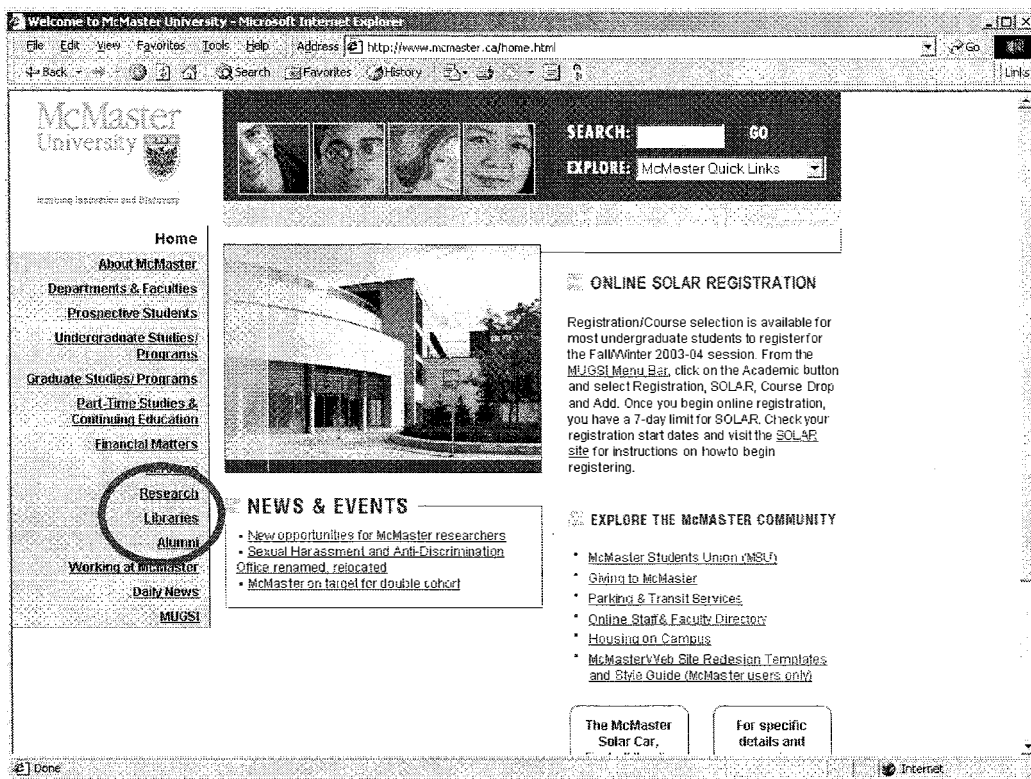


Figure 5-1: Gateway access from the McMaster University home page

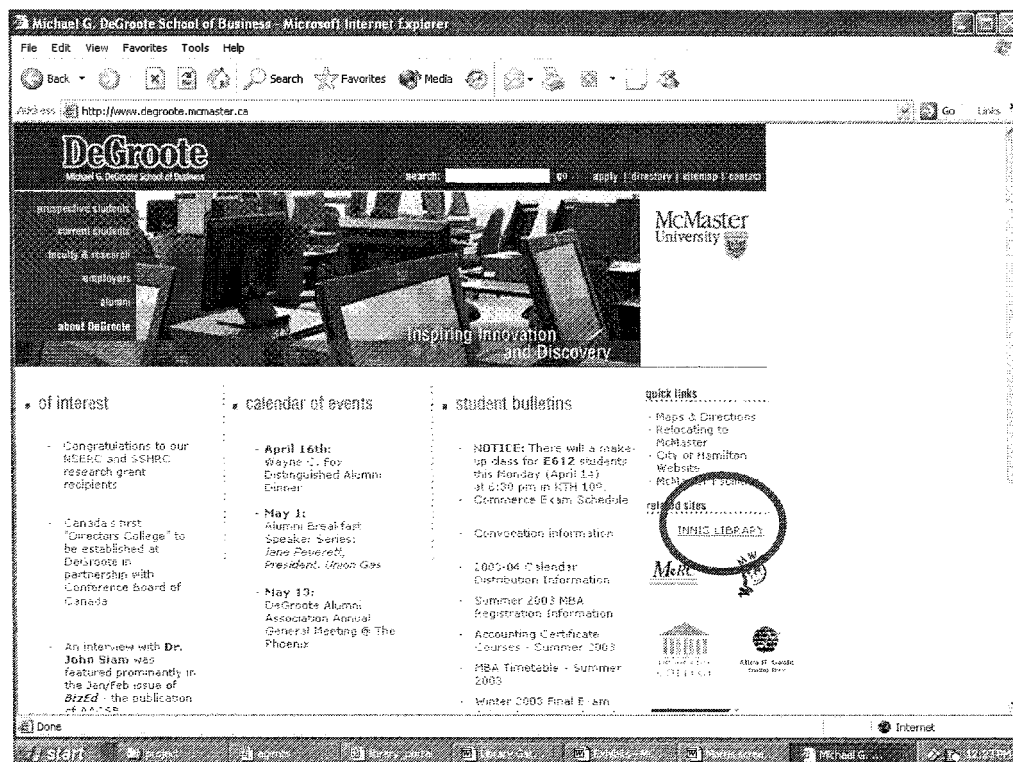


Figure 5-2: Gateway access from the School of Business home page

Visibility of the library is important in the case of new or perspective students or faculty who are checking out the McMaster University Web space. To encourage more visits to the Gateway, more links of interests need to be created and highlighted in related McMaster University Web sites. For example, new acquisitions at the Innis Library could be featured on the School of Business Web site. Likewise, new library services or resources could be featured or highlighted in various sections of the McMaster University Web site.

5.1.2 Interface Characteristics

Overall, though the Gateway has opted for a simple, inviting interface design, there are problems in its interface design which limits the overall perceived usefulness and ease of use with the Web site.

With respect to **terminology**, the Gateway has made some positive steps towards limiting its reliance on library jargon, but could go further in this regard by describing aspects and functions of the Gateway in layman terms. An example exemplifying good reduction of library terminology is the use of the phrase 'borrowing/circulation' rather than just 'circulation'.

However more improvements in terminology could be made. For instance, there is some confusion by lay-users with terms like 'hold' or 'reserves' in that some users think of 'reserving' library books rather than placing a 'hold' on them. Other users have difficulty distinguishing between 'reference' and 'reserves', especially students from non-English speaking backgrounds. The term 'reference' could be changed to 'research assistance' or 'information/reference'. The term 'reserves' could be changed to 'course reserves'.

Many users are confused over terms like 'catalogue' and 'electronic resources'. What is the distinction between these two terms? The Gateway does not do a good job at this. The problem inherently lies in the ambiguity of the term 'electronic resources', which could mean many things to many people. Is not the online catalogue an electronic resource? In fact, isn't the whole Gateway an electronic resource? Perhaps the term 'electronic resources' could be changed to 'electronic collections', 'external resources', or 'digital collections'.

Also, patrons have difficulty understanding the concept of an 'index'. This is complicated by the fact that sometimes indexes are referred to as 'databases' (e.g., in the How to Find Electronic Resources in the Innis Library Page). Users really do not understand the difference between indexes and electronic journals, or the fine distinction between suites of electronic journals (some with robust search engines) and an index. The issue of 'index' becomes even more complicated when people find out that some indexes include full-text. In this case, the distinction between a tool for finding articles and the articles themselves becomes even more blurred. Perhaps the term 'index/abstract' could be changed to 'articles' or 'article databases'.

Further, proper names have little meaning or relevance to most Gateway users, especially if they are new or infrequent users to the system. Thus, utilizing proper names in the Gateway for hypertext link labels, such as MORRIS, Innis, Thode, and Mills do little in helping users utilize or navigate the site. Having an icon labelled 'MORRIS – our catalogue' probably would be better renamed as 'Our Catalogue'.

One relatively easy solution to fix the terminology problem would be to add a glossary to the Gateway which explained the meaning of all common library terms used within the Gateway.

A better solution would be to poll library patrons on a consistent basis to gain their opinions on

the terminology used. This could be facilitated by asking random groups of library patrons (e.g. the first 20 people to approach the reference desk on a given day) their opinions on terms used and potential candidates.

In terms of **screen design**, there are both positive and negative aspects. From a positive perspective, the Gateway employs a simple, easy to read graphical user interface.

Some improvements that can be made include the standardization of JavaScript menus. Currently, these menus exhibit differently on different machines. The screen shot below in Figure 5-3 provides an example of how the JavaScript menus cause an overlay problem in Internet Explorer 4.1 running on a Windows 98 platform. Secondly, the pointer of the JavaScript menu should intuitively point the user from the text menu to the JavaScript menu. Currently, the pointer is closer to the JavaScript menu and points in the wrong direction.

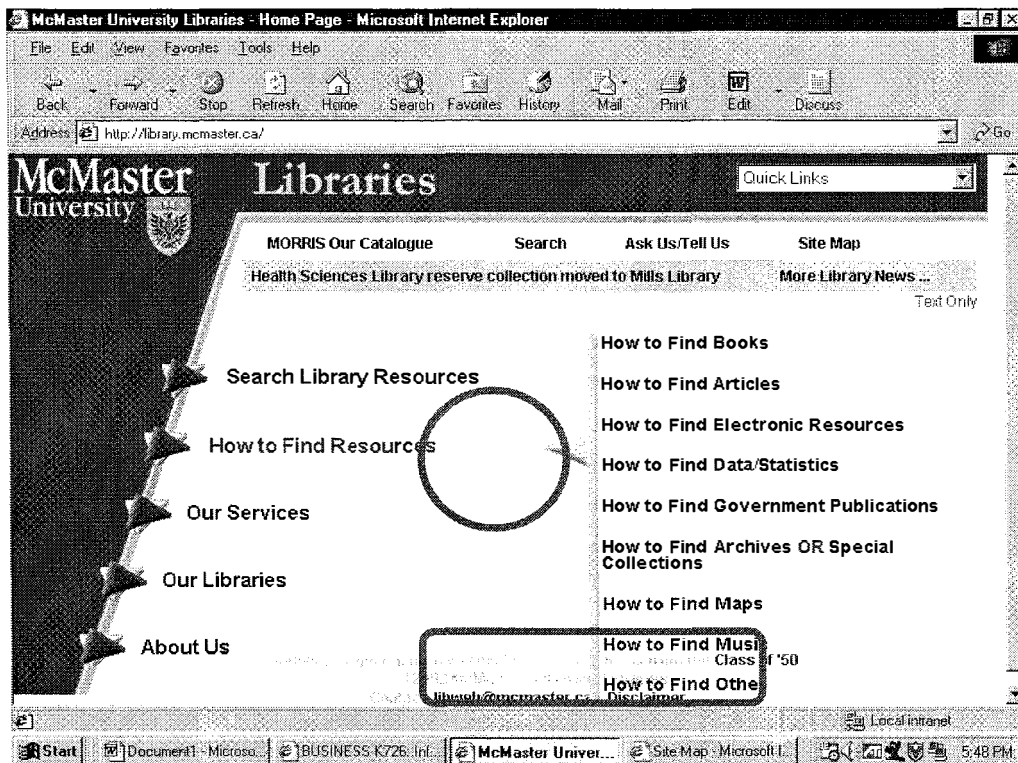


Figure 5-3: JavaScript menu problem

The consistent use of the 'Browse', 'Basic' and 'Advanced' tabs in the ERD interface which appear at the top of each Web page displayed gives users a consistent look, but clicking the other information tabs, namely 'Licenses', 'Trial Products' or 'Off-Campus Access', leads to three totally different page layouts, not only different from that of the Browse and Search pages, but also different from each other.

Problems with consistency across the Gateway Web site are not limited to these tab bars. Despite the standard use of colours throughout the Gateway Web pages, the layout on each page is often different. In a profound example, there are at least four different navigation bars used in different sections of the Web site. Sometimes, even pages in the same section use different navigation bars.

With respect to **navigation**, the Gateway provides several methods by which to help users

navigate the site. These methods include a drill down method through the use of menus (e.g., *how to find resources*), a search method by using a Google search (e.g., *search our web site*), and a textual site map. In addition to these methods, a *quick links* menu exists for links that the library staff believe to be important enough to highlight, and a menu exists for links that are accessed most often. Another good feature of the Gateway is that its two main search databases, MORRIS and ERD, are readily available from multiple points within the Web site.

A suggestion for improvement in navigation is to provide better visual cues that inform users when they have moved from the main library Web site to a specific library Web site, such as Thode or Innis. At first glance, the only change during transition to specific library Web sites is the change in title at the top of the screen. Due to the consistent colour schemes across the Web sites, this change is not significant enough to raise awareness that a transition to a different library has been made. Hence, users do not realize that there is specific information such as 'How To Find Resources' related to a specific library website.

A better suggestion for improvement would be to do away with individual library sites and replace these with one integrative Gateway web site design. Though the reasoning behind the design decision to mimic the Gateway's navigation and Web site layout on McMaster's physical library structure is unclear, it is not the best way to organize and present information resources to users. The majority of library patrons want their information organized by subject areas of interest or predominant categories, not by where the information is physically stored or managed. Further, much of the information desired by patrons is scattered across individual libraries and not neatly regulated within one physical library. There are many topics of interest, such as 'information technology', 'environmental concerns', 'human behaviour', that cut across the somewhat artificial divisions of Engineering, Business, Health, and Social Sciences & Humanities. In fact, there are hundreds, if not thousands, of such potential areas of interest. Designing the Gateway along four subject areas seems narrow in focus and not representative of users needs. Though some progress has been made in the recent version of the Gateway in moving away from a structure based on physical locale, it does not go far enough and, as a result, the basic problem still remains.

Designing Web sites on existing hierarchical structures is a common error made in many early enterprise portal systems (Terra & Gordon, 2003). A good example of a portal initiative whose design reflects the information needs and uses of its users rather than the hierarchical structure of its organization's departments is the Government of Canada's (GoC) portal site, available at <http://www.canada.gc.ca>. Recognizing the myriad of departments and agencies within the federal government's internal structure, the goal of this federal portal project is not to design the site's navigation in terms of physical and organizational divisions, but rather to design an integrative site where users could find information by topic of interest, such as 'youth', 'jobs', 'health, and 'taxation'. This would prevent users from navigating and collecting information housed across different departmental Web sites.

If recognition of individual libraries is a necessity, the sub-sites should provide unique information not found within the main Gateway pages. Also, when looking for information about a specific library, information should be displayed only about that library. For example, when selecting the *Innis Services → Instructions & Tours* option from the Innis library sub-site, a page is presented with general information about the topic. One more click is required for the Innis specific information to be shown on the screen. This navigation is confusing to users. In a similar manner, the *About Us → Hours* option is problematic.

Since the Gateway is sub-divided into 4 separate library sites, the concept of 'home page'

becomes an issue. For example, if one is navigating an individual library site, such as Innis or Thode, clicking on the 'home page' link forces one (quite unnaturally) to the main McMaster University Libraries page. Further, the placement of the home page link is unclear. Its position changes on various pages, thus some users may have difficulty finding the link to the home page.

When going deep into the Gateway's structure, there are several instances which force users to utilize the 'Back' button on their browser window to return to upper levels. Users should never have to rely on the 'Back' button to navigate a site. One recommendation is to provide a common navigation bar on the left side of all pages; if such a scenario were followed, user would always be only one click away from the Gateway's upper levels.

The main page on the McMaster University Libraries page has no obvious link to the ERD. This is in contrast to the individual library's main pages. With the ERD being one of the site's most frequently visited pages, a more obvious and convenient navigation to this resource is required. This is a vital concern and warrants immediate attention.

Both the 'Site Map' and 'Text Only' links reach the same destination page. Although the existence of both links is warranted by the fact that some users are only familiar with one of those terms, since the two links appear very close to each other on the interface, it makes sense to combine these two links together with a common label.

All current news items should be date stamped. For example, the McMaster University Library page lists its news with no date information, while the Innis page lists some of its information with date information. The date stamp should appear when the items are listed and within the text of the news items themselves.

With respect to 'How to Find Resources', there is inconsistency in what is displayed with the electronic resources option. All other options under the 'How to Find Resources' category provide an ordered list of steps of activities to carry out. The electronic resources option does not follow this format. Rather than giving (much needed) advice on how to search and browse information housed in the electronic resources section, the web page provides links to subject areas of interest (in the McMaster University Libraries page) or frequently used databases (in the Innis Library page).

Not all hypertext links are evident in the screen design. For example, the list of individual libraries in the McMaster University Libraries page appears as plain text, when in actuality they are hypertext links. These should appear as blue, underlined text. At a minimum, a highlight effect should appear when the mouse pointer is moved over each of these hypertext links. This problem is systemic throughout many of the Gateway's pages.

Though the Gateway provides sufficient information for people who want to make gifts or donations to the library, it would be preferable if donations could be made online. Requiring users to use another medium to make a donation probably results in many donations not being made at all. In any regards, people should also have the option of making a donation online. This is relatively easy to be implemented and does not require an overhaul of the site. Pages under 'Gifts & Donations' do not efficiently link to each other. For example, selecting 'How to Make a Gift to the Library' in the Gifts & Donations page leads to a page where one can select a 'Building the Library of the Future' links which leads to, once again, an option of 'How to Make a Gift to the Library'.

In MORRIS, there is inconsistency in the navigation and display of the *Forms/Recall, Storage*

etc. and *MORRIS News* tabs. Selecting either of those tabs, forces you to leave the MORRIS set of pages and there is no intuitive way to navigate back.

On a more macro level, the Gateway's navigation should facilitate easy access to MORRIS and the ERD from anyplace in the Gateway. Less 'real estate' should be spent on more minor items (in terms of users needs) such as 'How To', 'Our Libraries', and 'About Us'.

5.1.3 Individual Differences

Overall, the Gateway has little control over the personal characteristics of users which determine or have an effect on their perceived usefulness and ease of use of the library portal. In terms of **computer self-efficacy** and **domain knowledge**, the library staff at McMaster University have made positive steps in this regard by offering an extensive instruction program to library patrons both in the classroom and in the library. For example, staff from the Innis Library provide in-lab training to all incoming Commerce students and frequently provide in-class instruction to students in specific business courses. Virtually speaking, the Gateway attempts to increase domain knowledge with the *How to Find Resources* section that describes the most common tasks library users typically perform. With respect to **computer experience**, library staff have no control over this determinant.

5.2 Information Seeking

As suggested by the theory outlined earlier in section 3.2, there are two fundamental ways of retrieving information through a Web portal: searching and browsing. A robust library portal would support a range of information seeking activity from wayward browsing to goal-directed search.

In general, the Gateway has made a good attempt in facilitating both modes of seeking activities. For instance, there are many links and navigation paths to the site's library catalogue and electronic resources database. The site map provides a good overview of the information content posted on the site. The Google search facility by which to scan the contents posted on the Gateway is good. However, there is much room for improvement in terms of facilitating better information seeking activity overall.

Foremost is the confusion over the MORRIS library catalogue and the ERD. It is not apparent to many users the difference between these two database systems. Though the relevance of distinguishing between items housed in the library's electronic catalogue and items housed in indexes and electronic journals is important to library staff, it is rather a moot point for end-users. Library patrons want to seek information by topic. They would prefer search and browse mechanisms that allow them to conduct robust and comprehensive searches once across various databases in a single session. Why can't a single search mechanism in the Gateway scan for information on items of interests within the library catalogue and indexes and full-text electronic journals and present these results on a single Web screen? The results screen could identify the source of the returned information items and whether or not full-text or physical access is possible. If a user were interested in an item retrieved that was not available electronically in full-text or physically in the stacks of one of the university's libraries, the system could automatically direct the user to (and populate) an interlending loan form. Users would benefit with such a meta-search engine.

A less-preferred solution would be to keep the artificial distinction of a library catalogue and an ERD alive on the Gateway and to have more explanatory text on the Gateway highlighting the

difference between these two items.

An alternate solution is to redesign the Gateway screens to support the step-by-step flow of activities listed in the 'How to Find Resources' screens. Rather than just telling users what to do, why not have the screens guide the users in each of these tasks? Since information seeking is the primary reason members of the McMaster University community visit the Gateway, it warrants at least contemplating the redesign of the site in ways that facilitates the steps required in each of the 'How To Find Resources'.

There is some confusion over the "Search Our Web site" feature. Many users who utilize that option assume that the search includes searching through the MORRIS and ERD systems. This is not the case.

There is also some confusion in searching and browsing from within the individual library sites (such as Innis, Thode etc.). Some users believe that searches and browsing in these sub-sites would be restricted to materials within those physical libraries, which is erroneous. This is yet another argument for the need to abandon the four separate libraries web site design.

All home pages within the Gateway (i.e., the McMaster Libraries page and each of the four individual libraries home pages) should handle searching and browsing directly from those screens. Currently users have to click on a link to do any sort of searching or browsing. In fact, they have to decide if they want to search the Web site, search MORRIS, or search the ERD and then click on the appropriate link. The predominant reasons users visit the Gateway is to conduct some sort of information seeking activity. Thus, the facilitation of information seeking should be supported directly from each library site's homepage.

An ideal solution would comprise a search box on the home page (which would automatically scan the Web site, MORRIS, and the ERD for relevant material), as well as a set of predefined information categories that would facilitate the browsing of information. This is the same model used by popular portal sites, such as *Yahoo!*. Figure 5-4 shows an example of the Yahoo portal which comprises a search box for goal-directed search and information categories (at the bottom of the page) which facilitates browsing by categories. These categories are similar to subject categories one would see in a physical card catalogue in a library. They facilitate easy retrieval since the information contained in the system is pre-organized (i.e., indexed) prior to the formation of an information retrieval request in a manner users would prefer or most likely request that information. The site's search box facilitates more formal information search than could be conducted through category browsing.



Figure 5-4: The Yahoo! portal contains both a search box and information categories

Of interest is that the Gateway already has a robust set of pre-defined information categories, but these are buried in the Gateway's home page under the 'How to Find Electronic Resources' section (see Figure 5-5 below). These should be moved up-front and index not only the ERD, but also MORRIS as well.

According to Rosenfeld and Morville (1998), a robust web site should closely integrate searching and browsing. These authors redesigned the Argus Clearinghouse Web site and integrated browse and search on a single page (see Figure 5-6 below). The combined interface to searching and browsing makes it clear to the user what he or she can do. A similar search/browse combination should be found within the Gateway site. That is, combining both search and browse from a single interface within the ERD is an important feature to work towards in the future in any redesign of that page. People view browse and search as equally critical and expect the ability to perform both tasks from the same screen.

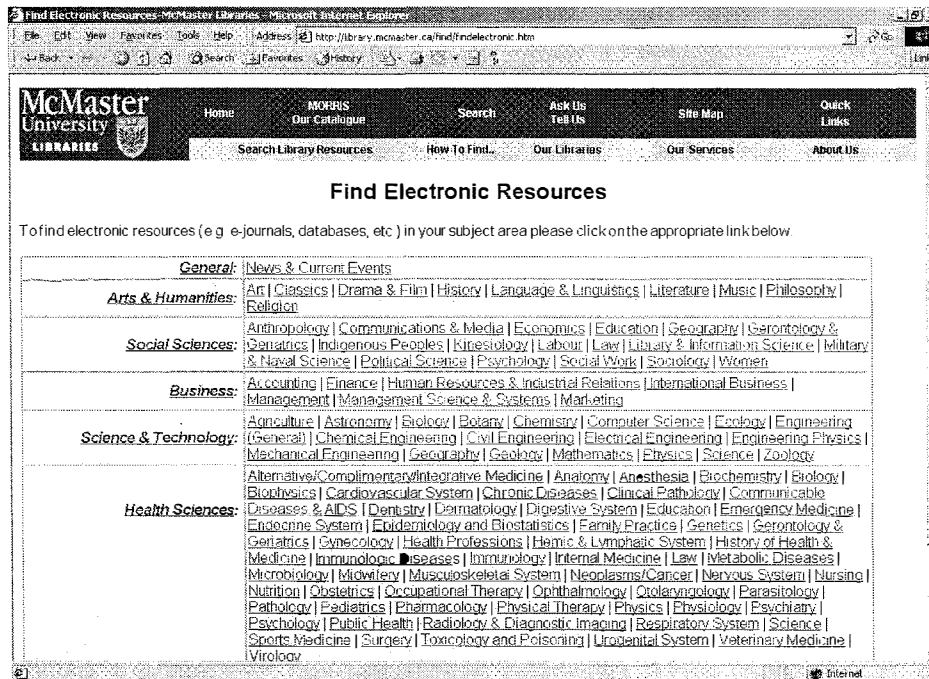
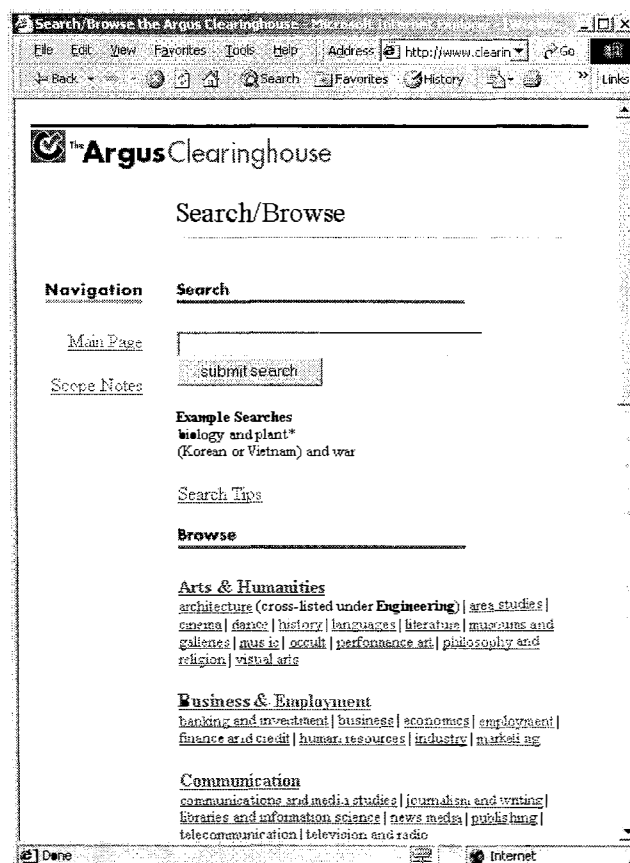


Figure 5-5: Pre-defined information categories

Figure 5-6: The Argus Clearinghouse browse & search screen (Available at <http://www.clearinghouse.net/searchbrowse.html>)

Recognizing the difficulty in devising an integrated solution to support both browse and search in the Gateway, it is more likely that the MORRIS system and ERD will remain disparate resources for at least the short term. Further commentary on information seeking is thus made on each of these database resources individually in the following sub-sections of this report.

Again, before examining MORRIS and the ERD individually, the preferred recommendation is an integrated solution to browse and search across both MORRIS and the ERD. These systems can remain transparent to end-users and a comprehensive, integrative front-end interface can accommodate a robust scan of both types of resources.

The reason for an integrative solution is that students currently have problems finding information they need in the Gateway. Many students at McMaster currently have a work-around to find information they need rather than doing separate searches across MORRIS and the ERD. The work around is to do a search with a robust single Internet search engine, like Google, find (and write down) potential articles and books of interest, then use MORRIS to find specific books available at McMaster or use the ERD to track down full text access to specific articles. Several students during the investigation of the Gateway site wondered why the Gateway does not provide powerful search capabilities like Google does. There was a desire by these students for a meta-search engine within the Gateway that would scan multiple indexes, electronic journals available in the ERD, as well as the MORRIS catalogue for items matching their query terms.

5.2.1 MORRIS

The MORRIS online catalogue has basic and advanced search functions. It supports keyword(s) search in titles, subjects, author and anywhere (see Figure 5-7 below). It also supports standard number, call number and series search. Most documents found in this catalogue are paper-based, however it also contains most electronic resources in the ERD. MORRIS does not include many of the free Web sites currently indexed in the ERD.

Note that MORRIS is a brand new product introduced in August 2002 with a substantial amount of development work yet to be done. However, as the tool currently stands, the MORRIS interface makes it extremely difficult to facilitate browsing. Though one can conduct a search by subject keyword, a preferred solution would be for the system to display a set of predefined categories or subject keywords. Otherwise, the user is left to his or her own devices to guess the most appropriate term. Why not let the user know what the subject categories are?

When searching using the *Title* option, the result page has two fields for each entry ('Title', 'No. Of Titles'). 'No. of Titles' does not provide any helpful information most of the time and does not need to be there. On the contrary, the date each book was printed would help users distinguish between different editions of the same title. Currently, if a book is available in three editions, the user only sees three entries with the same title and has to follow the link in order to find the desirable edition.

Help is not available in the part of the Web site where users need it the most. It is likely that many users will not be able to understand the difference between the *Author* and *Author Keyword(s)* options for example. This results in users having trouble in finding the books they are looking for. It is imperative that the search page contains a link to information about the different search options available.

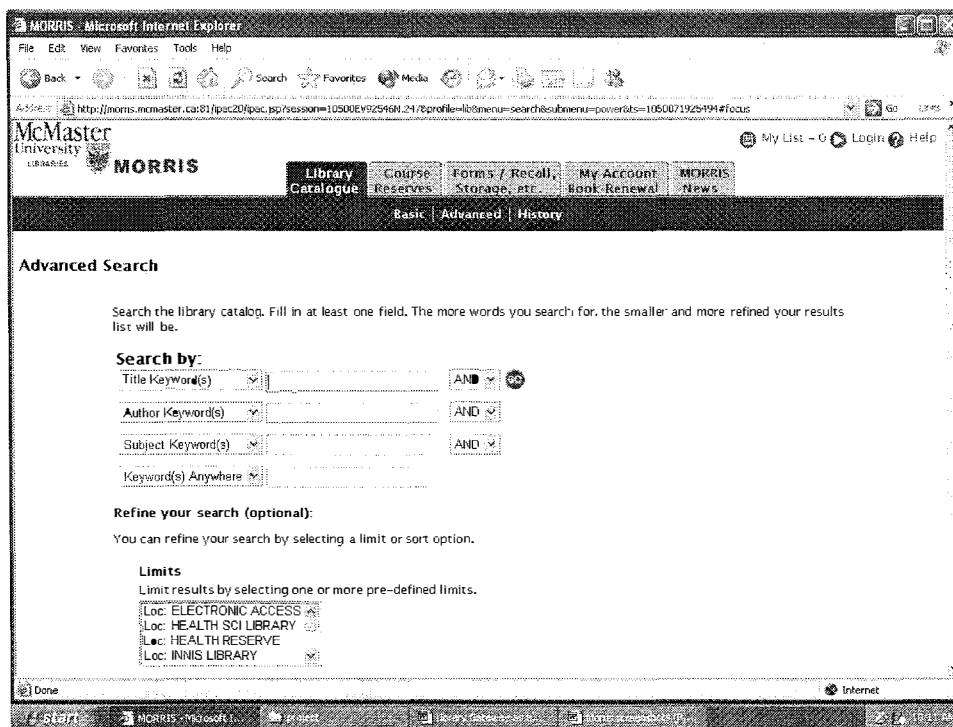


Figure 5-7: The MORRIS Advanced Search interface

At the upper part of the results pages, the *Refine Search* option is provided. However, this does not function the way it should. Instead of limiting the search among the already provided results, it simply initiates a new search. This option should be fixed or otherwise removed.

When checking course reserves in MORRIS, searching by *Course Name* could be easier. For example, having to put 'K726' instead of 'Business K726' should be enough. In the case where there are courses from different departments with the same alphanumeric code, the results page should list them all. In no case would there likely be more than a handful of courses with the same code. Currently, when only 'K726' is entered as input, the results page contains a number of entries, none of them having K726 in their course name. Moreover, even if 'Business K726' is entered, the results page does not contain reserves for this course. Instead, there is a list with 10 courses in alphabetical order, with Business K726 on top of the list. The user has to select the Business K726 entry to see the reserves, thus taking one more unnecessary step. Even if this step has to be taken, the other nine course names should not be shown.

The same problems appear when searching by *Instructor Name*.

5.2.2 ERD

With respect to the ERD, the Gateway offers browsing, basic and advanced searches for its users. They are connected using a navigation bar at the top of the E-Resources Database Web page (see Figure 5-8 below).

The ERD interface has set up the browsing and basic search interfaces on two separate pages. However, as mentioned above, searching and browsing systems should be closely integrated to aid users in their initial search efforts. Thus, rather than stand in isolation from each other, the two elements should be on a single page to allow users to switch quickly between browsing and

search functions until they become more familiar with the site offerings (Rosenfeld & Morville, 1998). Thus, it is recommended that the ERD page integrate the basic search function with a browse page containing a topical category hierarchy of the list of collections available, as a means of helping users learn a set of sources that are useful for their domains of interest (Hearst, 1999).



Figure 5-8: The ERD navigation bar

As such, an interface like Yahoo! or Google (Directory) for the ERD would have been a better solution. In this way, users, in one page, can see the available resources organized by thematic categories, but also have an input box to enter search keywords. Such a solution eliminates the need to have the tabs on top of the ERD page (e.g., Browse, Basic, Advanced etc.).

One should also be able to continue searching and browsing from the hits results page, especially if no hits or results are displayed. This would facilitate users remaining in an iterative process of searching and browsing activity.

5.2.2.1 Browsing the ERD

Steps have been taken to facilitate browsing, though an ideal interface design for browsing is not yet there. The Gateway allows users to focus their browsing to targeted types of electronic resources, such as journals or indexes. The Gateway also accommodates users in focusing their browsing to pre-defined subject areas, such as large subject areas (e.g., Arts & Humanities, Business, Health Sciences) and specific subject areas (e.g., Accounting, Agriculture). The Gateway also lets users restrict their browsing to titles beginning with certain letters. All these are good steps, however the effectiveness of the design remains a barrier.

Unfortunately, the existing browsing interface is not user friendly. The E-Resources Database page is too dense with text and the key step numbers 1 to 3 are hard to notice. People do not know what the categories in step 1 actually mean. There are probably too many listed and only the bigger categories (e.g., journals, indexes) need be displayed. These categories should be prefixed by the letter 'e' (e.g., e-indexes, e-journals) as a means of reminding users they are in the ERD area of the Gateway and are not searching the library's online catalogue. Furthermore, the tabs and links in the ERD page do not reference the same type of functionality or activity. Thus, 'License' should not be a tab.

It is difficult to understand how to navigate the browsing interface from one section to the next. There are three selection criteria with little indication of which have to be selected and how to complete the browsing function once the selection has been decided (see Figure 5-9 below). The presence of a "Go" button would reduce the time spent on the page. Currently, users have to go and select *ALL* or one of the letters to initiate the browse.

Figure 5-9: The current ERD browse screen

Though, more information about how to utilize the browse function is provided in the menu bar under the About tab, such instructional information would be better placed on the browse interface itself. This can be achieved by reorganizing the interface to promote a step by step methodology with step-by-step instructions included within the interface (see Figure 5-10 below for an example of how to do this).

Figure 5-10: A proposed re-design of the ERD browse screen

In the step 2 section on the screen, the parent subjects are listed on the top in the draw-down box, the child subjects are down below, separated from parent subjects. It's inconvenient for some people to do hierarchical browsing. For example, a user may want to know what subjects are

under social science, and then choose a child subject to do further browsing. Under the current layout, one can not do that.

In the *Browse* page, if a search does not bring any results, the same page is reloaded. The only difference is that there is the phrase “No Hits” written in the upper part of the page. It is very possible users will not take notice and will think that the search function just didn’t work.

When hits are returned, the subsequent page displays all the returns under each category: Index/Abstract, Journal/Magazine, Newspapers, References and Books, etc. It’s a quite long list; a user has to scroll down to find a journal or a book he or she is interested in. If the person cannot find anything of value, the user cannot close the page, but has to click the Back button on the Internet browser navigation bar to return to the ‘Browse Search’ home page and continue browsing by inputting different criteria.

5.2.2.2 Searching the ERD

It is important that users know exactly what is being searched and how they can formulate search queries when using search engines (Rosenfeld & Morville, 1998). The library web site shows which sources (journals, newspapers, web sites, etc.) have been searched after the results have been returned. This is good. By clicking on the *hints* section next to the search box, users are given important search information regarding query formation including; use of phrase searching and Boolean operators such as “and” & “or” to reduce or expand a search.

The ERD search function searches a list of available e-resources and not their contents. This fact should be better communicated, because many users are not aware of it.

An added functionality which would improve the Web site dramatically is the ability for the user to change the sorting order of the retrieved results (Rosenfeld & Morville, 1998). For instance, the user might not want the results organized by magazines, Web sites, etc. Instead, users might want to know which results are more relevant to their original search query. The user might also want to sort the electronic resources by the number of relevant articles to the query each has in their respective databases. The ability of the user to re-sort the search results would enhance the search engine.

It is important for the system to provide user feedback after each search request. This is especially true when no results are retrieved for a given search. To accomplish this, it is a good idea to create a page specifically for this zero result case that makes it clear that no results were retrieved and provide tips for improving the results (Rosenfeld & Morville, 1998). The library web site makes it clear that no results were found, however, the user isn’t taken to a separate page to offer advice on how to improve these search results. In the special case where a user enters a common, stop-list word (e.g., ‘a’, ‘an’, ‘the’) into the search engine, the engine returns the user to the search page and removes the stop word from the entry box. The page does not indicate that no results were found or the reason why this is so. This can be frustrating for users who might think the engine is not functioning properly and give up on their search.

The search interface should also attempt to reduce working memory load by providing mechanisms to keep track of user choices made during the search process (Hearst, 1999). These mechanisms could allow users to return to previous searches or jump from one search to another. The library website does not provide the means to go back to previous searches or add on to them through modification. This requires a user to keep track of their searches and results in their mind or on paper in order to learn from their mistakes and refine their search queries.

The McMaster library search engine handles precise search well if the user knows the name of a journal, a newspaper or a book. By using either the Basic Search or Advanced Search function, the user will find the item quickly. However, if the exact name is unknown, misspelled, incomplete, or if the user tries to guess the name of the resource, the system returns zero hits. As a result, the search function is rarely used.

To compensate for the limitations in the Basic Search and Advanced Search screens, most users turn to the Browse Search screen to conduct their goal-directed searches. This fact was substantiated by an analysis of the Web usage logs which indicate that approximately 75% of people use the browse facility to find information. Most users use the Browse feature in the ERD to generate a pseudo-listing of electronic resources, and then look for the journal or index they want – either by scrolling or by conducting a “ctrl-F” (find) search via the person’s Web browser interface to search for e-resources of interest.

On a side note, the Web usage statistics reports were not detailed enough nor collected all the appropriate information to deduce end-user behavioural patterns or make commentary on the usage pattern of some important links in the Gateway. For example, the Quick links menu on the homepage contains several links, but those links are not uniquely accessed only from the homepage, and they are also embedded in other pages as well. The statistical data shows only the total counts of these links. It does not show in which page they are clicked. So it is difficult to deduce if the Quick links are in the optimal position on the homepage. Similar situations applied to other links, such as the MORRIS catalogue, the ‘How To’ links, etc.

5.3 Personalization

Recall that personalization refers to the extent to which a library portal meets the individual needs of users. Either the system itself can tailor the delivery and presentation of information content or users themselves can customize the type and format of information displayed.

In terms of library patrons, the primary users constituting the audience are students, faculty, and outside community members. In terms of information needs, undergraduate students typically want quick and convenient access to information with few detours. They tend to favour convenience over quality, are not as familiar with core sources in their field so do less monitoring, and have a strong preference for full text products. Faculty and graduate students also want quick access to information but are more tolerant of detours. They as a user group are more interested in quality information sources (e.g., finding peer-reviewed material), more tolerant of citation-only material, and are more familiar with core information products so they are willing and enable to do more monitoring. Outside audiences, such as parents of students, alumni, other members of academic institutions, unaffiliated researchers and scholars, and health care practitioners, utilize the Gateway to a limited extent. Due to licensing restrictions of certain information products, the Gateway cannot provide them with access to ERD resources. Typically this set of users visits the Gateway to get contact information and determine the hours of operations of individual libraries.

One solution is to tailor the design of the Gateway based on these three specific roles. Users thus would have to sign on with a username and password on entry to the Gateway in order for the system to access personal profile information and tailor the site’s design based on these roles, or any other customization feature.

Another solution is to forgo roles and give users the ability to create their own personalized library page by selecting what they want to see when they access the library website. This would

not affect the default main page, since users will have to login using their username and password.

Currently, the Gateway does not support personalization to a large extent. In fact, personalization is restricted to certain features in the MORRIS system, such as *My List* and *My Account*. The *My List* feature keeps track of resources for a user. The *My Account* feature allows a user to receive an overview of their library account, hold requests and renew resources (see Figure 5-11 below).

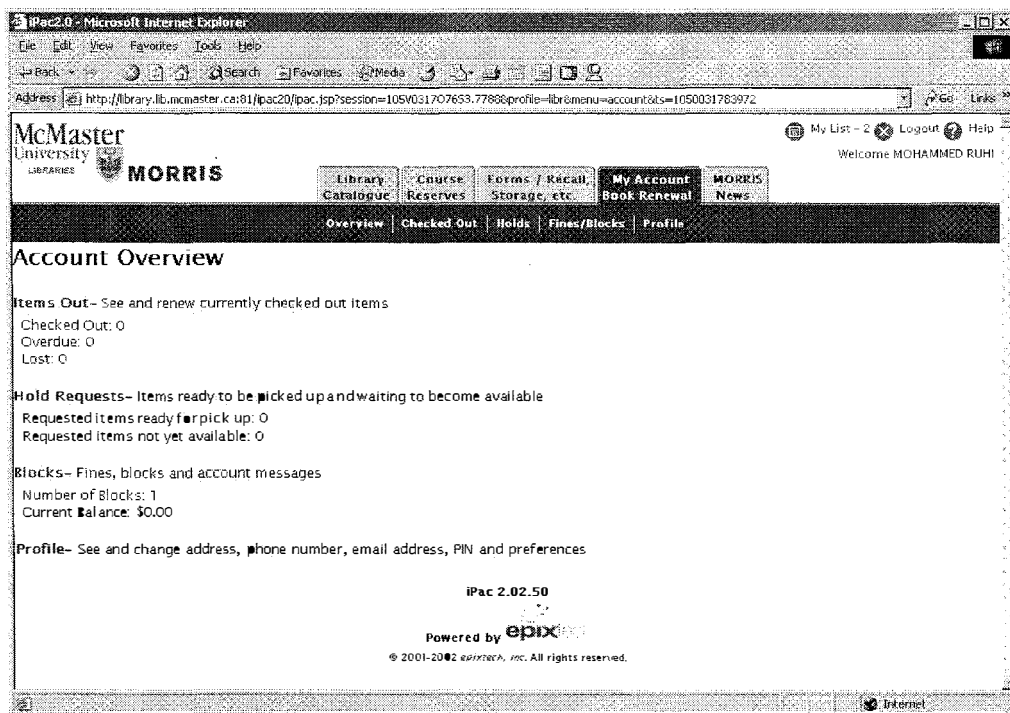


Figure 5-11: MORRIS personalization features

Other personalized information could be available in MORRIS. Historical data, such as which books did a user borrow in the past and when, should be added. Even if a complete list of past transactions cannot be provided, information about the last 10 transactions should be available, though for confidentiality reasons this may not be feasibly supported by the online catalogue.

When checking out course reserves from within MORRIS, the 'Health Reserve' is the default option for the location field, even if the user has visited MORRIS from the main page of another library. This default option should be dependent on the library page the user is visiting from. Computers that are located in the Innis library for example, should also have 'Innis Reserve' as the default option.

Another suggestion for improvement is for the Gateway to provide students with a personalized list of courses they currently are registered for. This would enable students with a tailored snapshot of reserved course materials pertaining to classes they take. Currently, students have to do a search on a specific course to identify reserved materials for that course. A preferred solution would be to present all reserved materials pertaining to a student on one screen. This may necessitate integration with McMaster University's larger campus Web initiatives with tools like LearnLink and WebCT.

Users could have the option of paying possible fines online by using their credit card from this screen.

Other personalization features could be implemented as well. For example, links to pages frequently visited and search results that the user is interested in could be saved and presented to users in the Gateway. Users might also appreciate it if the system could automatically notify them when new information arrives that might be of interest to them. This would require that the site store subject interest information in individual user profiles that would indicate the types of information and subject matter that the user would be interested in seeing in any update notification.

Although users can save the results of their MORRIS search on a list, the same function is not available when searching the ERD.

5.4 Knowledge Work

Recall the early definition of a knowledge portal as supporting three key areas: (1) an information content space to facilitate storage and access to relevant information content; (2) a communication space that helps library patrons make better sense of the information they receive; and (3) a coordination space which helps manage the flow of information content between various library patrons and knowledge workers.

Overall, the current Gateway implementation primarily offers only a content space. The group collaboration component does not exist at all and there is minimal functionality for communication. Since there are limited communication and work tools available on the McMaster University Library Gateway, its functionality is similar to an early stage information portal that concentrates on information retrieval and information message broadcasts only.

5.4.1 Content Space

The Gateway provides access to information within the library through MORRIS and the ERD. However, individual users currently cannot store information themselves on the portal but can only retrieve information online. Ideally, library patrons should be able to post reviews and offer recommendations on the content they find and utilize on the portal. This would help others users rate the authority and relevance of information items. Users who share similar profile information, for example in terms of related subject areas of interest, could share and recommend information items they find of value.

Another recommendation would be to allow students and faculty to post documents on the portal. This could simply be a collection of student essays or report. Gateway community members would benefit from a searchable knowledge repository of McMaster student papers. Often the knowledge and ideas stored in student papers are not captured and doing so in the Gateway would foster knowledge creation, distribution, and re-use. To facilitate the capture and retrieval of such documents, users would need a meta-tag template by which to categorize and index the documents they post to the Web. Some sort of subject category index would need to be made available to students and researchers posting documents on the Gateway to ensure that standard classification terms are used.

Another way to improve the information content stored in the Gateway is to tag certain documents as 'best bets' or highly-used / borrowed / accessed / downloaded items. Students and researchers when doing their information searches and browsing could restrict their seeking

behaviour to this elite set of documents, if they so choose. A similar approach is currently implemented in Microsoft's own enterprise portal application which provides a subset document space of 'best bet' information items that other knowledge workers in the company value and find of interest and high relevance. Another example of this is found in the library Web site of the University of Maryland Baltimore County (www.umbc.edu) that has a very useful category called 'Most used reference'. This subset of highly-valued information items is indexed by university library staff.

Another idea is for the Gateway to create dynamic, auto-generated lists of information resources of relevance to courses. For example, just by knowing the course name (e.g., 'Information Retrieval and Intelligent Agents') the system should be able to generate a reference list of documents, journals, books, and indexes that pertain to that course. This would be a very useful feature to students and faculty.

5.4.2 Communication Space

A communication space provides 'channels for conversations'. Currently, communication functionality is fairly limited on the Gateway. Two-way communication may only occur between a user and a librarian via e-mail or by use of an online form that gets sent to the librarian. Other methods of unidirectional communication towards the user include the information content or the news banner. However, the current communication of news has minimal effect due to several reasons. First, the user's eye is not attracted to the banner as it blends too well into the site and is about the same level as an advertising banner. Second, a user will only receive the news upon visiting a specific library web site (either the main site or library name). It is quite possible that a user will miss news bulletins that would be useful.

The ability to discuss articles online in discussion groups with fellow faculty to get feedback and different viewpoints would also be desired. This would require that the site have message boards and chat rooms that allow individuals to log on and discuss new developments in their fields of interest.

As such, the Gateway needs to make improvements in the provision of a communication space for faculty and students. Currently, only basic feedback tools are available for users to ask questions and obtain answers from library staff. There are no spaces online, such as bulletin boards and discussion groups, which will allow users to communicate about articles or issues of concern. News boards are limited to changes to the online library itself and not the broader university community. Such tools and features are needed.

5.4.3 Collaboration Space

A coordination space provides tools and methods to support cooperative work action. Tools could include discussion rooms, work flow to aid in creation or review of papers, and other site features such as bulletin boards. As mentioned earlier, the Gateway currently does not support any aspects of group collaboration in its implementation.

Access to e-mail through the Web site could help students facilitate knowledge sharing with other students online.

A work tool the Gateway might warrant implementing are citation management tools such as ProCite or EndNote. Such software programs manage and organize citations for users and generate bibliographies according to specific style formats. Students and researchers could benefit

through the sharing of personal citation databases of information items found to be of interest or highly-valued.

Another idea is to integrate the Gateway with the University's courseware tools (e.g., WebCT and LearnLink). This way students could utilize the Gateway from within WebCT or LearnLink and access tailored reference lists of resources for a course that are available in the McMaster library system.

5.5 Intelligent Agents

Two scenarios are presented below which illustrates various ways in which the Gateway can leverage the use of intelligent agents.

5.5.1 Scenario #1

With specific reference to the Gateway, there is the potential application of intelligent agents in:

- i) providing an effective front-end to library patrons to help them in their daily information seeking tasks, and
- ii) enabling a progressively efficient method for libraries to manage their information resources.

Hence, the components of an agent-based digital library framework can be regarded as an amalgamation of front-end and back-end software based technologies.

At the front-end, a combination of user interface agents (UIA) and search agents (SA) allow for customized information gathering and filtering based on individual user preferences. At the back-end, a procedural grouping of catalogue agents (CA) and recommendation agents (RA) facilitate dynamic access to internal and external resources.

User interface agents would be responsible for bi-directional interaction with the end user. On the input side, by utilizing history and preferences information in the user profiles database, the agents can help users in classifying their information needs and finding the information that they desire. On the output side, the agents can filter the information retrieved and package it according to the needs of the user. The four functions of classifying, finding, filtering and packaging information represent the typical services provided by a librarian in a physical library setting. Zick (2000) outlines these tasks as core to providing library services to patrons. It should be noted that in this proposed agent architecture, the software functionality provided by user interface agents resides on the service provider's systems, i.e. the University Gateway. This is to enable ubiquitous access to a customized interface irrespective of the user's location. This would be highly beneficial to library patrons who do not have access to their regular workstations at the time of access.

Multiple search agents residing on the Gateway system would enable users to formulate different types of queries based on the user's requirements and the profile parameters provided by the user interface agents. One application of these multiple search agents is to segment their functionality based on the patron's role (undergraduate student, graduate student, faculty etc.). These search agents scan the internal resources database and may also poll the catalogue agents for providing information about resources available externally.

The catalogue agents represent the backend component that is responsible for retrieving information on externally available resources. Through regular and on-demand polling, a network of these catalogue agents between the university library, other university libraries as well as individual publishers would allow for maintenance of an updated database of the available resources. By tracking user requests for externally available resources, information can be cached in a transient database for quick subsequent searches on similar resources. Another collaborative application of catalogue agents is the transmission of regular updates through reciprocal broadcasts on the availability of new resources. The agents internal to the library system would then communicate these updates to the recommendation agents.

The main function of the recommendation agents is to collaborate with catalogue agents to receive resource updates and also to scan the internal resources database for new acquisitions. In turn the recommendation agents use the information from user profiles to determine specific information that should be pushed to the user interface agents about these new resources. The information provided is customized according to the interests, preference and history of the library patrons.

Based on our discussion of the benefits provided by knowledge portals and the applicability of intelligent agents to the Gateway, we can see how intelligent agents can facilitate in the implementation of an all-inclusive library specific knowledge portal. Figure 5-12 illustrates the interrelation between intelligent agents and the various components of a library portal.

As shown in the diagram, the combination of user interface agents, recommendation agents and user profiles together provide a personalized user interface to the patrons. This constitutes the My Library component of the library portal.

The search agents provide individual points of access to the internally available resources. Additionally, the catalogue agents aid in caching information related to external resources. These components provide an effective user interface for formal and informal searching internally. This constitutes the Internal Resources component of the library portal.

Finally, the collaboration between catalogue agents to send and receive information about new resources to and from the library website enables efficient access to external information across various library and publisher sites. This constitutes the Remote Resources component of the library portal.

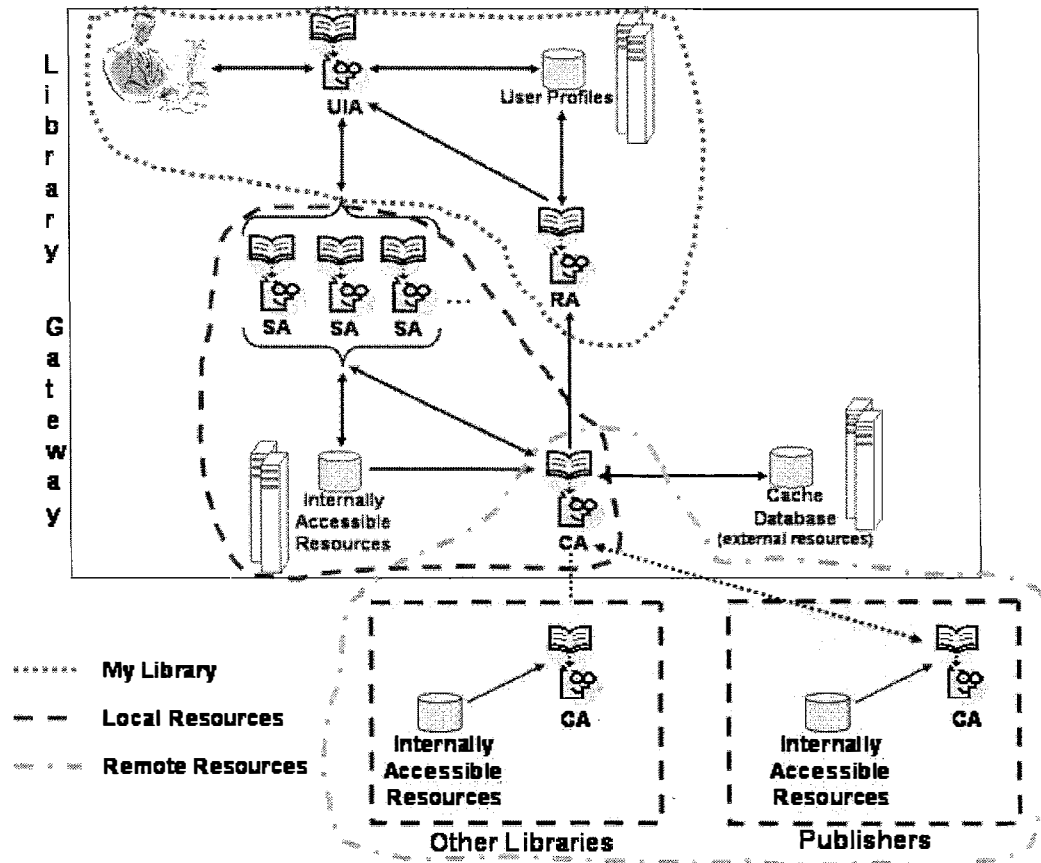


Figure 5-12: An agent architecture for scenario #1

5.5.2 Scenario #2

There are two types of agents which are required to improve search functionality of the site. The first group is 'User Agents' which will help students and faculty find information more efficiently. These agents learn individual user interests and preferences over time and use this information to find information that is more relevant to each user. The second group is 'Service Agents' which can help perform the tedious background tasks such as indexing library catalogues on the server side or information retrieval on the user side. A proposed schematic for McMaster's online library using intelligent agents is shown in Figure 5-13 below .

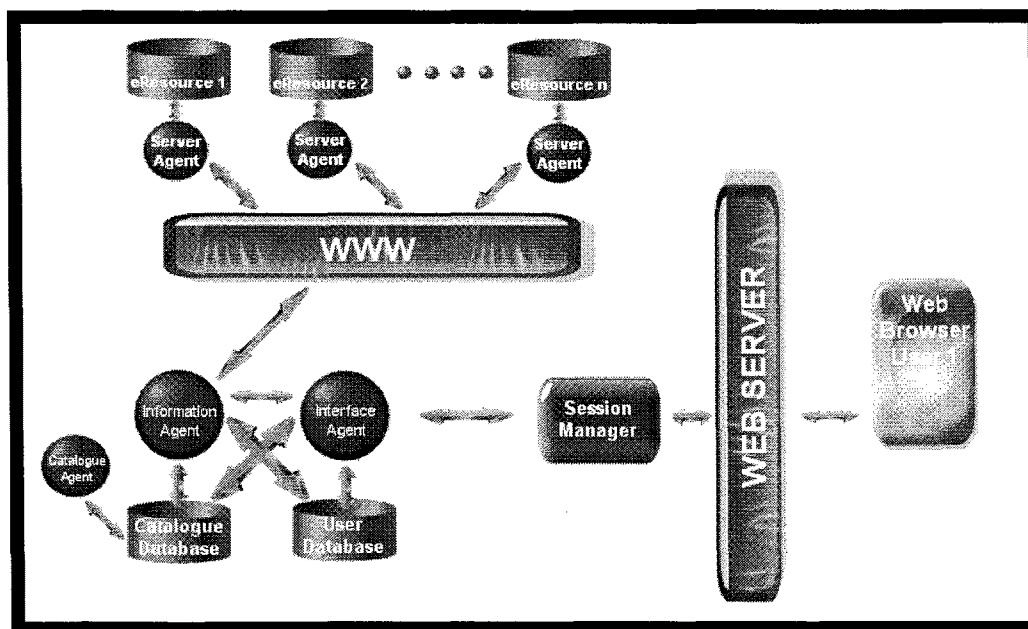


Figure 5-13: An agent architecture for scenario #2

The **interface agent** works in combination with the library's user database to retrieve, edit and store important user information to aid in refining search results. It uses the stored profile of each user to recall previous searches, filter out undesired sources of information, and help users to refine their key word searches. An initial user profile for each student and faculty member would be added to the system. Each user can manually train their agent in the beginning by inputting their faculty (i.e. business), their stream (i.e. marketing) and other points of interest to help the agent understand the type of information the user wants to retrieve. This initial training can help to integrate the interface agent with keyword searches since the agent can customize search results based on the user profile (Cheung et al., 2001). For example, the word "ratio" might mean 'financial analysis ratio' to a business student and 'ratio of strength to weight' to an engineering student. In each case the agent would organize the relevance of the search results according to the user's profile.

The interface agents would not only use manual training to learn a user's preferences but rather several methods congruently. The agent can observe and imitate a user's behaviour by tracking which sources they have used before. The agent can also adapt based on user feedback; this might involve the user telling the agent which resources are of interest to them, or telling the agent which search results were helpful. The agent could also be trained by the user inputting examples of articles the user is interested in; this can be a full text article or a specific excerpt that the user finds helpful. Finally, because the interface agents reside on the library server, they can interface with each other to find similar profiles and use results of other agents to tune their own (Maes, 1994). After determining what information the user is looking for, the interface agent then communicates with the user database to update the file and finally relays the search requirements to the 'Information Agent'.

The **information agents** (including search agents and alert agents) actually search several library and E-Resource collections to handle search requests by the user interface agent. Information agents are necessary to find, analyze and retrieve large amounts of information from these databases and return only the relevant documents to the user. In order to facilitate the searches on E-Resource sites, the user database must also store the proxy login information of each user

(login name and password). Information agents can then interface with the user database and retrieve this login information to gain access and search individual E-Resource database sites. The user preferences will help guide the agent to relevant resource sites to search for the information. The agent can also use 'Collaborative Filtering' by communicating with other information agents on the system to find relevant information retrieved by users with similar profiles. Each agent can compare its user's faculty, interests, library collection preferences and relevance rating of past search retrievals to the other agents within the system to find similar profiles. This will help automate the aforementioned issue of users refining their manual searches by comparing them with other students. Information agents can automate this process to eliminate the wasted time associated with repeat searches. These agents will also continually look for updated information that the user is still searching for and send an alert to the user when it becomes available.

All information databases will require **server agents** to communicate with information agents to facilitate information retrieval. Server agents will keep track of who has access to the databases as well as what information is available for retrieval. When a user's information agent requests information from a server agent, it will check to see if the user has authorization first, then it will check its database for any relevant documents to send to the user agent. The server agents can handle requests from several information agents simultaneously.

The **cataloguing** agent will automate the indexing and storage of library collections including books, magazines and online documentation. To save expensive storage space and indexing time, McMaster Library's cataloguing agent should only store relevant indexing information of each E-Resource itself and not every article stored in its database. This will allow the information agents to know which resources are available by interfacing with the catalogue database. The information agents will then be able to check the catalogue database to see which of these resources are available to McMaster university subscribers.

There are several important barriers to using agents successfully for information retrieval. One very important issue is the need for a common ontology (Nwana & Ndumu, 1999). In order for agents on different networks to communicate effectively with one another, it is important that they share a common ontology. However, different university libraries, including those at Vassar University (www.cs.vassar.edu/faculty/welty/papers/caia-94/section3_4.html) and Stanford (www-ksl.stanford.edu/knowledge-sharing/ontologies/html/#documents) are developing their own ontologies. There are currently several projects under the Semantic Web initiative which define mappings between different ontologies. Such efforts will help bridge the gap between libraries with individual ontologies and allow agents to communicate effectively with each other (Berners-Lee, Hendler, & Lassila, 2001, Fensel et al., 2003).

6. SUMMARY AND CONCLUSIONS

Recall the purpose of this report was twofold. The first was to propose a framework by which to evaluate the robustness of library portals. The second was to apply the framework to a real-life library portal initiative as a means of testing the viability of the framework in providing useful and salient recommendations concerning future enhancements to the portal system.

Library portals are more than just Web-based front ends to library environments. Rather, they are important vehicles by which to support the information needs and uses of library patrons through provision of convenient, personalized Web-based access to a comprehensive collection of information resources of relevance and authority. Portals are being embraced by libraries and may be their salvation in the battle against users turning to other portal systems or Web search engines

as a place to seek and find information.

This report proposed an evaluation framework for library portals that assesses the overall robustness of library portals on five dimensions: (1) the usability of the system interface; (2) the ability of the portal to support a wide spectrum of information seeking activity; (3) the personalization of the interface in ways that match individual user needs; (4) the extent to which the portal fosters knowledge work; and (5) the degree to which intelligent agents are employed.

The viability of the framework was tested on a real-life library portal initiative, the McMaster University Library Gateway. Overall, the system was found to exhibit some good characteristics of a knowledge portal, however several recommendations were suggested to improve the portal's overall robustness.

In terms of **immediate recommendations**, there are three:

- (1) *Improve the terminology used on the library portal interface to limit or reduce library jargon.* Avoiding library-speak can improve users' perception of the usefulness and ease-of-use of the system.
- (2) *Fix inconsistencies in the screen design.* All screen layouts should follow the same template structure in terms of tab bars, home page icons etc.
- (3) *Clean-up some navigation problems.* In particular, avoid reliance on use of the 'Back' button in the Web browser interface to navigate the system.

With respect to **short term recommendations**, there are three:

- (1) *Provide an integrated library portal site design that does not mimic the physical structure of individual libraries.* Users want a comprehensive view of the McMaster library system based on topic areas of interests. These typically cut across the artificial divisions of the four current physical library structures.
- (2) *Make the distinction between the library catalogue and other electronic resources transparent to users.* Users do not see the difference between McMaster's repository of personal holdings and materials they can access in external databases. Though the library can still physically maintain separate resources databases (if they so choose), this artificial division of information resources available to McMaster library patrons does not have to be highlighted or maintained in any user interface to library resources.
- (3) *Provide better Web log tracking metrics.* The current tracking logs capture insufficient information to warrant sufficient analysis on which to base any recommendations.

In term of **long term recommendations**, there are four:

- (1) *Personalize the site to individual user needs.* Users have specific subject interests and want the portal to provide that information in convenient and accessible ways.

- (2) *Provide communication and collaboration areas.* These two areas are under-represented in the current implementation of the Gateway.
- (3) *Provide a single browse/search function that is immediately accessible from the portal's homepage and does comprehensive searching across the entire library's resource collection.* The predominant reason users access the Gateway is to seek information. This option should be on the homepage of the Gateway and should not require users to click on a link to get this function. Further the search facility should provide an integrated solution for browsing and searching, namely in the provision of a single search box and a listing of information subject categories. One idea is to rethink the need for two cataloguing databases (MORRIS and the ERD). Rather than trying to embellish a separate ERD tool, steps could be concentrated on making MORRIS better in that it would facilitate the storage and management of all resources and thus provide a single comprehensive resource collection for retrieval.
- (4) *Leverage the use of intelligent agents.* The widespread use of intelligent agents may be a few years off, however, there are still some key changes to the Gateway that can and should be implemented. First, a user database should be set up to allow each student and faculty member to log in with an individual ID and password. The database should store the history of user searches and past information retrievals to allow 'memory jogs' to help users find prior searches and relevant information for their research. This database should allow users to customize their user interface. Each user should have their preferred interface configuration stored in the database for future retrieval. Students and faculty should also have a direct link from the library portal to their e-mail accounts to help facilitate knowledge sharing through the portal.

In conclusion, the authors hope that the recommendations suggested above inspire change in the design of the McMaster University Library Gateway in ways that lead to increased perceived usefulness and ease of use of the system, facilitate effective and efficient end-user browsing and search behaviour, better match the information needs and uses of library constituents through personalization of the portal interface, foster knowledge work, and leverage intelligent agent technologies to the Gateway's advantage. It is also hoped that the framework will serve as a basis for informing and evaluating the design of other library portal initiatives in ways that promote portal use and library patron satisfaction.

On a final note, this working paper is an attempt to raise awareness among library staff for the need for a strong and sustained commitment to the ongoing and continuous development of a library's portal. The portal is the library's virtual presence on the Web and is often the main medium by which patrons interact and utilize the library's resources and services. Thus libraries implementing portal solutions need to be readily aware of the need to address, on a continual basis, improvements to a portal's design and to deal with technologies and relationships affecting the portal as they emerge. This may require libraries dedicating staff to the portal's development so that a core group of people are constantly investigating new technologies, finding out what other libraries are doing, polling users on their satisfaction, and analysing portal usage behaviour. Doing so will help position libraries as the trusted first source of information to which users turn for help to address their information needs.

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