Digital Libraries and Institutional Repositories: Building a New Delivery Framework

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Institutional Repositories and Digital Library Services: Building a new delivery framework.

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Abstract

Librarians invented concepts and established standards so that principles of organisation could be applied to stores of knowledge. This paper considers how the move from physical to digital stores has created new imperatives for academic libraries and considers the roles institutional repositories will play in the development of new services.

Institutional repositories are being used to capture original research and other intellectual property generated by an institution's constituent population. We should not limit our thinking of this digital material as only being recognisable units of research outputs – the easily managed published material that forms the final link in the scholarly communications chain. Academic Libraries will need to develop a better understanding of ways in which scholarship and learning are created, used, reused and preserved in the digital environment.

How our users interact with each other and with information resources have undergone a fundamental change. Changes in the way data, information and knowledge are gathered, shared and disseminated are determining the types of services libraries will have to support. This paper will look at the elements of these two areas of developments (the rise and rise of institutional repositories and how our users gather, create and disseminate information) and outline the development roadmap UNSW Library is undertaking to ensure the services we build are relevant to our users.

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Setting the scene

Librarians invented concepts and established standards so that principles of organisation could be applied to stores of knowledge. The move from physical to digital stores has created new imperatives for our organisations. Simplistically, libraries and archives came into being to provide a central location for hard-to-find, scarce, expensive or unique material. The process of searching for information within a traditional library is done within highly structured systems and information is exposed and knowledge gained as a result of successfully navigating these pre-existing structures. The librarian helps guide and navigate this system where every piece of content has a preordained place.

Wikipedia defines the modern library as "increasingly being redefined as places to get unrestricted access to information in many formats and from many sources……libraries are understood as extending beyond the physical walls of a building, providing assistance in navigating and analyzing tremendous amounts of knowledge with a variety of digital tools."

Others such as Google, (www.google.com) Accoona (www.accoona.com), Exalead (www.exalead.com) and many, many more are doing this too. What do libraries need to do differently to add value? Could our value add be to connect users to authoritative, appropriate and authenticated information? It's certainly not about providing ACCESS. As Academic Librarians our job is to provide our users with a competitive advantage. So we need to know what our users want and how we can provide a service that meets those requirements. We should start with the premise that our users are ignorant of what they want – that's why they are learning and researching – to extend their knowledge. Hence the fundamental of our services should look at how we can support them moving beyond ignorance – i.e. having the tools to connect the user to the things she doesn't know exists.

Libraries needs to develop such services to cope with the fact that discovery and delivering services need to be instantaneous - attention spans are short and alternatives are more attractive. There are many demands on attention and many resources are available. Where attention is scarce, the Library needs to provide services which save time, which are capable of being used by members of our community to satisfy their personal information needs and fit into their workflows. Aggregating resources alone is not enough. Resources and services need to be tailored and moved into the users' environment in ways that support their research, teaching and learning. Libraries now extend beyond the physical and services include providing assistance in navigating the large amount of information that is now available. Success lies in how well we can combine these

new services for our users so that the library is still relevant to their information and knowledge requirements.
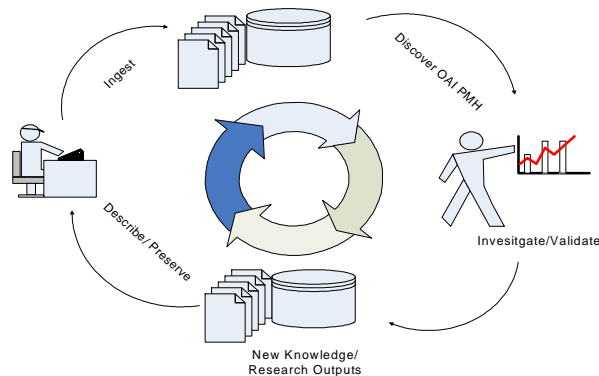
What about Repositories?

The term "repository" has begun to be used in reference to some types of digital collections and data stores. Unlike a collection of digital objects housed in a traditional library database, institutional repositories are being used to capture original research and other intellectual property generated by an institution's constituent population (Crow 2002). Clifford Lynch (Lynch 2003) goes further. He sees institutional repositories as 'a set of services for the management and dissemination of digital materials created by the institution and its community members. It is most essentially an organisational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organisation and access or distribution.'

We librarians should not limit our thinking of this digital material as only being the easily managed published material that forms the final link in the scholarly communications chain. The academic community, including the library, will need to develop a better understanding of ways in which scholarship and learning are created, used, reused and preserved in the digital environment and of the relationships and infrastructure necessary to sustain these activities. Academic and research libraries have always provided a supporting role in research endeavours by providing access to scholarly information resources, and by providing assistance to researchers in the use of these resources. These services must now be extended to support the new ways of scholarly communication.

Van de Sompel and others (2004 2005) see repositories growing expedientially as their role in the scholarly communication value chain become more widely recognised. He sees this value chain as beginning with the registration of new knowledge from research outputs that are ingested into the repository. As this research is discoverable through such standards as the OAI-PMH harvesting protocol it is accessed and validated by different parties. This validation builds awareness and leads to new research outputs. The end of the chain occurs with the archiving/preservation of the knowledge. Libraries and the repositories they service will become content nodes on the network, capturing the intellectual output and exposing it to the wider community.

This diagram shows how the scholarly communication chain is changing with new online ways of creating knowledge. The digital librarian will assist with the ingestion of research outputs such as datasets and research papers, so they are described for maximum discoverability and so they can be preserved. These research outputs will be discovered using protocols such as OAI-PMH and new services (obtain/harvest/put) (Van de Sompel et al 2006). Research outputs and digital objects will be used to allow the re-use of datasets hosted by various repositories for the creation and publication of a new dataset and will contribute to the development of new knowledge and new research outputs – which will be stored in other institutional repositories. And the cycle will continue.

Repositories are about facilitating the use and re-use of material in many contexts. The value of storing and managing the research dataset will become more widely recognised as it is demonstrated that repositories, as both knowledge stores and data stores, facilitate the creation of new knowledge by allowing for non-anticipated use of research datasets. The digital librarian must therefore build skills in data management, access control policies as well as building and exposing metadata to ensure maximum discoverability. This should not be considered a conceptual leap from traditional librarian skills. After all, repositories are about facilitating the use of materials in many contexts – this is a core function of libraries that librarians have always provided. However, digital library services are not the same as establishing and managing an institutional

repository. Digital library services involve the organisation and management of information beyond traditional physical publications to facilitate access to these digital objects. It may also include a process of digitising material or assembling digital objects into collections or mining data to build access to knowledge. Digital library services do not, in themselves, ensure that information is discoverable to users outside of the Library's immediate user base and its integrated library management system.

Requirements to make research data accessible are gathering momentum. The funding rules for the Australian Research Council Discovery Projects commencing in 2008 'encourages researchers to consider the benefits of depositing their data and any publications arising from a research project in an appropriate subject and/or institutional repository'. It is in the management of research data and data sets, held inside the repository alongside the published findings that will challenge us. There are two aspects of research data that relate to academic libraries:

- Data as *primary source material* available for further research and experimentation, using particular datasets or groups of datasets; and

- Data as part of *enhanced publications* that form the basis of modern, digital scholarly communication. (Smith 2006)

For "enhanced publications" that include scientific data as a useful part of the research output, there are missing standards that academic libraries are well positioned to define, including:

- Ontologies for these complex/compound publications that include data

- Identifiers for publication parts that work across disciplines

- Consistent description practices for enhanced publications and their parts

- Data structuring conventions

- Interoperability protocols for searching and retrieving data.

Broadening the scope of libraries and archives to include stewardship of digital scientific research data brings the bigger challenges. There are unanswered questions about:

- The required technical infrastructure, and who will develop and manage it

- Collection practices involving decisions about what data will be kept, when, in what form, with what tools, what description

- Digital preservation practices, which are still being formulated

- The legal framework that is necessary to allow this to happen at all.

- Collection policies and practices (appraisal, selection, weeding, destruction, etc.)

- Data clean-up, normalization, description, and submission to archives

- Collaboration with researchers around scholarly communication practices

Libraries will contribute to defining needs and requirements, but it is unlikely that they will be the primary providers of the large-scale storage infrastructure required. Nor will they provide the specialized tools to work with the data (sometime at the level of individual datasets). It is also unclear whether libraries will provide the technical solutions to long-term digital data preservation. It is certainly within the mission of academic libraries to preserve the scholarly record, but the technical challenges and costs involved are large, and libraries will need to invest seriously in this area if they wish to help find solutions.

They will however assist researchers in providing detailed information about the data to maximise discoverability. And they will assist and support the legal and behaviour framework (similar to the support provided for creative commons licensing) to enable "open science" based on "open data". However the greatest contribution libraries can provide is their expertise in collection management and the management of descriptive consistency to achieve economies of scale *across all scientific research domains* and not just perpetuate the creation of data silos within particular scientific sub-disciplines. To illustrate, the discipline of systems biology is dependent on the existence of well annotated data sets defining and describing the components of these systems, especially genes and the proteins they encode. Information on these compounds is accessed through structured bioinformatics databases and from the scientific literature such as Medline and PubMed (Kersey and Apweiler 2006).

Work has begun (Van de Sompel et al 2006) on defining a framework and identifying where standards are needed to provide services across distributed repositories, so that digital objects in these repositories can function as units of scholarly communication in cross repository work flows.

The environment we operate in

Traditionally library users have had to adapt their workflow to the library. As the network becomes more important libraries need to adapt their services to the network workflows of the user. Users no longer need to come to the Library, there has been a shift from needing to directly access the library catalogue and its other databases. Academic libraries must now provide relevant services in an environment where there is a cornucopia of content and information services. Full text, available now, at no direct cost, is becoming the expected norm. Our community members are changing the way they interact and engage in their research, teaching and learning activities. Most importantly, the amount of time our users are prepared to invest in learning about and using our services is reducing and is now almost non-existent. The future of the academic library is challenged by these new dynamics. They have caused us to think about how to deliver and integrate services; the future of the academic library lies in how well it meshes with a whole range of related services. (Wainwright 2004)

Dempsey (2006) writes that the development of the web and greater depth of connectivity has allowed libraries to move from a peripheral role to a central role in the information space that supports research, teaching and learning that Universities engender. Raymond Yee (2005) from the Interactive University Project, at the University of California, Berkeley has developed a tool called the Scholar's Box that encapsulates the concept. The Scholar's Box gives users "gather/create/share" functionality, enabling them to gather resources from multiple digital repositories in order to create personal and themed collections and other reusable materials that can be shared with others for teaching and research. This gathering and sharing brings together users with the resources and services used from the network.

One important trend in this new information space is the discovery-to-delivery service framework – services between a user and a distributed library resource encompassing resource discovery, linking to resources and requesting/receiving delivery. The Web is free-associating, unrestricted and disorderly. Searching is secondary to finding and the process by which things are found is unimportant. "Collections" are temporary and subjective - where a blog entry may be as valuable to the individual as an "unpublished" paper as are six pages of a book made available by Amazon. The individual searches alone without expert help and, not knowing what is undiscovered, is satisfied.

The primary importance for UNSW Library, like all libraries is to provide our users with services that support them in their academic endeavours and provide them

with a strong competitive advantage. As the name "Net Generation" implies, our latest group of customers is a generation that is the first to have come of age in an environment where ubiquitous computing has existed as long as they can remember. Unlike previous generations such as the "Generation X" defined by Coupland (1991) or the Baby Boomers, this new generation were born in the Information Age and are more likely to exhibit attitudes and behaviours that Frand (2000) characterized as the "Information-Age Mindset."

These users are a comfortable with self service and working it out for themselves, and they want a high degree of configurability. Studies and papers (Frand 2000; Woodall 2004; Lippincott 2005; Oblinger and Oblinger 2005) generally agree that some of the key characteristics include:

- They are generally confident in large groups and organisations, socialising there needs and are comfortable with creating/aggregating their own information – see digg (share, discover, bookmark). (http://digg.com), MySpace, flickr, youTube and Facebook (sharing information, images, sounds and video) (http://www.myspace.com http://www.flickr.com http://youTube.com http://www.facebook.com)

- They want to be independent problem solvers and are happy with "self-service"

- They are accustomed to media-rich entertainment computing

- They are proficient in using many kinds of media

- Multi-tasking is the accepted norm for their personal, social, and work activities

- Reality is no longer real (cannot assume the truth or authenticity of anything online)

- Actions are more important than knowledge and they have little tolerance for delay

- Typing is better than writing

- Staying connected is essential

- They prefer to build a wide, sustained network of connections via technology, and willingly provide sign posts and act as way finders to those coming after them – the age of information sharing is also the age of recommending/tagging.

Development of "information age" services and greater connectivity allows libraries to move from peripheral ancillary roles to a central active role in the information space that supports research, teaching and learning. There has been a dramatic shift from users having to develop an understanding of the way the library provides resourcing services and tailoring their information seeking patterns based on these services. Now the library needs to provide services that saves time and which are capable of being used to meet highly personalised information needs which fit into individual workflows. We need to be able to take our resources, combine with others and present services in a way that allows users to incorporate their own delivery methods.

McDonald and Thomas (2006) state that features such as personalisation and recombination of information resources are pervasive in the external software and systems world, but libraries generally have not demonstrated the desire or intent to adopt these capabilities. Libraries need to develop services and facilities to create opportunities to make library information look and behave like information that exists in other online environments, such as the researchers' repository.

How do you provide links back from other discovery venues to the library, so that the user can actually get the resource of interest? How do you support metadata creation or document deposit in an extensible way? These are some of the questions we will have to answer as we define how we will deliver services into the users' information space. We need to be able to take our resources, combine them with others and present these services by allowing users to incorporate their own delivery method. We need to move beyond the situation where library services are only available to those members of the community that makes its way into the library web presence and manages to find what they are looking for.

Development Roadmap for UNSW

Like all academic and research libraries UNSW Library has been exposed, and reacted to, these changes in the scholarly communication cycle and how people use libraries to access information. Studies in the late 1990's (Voorjib 1999) on student and academic usage patterns show the majority believed searching the Internet or the Web provides sufficient information resources. Later work (Palmer 2006) shows how the Internet is influencing what information comes into play during the process of scholarly production. At the same time, online services and increased connectivity are blurring the lines between "user" and "library" in the information space. This new shared information space is fostering the

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development of new resources for information access that assist researchers in identifying and finding sources of information.

At UNSW, our services need to focus on the priorities established and re-affirmed by the new Vice-Chancellor. These priorities are to continue to build a research intensive professional and scientific university, with an emphasis on applied research. The university's priorities are to strengthen research and support the academic mission in producing "job ready" graduates. UNSW Library services are being developed to confirm UNSW's distinctiveness and support the academic mission.

Recently the Library has recognised that there was a need to review and change the workflow processes it employs to provide information services. A new Information Services Department has been created with resources dedicated to service development and innovation, keeping abreast of new technologies and services implemented overseas and locally that provide opportunities for the UNSW community. Once the Innovation group has identified and defined a new service, the requirements will be passed to the Service Development Unit for realisation. The Academic Services Teams will then deliver these services to the UNSW community.

The staff in the Information Services units will define and design the service framework so that we can reduce the number of platforms we maintain, develop common services that can deploy across resources and into the users information space, linking disparate data stores using agreed metadata standards to describe objects and their usage. Standards based services will be developed to harvest metadata and build linking services in a scaleable and extensible manner and provide usage and rights management based on descriptions held at the object or remote resource level. To be relevant and useful, we will also need to build user profiling capabilities to personalise services. All these will need to be developed within web and network based services to take our library services into the users' space. These teams are now deploying as quickly as possible some services that can act as demonstrators and incubators and provide stimulus to the service development framework. This will enable us to identify "core" services needed to meet essential needs which can be prioritised, before expanding facilities and services to fulfil a complete service development framework.

The current UNSW Library information space is based on the pre-digital era, where access to resources is tightly integrated within the integrated library system platform. Service provision is one of multiple web front ends, each relatively standalone. We have deployed our library system as a "silo" application,
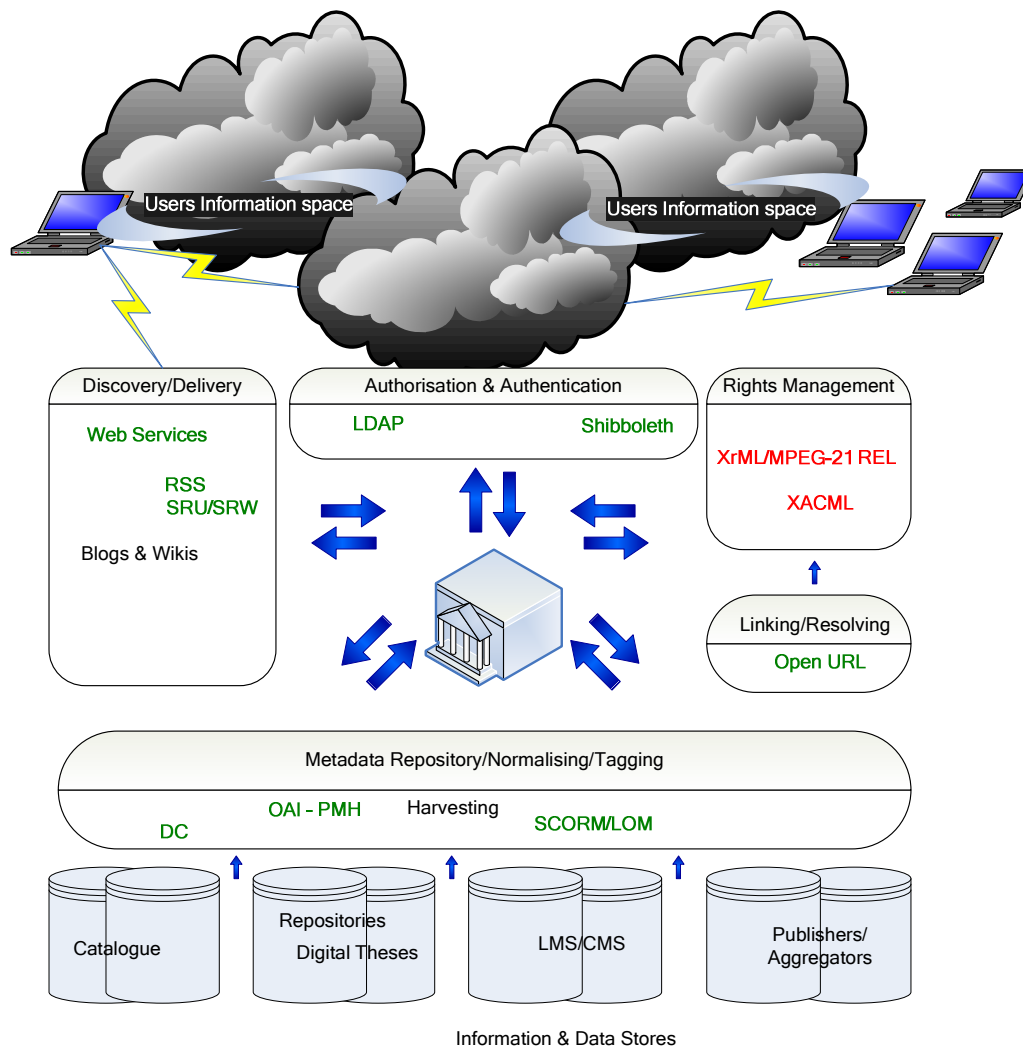
with limited interconnections and interactions– the user comes to the Library catalogue and to Sirius, the name give to the access service for electronic and online resources.

In 2000 the University Librarian at UNSW circulated a paper entitled *Enhance the Learning Experience @ UNSW*. The document articulated the concept of the hybrid library and proposed that the Library 'provide students with seamless integrated access, independent of time or place, to digital and print information resources to enhance the learning experience and support the University's teaching activities.' (Bate 2000).

To realise this vision we need to take our services and resources into the users' space. With this in mind we have identified "modules of functionality" that are required to take library services into the users' information space. Conceptually, the new service architecture will look something like the model, below. As you can see, the library catalogue, once the focal point of the library's services is but one of many data stores. These data stores will be augmented, combined and tagged to provide an aggregated service for all resources. Other "modules of functionality" are required to provide:

- Discovery/delivery services (these will rely heavily on Web 2.0 services)
- Authorisation and authentication, rights management and linking/resolving services.

We have begun to identify some of the standards and protocols that will be used – these are colour coded green – those in red are areas where standards (defacto or otherwise) are still coalescing.

Information & Data Stores

In the context of the UNSW information space, ARROW@UNSW plays a major role in managing the research outputs of the University.   As such it also contributes to the UNSW response to the Research Quality Framework (RQF), the Australian Government's initiative, to formulate a world's best practice framework for evaluating research quality and impact.

As contributing partners to the ARROW project (Australian Research Repositories Online to the World) UNSW Library is building repository services to serve the needs of the University. The ARROW project has been developing and testing software solutions to support best-practice institutional digital repositories. A wide range of digital content types will be managed in these repositories. This includes a potential path for the redevelopment of the ADT metadata repository.

UNSW Library is the lead in a project that is digitally aggregating thematic research material within the Visual Arts sphere. The Dictionary of Australian Artists Online (DAAO) draws from the work done by Prof. Joan Kerr on the

Dictionary of Australian Artists (Kerr 1984, 1992). The online dictionary aims to reflect the entire landscape and history of artistic production in Australia. Stage one of the DAAO will contain over 5,000 biographies of Australian artists and will provide bibliographic data, contextual information, papers, images and audio. Relatively unexplored areas such as relationships between Indigenous and non-Indigenous art will be realised through the DAAO. (DAAO 2005)

We are now beginning the work to build services over numerous data stores, including the UNSW institutional repository and the new repository of ADT meta-data. These services will be extended to provide an Amazoogle interface to UNSW resources and will include delivery services featuring RSS feeds and Mashups. A good example of this, which we may draw from, is Bookjetty (http://www.BookJetty.com) that combines Amazon purchasing with catalogue records from the National Library Board of Singapore

We will also look at recommender services such as those demonstrated in the California Digital Library's Melvyl Recommender project. Melvyl Recommender Project: (http://www.cdlib.org/inside/projects/melvyl_recommender/)

Challenges

There are new opportunities and risks facing our profession and businesses. For libraries, it is important to focus on the users, who are demanding information in many formats and through many channels. At the same time, budgets are shrinking, staff are aging, users are becoming more technologically advanced, and libraries and librarians are concerned with their roles in the greater information community. Google has transformed the landscape.

We must create organizations that welcome and foster those who are technologically savvy. But, as Colin Steele and Mechthild Guha (Steele and Guha 2000) point out in *Staffing the Digital Library in the 21st Century,* 'many of the middle to senior staff in our libraries were brought up in the more constrained environments of the role of the librarian.' They may not naturally value the contributions of tech-savvy staff as much as they value book selection and traditional reference service.

We need to build staff experience and skill sets to understand the workflow requirements and constraints of the new services we must deploy. We will need to adopt and contribute to standards that will allow interoperability between their components as well. We need an understanding of standards and their relevance to the challenges we face and an appreciation of how they can assist in meeting our business needs. As the information environment becomes more complex and

distributed we must move to new types of user-centric services and standards will be crucial to facilitating this.

Digital objects require more complex asset management structures. As well as describing the information and intellectual content of the object to exploit digital objects to their full we need other information – information about the objects format, and transformation capabilities, information to preserve and extend its use and information on access and usage rights. Access and interface issues need to be addressed in an environment where digital rights management and licensing constraints play an important factor in managing access.

We will also need the ability to create and exchange data models so that heterogeneous repositories can expose themselves to the rest of world. The will require standard data models for representing digital objects, a common format for serializing digital objects into surrogates compliant with that data model, and three repository services for requesting access to and deposit of those surrogates: obtain, harvest and put (Van de Sompel et al 2006).

Various XML-based constructs aimed at representing complex digital objects have emerged over the last several years such as the metadata encoding and transmission standard (METS), the Shareable Content Object Reference Model (SCORM) and the MPEG-21 Digital Item Declaration Language (DIDL). Within a METS document for example, there can be four types of metadata: technical metadata (information about an object's creation, format, and use), rights metadata (copyright and license information), descriptive and administrative metadata regarding any primary source from which the object derives, and digital provenance metadata (information regarding source/destination relationships between files, such as master/derivative relationships and information regarding migrations/transformations). (Library of Congress 2005)

The digital librarian must contribute to these initiatives so that they can describe and manage complex digital objects, build and support stable and extensible knowledge stores and carry out the acquisition, description, and access facilitation to provide information services to their community. When considering issues of rights to the use (and reuse) of materials concerns of data authenticity and data integrity also need to be addressed at the object level. Van de Sompel (Van de Sompel 2005) mentions numerous initiatives, including the Open Digital Rights Language (ODRL) initiative, MPEG21-REL and XRML and makes the point that machine-readable rights expressions are needed for the machine-to-machine interactions that will be deployed to extend the use of repositories.

Librarians need to ensure they have a role in the adoption and deployment of this technology. Assisting with the standards and frameworks needed to describe collections of research data to maximise discoverability is another way librarians can contribute to extending the use of repositories. We must resist the temptation to go on building digital library services which focus on our collections, our metadata, and library workflows. While these projects use tools and techniques that can be applied to new services that must be developed to support and exploit repositories, a library centric focus doesn't allow the user (the researcher) to enter created content into the data store, nor do they provide for easy metadata creation. Bottom line: if we focus on our internal systems and needs a new opportunity could pass by. Instead, libraries should reinvigorate digitization projects as part of a larger institutional repository framework.

The way forward

What makes innovative libraries different from their counterparts? What are the conditions that help foster innovation and creativity? How can libraries make effective decisions about resource allocation that take into account existing needs while providing opportunities for experimentation? How do you encourage staff to take the inevitable risks that accompany innovation? And what can management do to create an organizational climate and management structure that supports creativity?

Libraries need to focus on the value add they provide to their users helping them find information that is authoritative, appropriate and authenticated. We need to get into the users' space and discover how they interact for their needs for information and how they satisfy those needs. To do this well, we must have a relentless interest in and understanding of what users want to do with information and how they find it, place it in a personal context, use, and sometimes store and reuse it. We must be active in defining a service framework that uses standards to describe, harvest and link to distributed and heterogeneous resources. Such a framework must use standards so that the work we do is extensible and scaleable and will have to include user profiling capabilities so that services can be personalised.

This will require libraries to develop a mechanism and framework to gather individual projects and service descriptions that together create a cohesive whole service. At UNSW the Digital Libraries Program Office and the Services Innovation Unit work closely together to identify services and specify how they

these will be developed or modified from existing ones and how they will be delivered into the user space. We are developing business analyst skills that will help us determine the role of the catalogue – this is only one of many data stores – what do we want to do with this asset to maximise our investment in its creation and maintenance? Do we augment/mashup the catalogue with other data such as "items in this category are listed in these courses" or "patrons who borrowed this book also borrowed" as suggested by the Melvyl Recommender project? How do we go about branding our collections and collaborating with suppliers such as Bookjetty?

If nothing else, we must remember that things will change. Change is always going to happen – it's only the pace of change that will vary – and we can't expect it to slow down. So we will need to have flexible modular systems that can respond to change quickly and easily.

> 'It is expected that repositories will continue to focus primarily on serving particular communities, for example subject-based or institutional communities; or be responsible for a particular content type, for example images or learning materials. However, the repositories of the future will be much more interoperable with systems used to support learning and teaching, Virtual/Managed/Personal Learning Environments, assessment systems, ePortfolios, etc., as well as with authoring tools, other repositories, portals and library systems.
>
> By 2010, simple metadata will no longer be created 'manually' to the extent that it is now. Techniques such as text and data mining, topic mapping and so on will be used to create metadata and extract information. However, it is still unclear as to who will be responsible for this 'knowledge extraction' and what level of aggregation will be required for it to be effective.' (Heery and Powell 2006)

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