INSTITUTIONAL E-PRINT REPOSITORIES FOR RESEARCH VISIBILITY

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Introduction

A pivotal stage has been reached where the international movement towards open access to research results is meeting the growing development of institutional digital repositories (also known as e-Print archives) and encouraging new forms of scholarly communication and e-research collaboration as a result. Institutional repositories enable an institution or research laboratory to showcase the digital assets that are created by its employees and students. These repositories are beginning to supplement discipline based repositories as a method of making research results immediately accessible. Open access implies 'free at the point of use' enabling any researcher who is interested to read research output which is relevant to him/her. Ultimately new forms of analysis of the literature will be possible since all research will be accessible in digital form.

Adding e-Prints (full text and perhaps supplemental material) to research publication records promotes visibility particularly when records are searchable by both general search engines and specialist global 'Open Archive Initiative compliant' search engines. e-Print repositories can consist, narrowly, of peer-reviewed journal articles or can extend to the whole of research output including conference papers, posters, pre-prints , multimedia and dissertations, even primary data. The range of content will depend to some extent on the discipline.

The Open Access movement is likely to impact on the traditional publishing paradigm and turn the world's research literature into a global resource accessible to everyone over the internet. Institutional repositories provide this increased visibility to an organization's research and at the same time researchers benefit through wider and more rapid dissemination of their work.

Background

The digital world has brought new opportunities to institutions such as universities and research laboratories. It enables them to think anew about how to make the most of their valuable institutional assets including the publications produced as a result of their research. The archivist traditionally preserved the paper or physical assets of an institution and they were stored carefully away to preserve them. The online catalogue gradually made readers more aware of these hidden treasures but reading or viewing them required a lengthy planned process. New simple digital library software, particularly with the potential for distributed author submission, brings huge possibilities for an institution to emphasise and be proud of its valuable assets. It can recognise new digital materials created in house, such as research output and learning objects, as well as other material, for example, a famous author's papers, retained for research purposes.

The digital environment and the expansion of the World Wide Web (1) allows an immediacy which benefits author and reader and particularly helps stimulate new research by the timely interaction possible. However, the present system of scientific publishing with spiralling journal prices has created a crisis in which library budgets are unable to keep pace. Indeed, an author frequently does not have easy access to his own article and if the library does not subscribe to the journal, even in the Google age, the chances are that it may not be found or read at all. A journal paper which takes two years to appear can, in any case, be lost to prospective readers in the meantime. The potential for the author, (if he is able to reject the normal Faustian bargain with the publisher, by retaining copyright and, therefore, keep access to his own paper, making it immediately available and visible to all), was recognised much earlier in the nineties (2). International initiatives, both campaigning and technical, have since helped to produce an environment where an author has greater support to make this happen. There is now an international movement encouraging two complementary paths to address the problems caused by the present system: alternative scholarly publishing models (open access journals) and institutional repositories (open access e-Print archives).

The institutional repository is being proposed as an essential infrastructure for the digital age (3). As authors 'produce increasing amounts of original material in digital formats—much of which is never published by traditional means—the repository becomes vital to protect the significant assets of the institution and its faculty.' (4). While a repository can be composed of many types of assets, materials such as learning objects present their own special challenges, and we concentrate here on the particular value of the institutional **research** repository.

Regardless of the particular combination of databases chosen by an institution to showcase their assets they are all, in principle, searchable together if they adhere to common standards. The institutional research repository of 'e-Prints' is making an

impact because of its pivotal role in increasing the visibility of research and hence enriching the whole collaborative research process in an inherently digital world.

e-Print Archives and Repositories

The rationale for e-Print services has been debated extensively (5), (6) and the success of this initiative is now being measured by services such as the [Institutional Archives Registry](#) and [e-Prints UK Statistics](#).

Reprints are paper copies of published papers, which historically, institutional research libraries disseminated worldwide as bound (or loose) Collected Reprint volumes. *e-Prints* are electronic copies of those papers (journal articles, book chapters, conference papers etc) plus any other research output such as working papers, reports and conference posters.   They can be: *preprints* – unpublished papers before they are refereed or *postprints* - papers after they have been refereed.   An e-Print archive is an online depository of these 'document types' and is usually internet based for free access and dissemination. Since 'archive' has connotations of old holdings rather than providing visibility to new research the word 'repository' is also now commonly used. There are leading supporters of e-Prints (7) who define e-Prints more narrowly to encompass only peer reviewed journal articles. However, many institutional repositories focus on the collection and preservation of all types of output not limited to research literature, but including scientific data, learning objects, administrative records, museum and image collections, multimedia and many other types of content.

Institutional Repositories alongside subject repositories form part of a global searchable system of distributed interoperable repositories which will impact on the scholarly communication process by facilitating early dissemination of research results, long before their final appearance in a printed article.   More broadly, they are also seen as part of the digital infrastructure of the modern university, offering a set of services for the management and dissemination of digital materials created by the institution and it community members. (8) Open access to the products of research is in keeping with the scientific tradition of data sharing through scientific data archives and contributes to the vision of the e-Science initiatives around the world. It is hoped that providing open access to the scientific literature, as with DNA sequence databases, will encourage "the development of new, more sophisticated, and valuable ways of using the information". (9)

Centralised subject e-Print archives have achieved some success but a complementary institutional based model is now being advocated. Libraries, among others, are now taking the opportunity to set up institutional e-Print archives or institutional repositories under the [Open Archive Initiative](#) umbrella.

Open Archive Initiative

OAI is supported by the Digital Library Federation, Coalition for Networked Information, and a National Science Foundation Grant. Its mission is to 'develop and promote interoperability standards that aim to facilitate the efficient dissemination of content.'   The Open Archives Initiative has its roots in an effort to enhance access to e-Print archives as a means of increasing the availability of scholarly communication.

The facilitating software is the OAI Protocol for Metadata Harvesting (OAI-PMH) which creates the framework for interoperability between distributed e-Print servers by enabling metadata from any OAI registered archive to be harvested and aggregated into one searchable database/interface. The metadata format is based on the Dublin Core Metadata Element Set and includes such information as author, date, title, subject and abstract. Archives can be OAI-compliant even if their full-text contents are not open-access. OAI-compliance applies only to their metadata. OAI interoperability is possible for all online content, open-access or not.

Subject vs Institutional e-Print Archives

The best known e-Print archive is arXiv (originally at Los Alamos but now hosted at Cornell), initially set up for high-energy physics but now covering a broad physics base including Atmospheric and Oceanic Physics, Math, Computing Science and Non linear Science. This and other early e-Print services are subject based and hosted by a single domain and rely primarily on researchers to remotely deposit their papers themselves using a simple Web form-based procedure (self-archiving); some archives do also accept papers sent to them by email.

Despite the success of the Los Alamos e-Print archive implementation started in 1991, there has been cautious uptake by other subject communities and only a few centralised subject-based archives have been successful eg CogPrints at Southampton, the Chemistry Preprint Server, WePeC, etc   As a complementary model an institutional based archive, offering both self and mediated archiving, is now being advocated, particularly in the excellent report, *'The Case for Institutional Repositories: a SPARC position paper*, (10). The deposit process is more complicated in disciplines where authors already contribute to subject based archives such as arXiv or RePEC or contribute to project collaboration databases. Institutional research repositories can provide a store for the electronic document when it is not already stored in a trusted repository elsewhere such as in arXiv.

Institutional Repositories

All types of organizations that generate a substantial corpus of research can establish repositories, not only universities and colleges, but government departments, research councils, societies and commercial organizations etc. *A digital repository should be the hub of any organization's knowledge management.*

Institutions can provide the technical, cultural and organisational framework to support the start-up and maintenance of e-Print archives. Historically, research libraries have always maintained a role in research dissemination. Many scholar-authors have become active partners with their library, helping to play a role in making research more accessible and libraries often act as managers for the organization's imprint. Information managers because of their existing stewardship of organisational assets and their trusted position within the community, are the logical administrators of institutional repositories and many are now taking a lead role in the IR movement.

Capturing, preserving and disseminating an organization's intellectual assets, an institutional repository provides a meaningful indicator of academic and research

quality. It provides an historical as well as a current research profile.   Normally this is disseminated (and disaggregated) through scholarly journals. Publication in prestigious journals brings kudos to the researcher and the organization, but is distilled throughout some 24,000 journal titles. Projecting a holistic view of an organization's research activities increases visibility and reflects on scholarship which, in turn, supports funding opportunities and recruitment activities.

It is however not necessary for each institution to operate entirely on its own and already it is seen that many universities and regional consortia are joining to provide the institutional repository infrastructure via collective working.

International and national initiatives: a growing focus on open access

A useful timeline on early e-Print activity was provided by Suber (11) and, now that change is happening in earnest with new and varied initiatives appearing so fast in the international arena, it is vital to scan such alert services as Open Access News regularly to keep up with them.   However, no discussion on self archiving would be complete without mentioning Prof Stevan Harnad of the University of Southampton who originally advocated self archiving in 1994, and who still hosts the discussion list, American Scientist Open Access Forum, and maintains a healthy dialogue concerning developments in e-Print archives.. There has also been a growing focus on open access with such services as PubMed Central.   BioMed Central and the Public Library of Science are two leading components of open access publishing and now commercial publishers are starting to offer an open access model eg. Springer-Verlag. More compelling than words however, e-Print advocacy was strengthened by funding initiatives from the Mellon Foundation who provided US $1.5 million for seven US projects and the Budapest Open Access Initiative released in February 2002 and supported by the Soros Foundation Open Society Institute's Information Program, which aims to accelerate progress in the international effort to make research articles in all academic fields freely available on the internet. The OSI Information Program has committed funding of US$1million per year for three years in support of open access projects.

In 2002 the UK Higher Education Funding Council (HEFCE), Joint Information Systems Committee (JISC) announced a funding call - FAIR (Focus on Access to Institutional Resources) under their Information Environment (IE)/ Learning and Teaching/Infrastructure Development programme. Successful applicants included the Universities of Glasgow, Edinburgh, Strathclyde, the Consortium of University Libraries (CURL), UKOLN (a bid which includes OCLC as a partner), and Southampton University.

Major international initiatives on a countrywide basis include the DARE Project a collective initiative by Netherlands universities awarded 2 million Euros for 2003-2006;   CARL – Canadian Association of Research Libraries launched in 2002 and in Australia, the ARROW Project - Australian Research Repositories Online to the World with a AUS$12m national support for implementation.

Some early institutional (library) adopters around the world include: Australian National University, Hong Kong University.   Universities in Europe: Utrecht, Groningen, Lund, Humboldt in Berlin, Max Planck Institute in Hamburg. In the

USA, MIT, Caltech, California Digital Library, Library of Congress etc.   For a graphic list of e-Print archives around the world see the [Institutional Archives Registry](#).

Internationally there are a growing number of declarations in support of open access: Budapest Open Access Initiative 2002; IFLA Statement on Open Access to Scholarly Literature and Research Documentation 2003 ; Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities 2003 ; World Summit on the Information Society 2003; OECD Declaration on Access to Research Data from Public Funding 2004.

Software

Early implementators installed the original e-Print archive software, [EPrints.org](#) (now GNU EPrints) which still remains the software most used. In the last few years, new software has been developed: DSpace, CDSWare, i-Tor, Fedora, MPG, eDoc, MyCoRe and daily more, including commercial platforms eg. Ex Libris.   All are OAI compliant and have core plus their own functionality. The Open Society Institute has produced a useful guide to IR software and already it has been issued in several editions, to keep abreast of new developments and new softwares (12). It is therefore important to make a well informed choice when selecting the IR software, although experience has shown that whatever software is chosen, customisation and additional functionality is often necessary.

There are a number of issues facing those establishing Institutional Repositories. Installation of the software is in general straightforward but the main issues are based on cultural and managerial issues. (13)   An institutionally defined repository implies definitive and qualitative information.   Taking responsibility for the institutional repository will task the team with addressing the many issues up front: the administrative and operational load, definitive authentication of depositors and deposits, breadth of collection policy and withdrawal policy, and quality control of the metadata. In particular preservation is an implied activity with at present no definitive answer.

Copyright and Preservation

Author's rights and interpreting publishers' copyright policies in respect of institutional repositories are current areas of deep discussion as are standards for long term preservation. RoMEO, a UK project, produced an important survey of Publisher copyright policies & self-archiving in 2003 which has now been converted to a database which is actively managed (14) ; it is particularly useful as a check for authors wishing to deposit full text.   In the following months and particularly during the UK House of Commons Select Committee on Science and Technology investigation into Scientific Publishing (15) many more publishers have begun to allow authors to deposit postprints, the post refereed, pre journal versions of their article (the so called 'Green' publishers).   The report from this committee supports open access and institutional repositories and is a welcome addition to the growing call for open access publishing. In the UK this could move the institutional repository culture forward at a tremendous pace, particularly because the recommendation is that IRs should be government funded.   The important issue of preservation for

institutional repositories is now being investigated under national funding proposals in a number of countries, and the useful document exploring the feasibility and requirements for the preservation of e-Prints (16) highlights the need for a national e-Print preservation service.   If the e-Print content of institutional repositories is to continue to be made available in the future, the concept of preservation must be grasped. A depositor's fundamental expectation of an institutional repository is that the content will be preserved in perpetuity. A shared perhaps national approach to e-Print preservation, appears to be the realistic future.

Advocacy: a route to gaining content

Successful subject based archives provide a natural incentive for authors to deposit their papers. Their work is immediately seen and used by their professional colleagues in their global community. Early institutional e-Print archives have, however, experienced problems with the acquisition of content.   Discipline culture has been suggested as a barrier. Applying established human computer interaction principles and consulting users to improve the deposit process can enable a broader range of disciplines to join in and try self-archiving with confidence. (17)   Incentives need to be thought through with care as the aim is not just to solicit content but to build a framework which will satisfy the needs of busy researchers on a continuous basis. Researchers have raised the issues of copyright and of quality control (particularly peer review and the potential for undermining the status quo of current publishing practices) although amongst the physicists these issues have been gradually resolved as they built up their own specialist archive. (arXiv). Copyright support is now available from the database of publisher copyright policies (14) which shows the current status. Authors can write to publishers to ask for retrospective permission to deposit as well as lobby publishers to change their conditions to allow self-archiving. The database also encourages publishers, by peer pressure, to join others in offering open access by allowing parallel deposit in a repository. Quality control within the Institutional Repository can be aided by providing an opportunity to search for peer reviewed material only if required, although it is becoming evident that in some disciplines the whole of a person's research output is felt to be a more meaningful representation.

Of primary importance to gaining content is the availability of a user-friendly e-Print archive on an easily accessible site with targeted help. Advocacy methods can include briefing papers to management, leaflets, institutional magazine articles, presentations at departmental meetings and committees, special advocacy events and personal contact with key staff with research policy responsibilities. These activities build up both awareness and understanding. Creating exemplars for key departments and creating champions to spread the word are useful ways of starting to change the fundamental culture. The process of saving and including the full text of research papers in an institutional publications database has to become embedded in the publication workflow of the researcher. Depositing one article shows that the deposit process is not difficult but it is not enough to ensure all future articles will have the same fate.

Listening to and acting on user needs is perhaps the most significant task undertaken to help achieve the embedding process (18). Because researchers and academics are

asked to provide information about their publications for a large variety of demands in formats that vary each time, the following core needs have been identified:

Providing a secure store for publications in electronic form at an early stage for sharing with the research community or enabling visibility of one's work as a professional ; Providing information for a department's own research recording (regardless of where the electronic document is stored) and from there the Institution's Research Report ; Providing information and documents for CVs, job and fellowship applications ; Providing information and documents for a department's public' face'including lists on its web site in a variety of forms (by person, group, project or topic) and also publicity in printed form ; Providing information and documents for research proposals ; Providing information and documents for Research Assessment Exercises ; Providing information and documents for other publication archives such as those of research funders or subject based archives, providing a simpler way of maintaining a personal web site.

To enable all these needs to be fulfilled successfully a number of services have been suggested that institutional repositories or other publication services could offer to make these processes easier. The most fundamental one is perhaps that authors would appreciate most being able to just input data once and use this for multiple outputs. Other useful add-ons suggested include: Provide export to personal bibliographic software e.g. EndNote, Bibtex, etc ; Provide conversion to pdf format if required for deposit ; Provide conversion to html and perhaps plain text that could be cut and pasted into any future publication. ; Provide 'metadata importers', for example, for multiple authors (which may in Physics even stretch to 500 or more).

Advocacy and thoughtful supporting practices can offer a constructive route to gaining content.

Metadata Issues

Implementers are offering a variety of institutional repository models to test for best practice. Both speed of deposit time and metadata quality need to be addressed. Reasonable accuracy of metadata will inevitably improve the search results achieved by Service Providers. To encourage depositors a range of options from total self archiving by the author to full mediated archiving by the archive administrators are being explored. It is tempting to offer a 'fast track deposit' workflow but this has to be offset against the reduced quality of the metadata if the minimum essential information is not provided. An administrator may intuitively have a librarian's sense of what details are essential for a good citation but there is some information that only the author is likely to know, for example, whether a paper has been peer reviewed. A balance is perhaps the best compromise. Building in good information management practice into self archiving software such as GNU EPrints is proving beneficial in the journey to produce a sustainable research repository. Distributed author and administrator deposit entails bringing new creative ways of thinking into the traditional library world to achieve a sustainable yet interoperable compromise. The original EPrints.org software was developed for author self archiving, so it and other software products have had to develop functionality to accommodate the full needs of an institutional repository. Additional fields such as those for organizational structures, corporate authors or a subject classification may be added as required.

Whilst this metadata is not essential for OAI compliant harvesting, it is a retrieval requirement to enable the e-Print archive to be used as an institutional research management tool. With rich metadata the one repository record can be used for multiple purposes. Designing the deposit to ensure the significant fields are populated well, enables an author to have his work quoted with an accurate citation every time. Although citation requirements may be different for different reporting purposes, a core citation can provide sufficient information to be adapted easily, for example, by using bibliographic reference management software. As search services develop to take full advantage of the growing number of OAI compliant repositories so mediators have given advice to fledgling institutional repositories to ensure their metadata is of sufficient quality to make cross searching a viable service.

Service Providers

Institutional repositories (Data Providers) make metadata available via a well- defined protocol (OAI-PMH). The exposure of the metadata allows other organizations (Service Providers) to harvest it, then aggregate it, post process it and refine it, with the goal of developing services that add value (19).   Cross archive searching services such as OAIster and my-OAI , harvest metadata from institutional repositories registered with it and provide a search engine together with a simple and advanced search interface, providing a resource discovery mechanism similar though not the same as a Z39.50 search. A Service Provider's services will only be effective if quality metadata is harvested (provided). Guidelines have been published for Data Providers that help them set up their repository metadata quality practices from the beginning. (20)

At the moment. there are few global general (multi subject) Service Providers and in the main, Service Providers are either subject based eg. RePec, or organisational based eg. CNR Italy, SAIL –eprints. A different type of service provider CiteBase, offers an experimental service developed by the University of Southampton based on arXiv, which demonstrates some value-added features like citation analysis and download counts. Some Service Providers harvest from Data Providers and other Service Providers as well, and offer enhanced metadata. ePrints UK is developing discipline-focused services providing views of available e-Prints using an automatic subject classification software from OCLC, one of its project partners. Commercial companies are also harvesting IR records and providing a search function including their own material eg. Elsevier Scirus.

Metadata for items in repositories can also be searched by using global search engines, like Google, and for very specific searches (author, title keywords) this works well.   However, a general keyword or subject search with general search engines, results in a huge amount of non relevant items. A Service Provider only searches through its registered institutional repositories and offers focused access to IR material only.   Google is now becoming interested in harvesting the scholarly material in IRs and is partnering 17 Universities who have IRs to create a scholars search portal. (13)

Uses of Institutional Repositories

Many organizations are now looking at other uses for Institutional Repositories apart from extending scholarly communication by making research more accessible, earlier. Within learning and teaching IR support can capture and store courseware and learning objects for multiple student/staff use. IRs can offer central digital asset management and e-Publishing for conference papers and even an organizations' own journal. Preservation is central to its role in knowledge management and already it is seen that IRs are being proposed for national research reporting.

Conclusion

It is already apparent that the ability of Institutional Repositories to distribute information rapidly from author to user via distributed but globally searchable repositories, is having an impact on traditional scholarly communication. Publishers are offering or considering the open access publishing model, plus publishers are increasingly allowing authors to deposit the full text of their post refereed, pre journal article in their own organization or subject-based repository. This is gaining momentum because it is possible for organizations and funding agencies to mandate the self archiving of research.

Institutional repositories are now being recognised as a significant way of valuing and showcasing an institution's intellectual assets - a major tool in opening access to research. 'A mature and fully realised institutional repository will contain the intellectual works of faculty and students--both research and teaching materials--and also documentation of the activities of the institution itself in the form of records of events and performance and of the ongoing intellectual life of the institution. It will also house experimental and observational data captured by members of the institution that support their scholarly activities.' (3)

Within information cyberspace, Institutional Repositories contribute to the vision of 'joined up research'. In the digital world the availability of original data, together with the ability to track its use in subsequent research work, scholarly publications or learning materials, will have a significant long-term impact on the whole scholarly knowledge cycle. (21) It will be possible to increase the access and speed of dissemination of research activity for the benefit of the wider community.
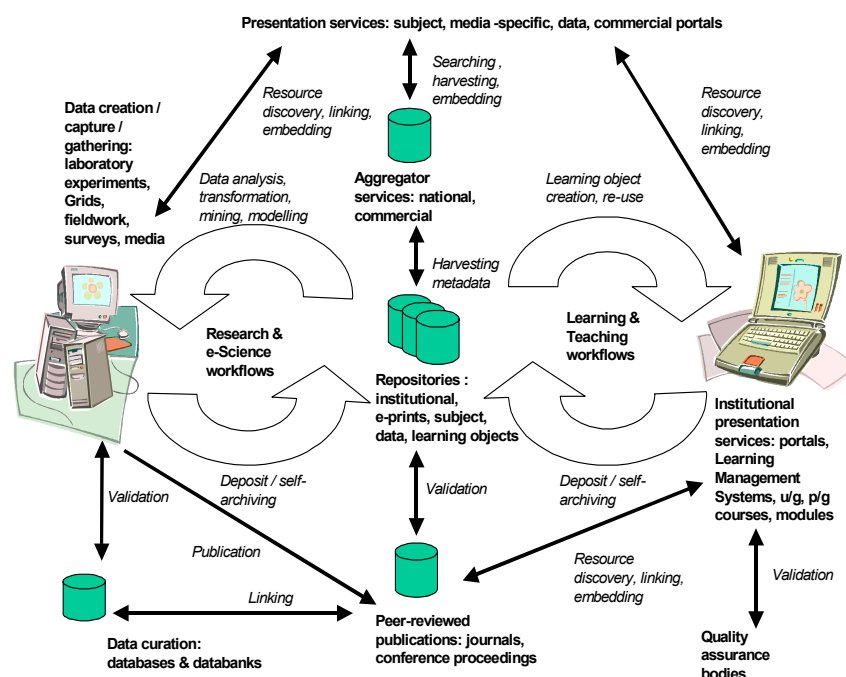
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