

# Co-operation for digital preservation and curation: collaboration for collection development in institutional repository networks<sup>1</sup>

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## Abstract

The digital preservation problem is a series of interrelated technical and organizational challenges that can only be met co-operatively by the many different stakeholders that are involved. The rise of the institutional repository paradigm backs this up with its focus on co-operation within national or subject-based networks and the wider positioning of repositories within modular service frameworks like those devised by the Digital Library Federation's Service Framework Group (Lavoie, Henry & Dempsey, 2006). Long-term preservation is one of the areas where it is widely perceived that institutional repositories will need to co-operate. So, for example, it is assumed that not all institutions with repositories will be able to provide appropriate levels of preservation and curation infrastructure, technical support or expertise. Instead, it is expected that repositories will co-operate on preservation, e.g. within national or regional consortia or with preservation services provided by third parties. These preservation services might include both services that undertake to preserve content on behalf of repositories as well as shared services like registries of representation information that can be used to support specific preservation functions. One of the areas where co-operation is likely to be important is collection development, e.g. helping to reduce duplication of effort while also enabling coordinated decisions to be made about the scalable adoption of multiple preservation strategies. However, it is not entirely clear in all cases what would be the most appropriate levels for co-operation, the exact form that co-operation should take, or what forms of additional policy-level co-ordination might be necessary.

## 1. Introduction

While many of the challenges underlying digital preservation and curation are technical in nature, it has been increasingly recognized that successful long-term solutions to the problem will need to be as much about social and cultural processes as about technology. For example, Lavoie and Dempsey (2004) have pointed out that digital preservation is ultimately a shared challenge that needs to be met co-operatively.

*Preserving our digital heritage is more than just a technical process of perpetuating digital signals over long periods of time. It is also a social and cultural process, in the sense of selecting what materials should be preserved, and in what form; it is an economic process, in the sense of defining what rights and privileges are needed to support maintenance of a permanent scholarly and cultural record. It is a question of responsibilities and incentives, and of articulating and organizing new forms of curatorial practice. And perhaps most importantly, it is an ongoing, long-term commitment, often shared, and cooperatively met, by many stakeholders.*

It would, therefore, seem that the development of policies and infrastructures that support intra organizational co-operation on preservation activities will be necessary if digital materials are to survive in a reliable and re-usable state over time.

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This new focus on organizational infrastructures and policies for long-term preservation and curation is becoming particularly relevant for the growing development and deployment of institutional repositories by universities and other research institutions. The creation of a repository usually implies an institutional commitment to the ongoing management of content, including its long-term preservation, yet the primary focus of much recent repository development has been on facilitating 'open access' to research outputs, with comparatively little attention paid by individual institutional repositories to the long-term availability and sustainability of the repository and its contents. It has also been acknowledged that not all institutions with repositories will always be able to provide (or afford) appropriate levels of preservation and curation infrastructure, technical support or expertise. For this reason, many advocates of institutional repositories assume that institutions with repositories will not, in every case, need to undertake the preservation of content themselves (Swan & Awre, 2006). Instead, it is expected that repositories will need to co-operate on technical preservation activities, e.g. within regional consortia or with third party preservation services provided by the larger research libraries, data centres, or the commercial sector.

This paper will introduce the issue of collaborative collection development in more detail with specific reference to the implementation of institutional repositories. It will first provide some general background on institutional repositories and provide a rationale for co-operating on long-term preservation. Further sections will introduce collaborative collection development and its potential application to the long-term stewardship role of institutional repositories.

## **2. Institutional repositories and collaboration**

In recent years an increasing number of universities and other research institutions have begun to develop and implement digital repositories that help manage and provide access to various types of institutional content, chiefly research outputs or data. As with most trends, the reasons for this growth of interest in institutional repositories are varied. One factor has been the growing perception within institutions that they need to manage their digital assets in new ways, e.g. to support submissions to ongoing research assessment exercises or to comply with the requirements of research funding bodies on the retention of primary data. In addition, the widespread availability of open-source repository software has at last made it technically feasible for institutions to attempt to manage institutional assets themselves and to provide wider access to content (where required) via interoperability tools like the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). A second factor has been political or strategic moves to encourage open access (OA) to the outputs of publicly funded research, e.g. initiatives like the Budapest Open Access Initiative (BOAI) and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities. As a response to these strategic imperatives, an increasing number of funding bodies - as well as some universities and research institutions - are beginning to make research grants conditional on grantees providing open access to research outputs, e.g. through depositing in OA repositories or by publishing in OA journals. These initiatives have made it strategically important for institutions to respond to the needs of researchers and research funding bodies, both of which will increasingly expect OA repositories to be available at all universities and research institutions.

Crow has defined an institutional repository as "a digital archive of the intellectual product created by the faculty, research staff, and students of an institution" (Crow, 2002, p. 16). While initially conceived as a means to facilitate access to research outputs - chiefly peer-reviewed research papers - it was soon realized that institution-based repositories also offered an opportunity for universities and other research organizations to reclaim responsibility for the management and distribution of a wide range of information types, including research papers, technical reports and working papers, scientific datasets, learning resources and even administrative records. In many cases, the setting-up of a repository implies some kind of

commitment to the ongoing management of such information. For example, Lynch (2003) emphasizes the organizational commitment represented by university-based institutional repositories.

*In my view, a university-based institutional repository is a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members. It is most essentially an organizational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organization and access or distribution.*

This organizational commitment, however, does not mean that each and every institution with a repository (or repositories) will need to preserve content themselves. Indeed, not all institutions with repositories will hope to be able to provide appropriate levels of preservation and curation infrastructure, technical support or expertise. In these cases, there will be a wide scope for co-operation on fulfilling the organizational commitment to stewardship, e.g. with third party preservation services provided by national libraries, data centres or commercial providers as well as with shared common services like registries of file format information, all of which could potentially be coordinated on number of different levels

Existing examples of this kind of co-operation include the DARE (Digital Academic Repositories) programme in the Netherlands, where the national library has taken responsibility for developing and implementing a strategy and infrastructure for providing long term storage and permanent access to all content deposited in participating repositories (<http://www.darenet.nl/>). In the UK, the Repository Bridge project successfully demonstrated the beginnings of a similar preservation service approach for a specific type of content, electronic theses, by showing how such materials could be harvested using OAI and METS from Welsh IRs to a preservation repository at the National Library of Wales. Two more UK projects are further exploring the role of collaboration and service provision, SHERPA DP and the PRESERV project. The SHERPA DP project (<http://www.sherpadp.org.uk/>) specifically looked at the development of a shared preservation environment for a network of institutional repositories. The project partners articulated a disaggregated framework based on the Reference Model for an Open Archival Information System (OAIS) that would enable preservation services to be outsourced to third parties like the Arts and Humanities Data Service. In this framework, participating repositories would regularly transfer content (with its appropriate metadata) to the third party service for long-term preservation. In order to explore in more detail the interactions that would be required within such a framework, SHERPA DP looked at the use of packaging formats like the Metadata Encoding and Transmission Standard (METS) as a means of transferring data and metadata and outlined a number of different use scenarios (Knight, 2005). In another UK initiative, the PRESERV project (<http://preserv.eprints.org/>) developed a simple model that demonstrated how a series of modular preservation services might be able to help support repositories. These include, for example, services for bit-level preservation, for object characterization and validation, and for preservation planning (risk assessments, technology watch, etc.). To take this a step further, the PRESERV project explored how format identification tools like PRONOM-DROID (<http://www.nationalarchives.gov.uk/aboutapps/pronom/>) from The National Archives could be utilized to provide format profiles at the repository level. The project applied this to the Registry of Open Access Repositories (ROAR) to provide format profiles for over 200 repositories (Hitchcock, *et al.*, 2007). The project team has now suggested that other modular services, particularly web-based services, could be developed to deal with other aspects of preservation functionality, e.g. format validation, preservation planning or migration. Hunter and Choudhury (2006) have also explored modular approaches to the development of preservation services. Some of the wider organizational implications of linking UK repositories have been investigated in a scoping study commissioned by the Joint Information Systems Committee (Swan & Awre, 2006).

### 3. Collection development and collaboration

Collection development is a term that is used in the library world to refer to "the selection and acquisition of material for an expanding collection and decisions on the material to be included in that collection" (Law, 1999, p. 1). Guidelines from the IFLA (International Federation of Library Associations and Institutions) Acquisition and Collection Development Section say that the primary function of collection development policies is to provide guidance on selecting for and deselecting resources from a collection (Biblarz, *et al.*, 2001). Typically, collection development decisions apply at different stages of an institutional workflow, including the selection, acquisition, processing, housing, weeding, retention, preservation, relegation and discarding of library materials. Collection development is now often viewed as being one component of a wider activity known as collection management, which additionally includes things like "collection policy development, materials budget allocation, selection, collection analysis, collection use and user studies, training and organization of collection development staff, preservation, and cooperative collection development" (Branin, Groen & Thorin, 2000, p. 24).

In the research library sector at least, there has been an increasing emphasis in recent years on the need for co-operative collection development, partly in recognition of the fact that no single institution can hope to aspire to collect the entire record of scholarship but also to help economize on physical storage requirements. For example, a recent UK report commissioned by CURL (the Consortium of University Libraries) and the British Library investigated the potential for "space and cost-savings that might be made as a result of collaboration over the storage of little-used periodicals and serials" (Fielden, *et al.*, 2005, p. 99). Also, the growth in the availability of networked resources has encouraged an additional focus on collaboration and resource sharing. For example, Greenstein (2004, p. 15) argues that networked information "does not need to be located anywhere in particular to be accessible." This nature permits the acquisition of substantial collections of networked resources by consortia like OhioLINK or the Joint Information Systems Committee. Branin, Groen and Thoren (2000, p. 28) consider that this centralizing trend means that collection development will focus more on co-operation with other institutions on licensing content, on providing seamless user access to content from different providers, and on negotiating the right to maintain access to older content after a subscription has been cancelled. On the other hand, however, the increasing development of institutional repositories means that institutions will need to consider their own collection development requirements within a wider national (and international) context.

National and international co-operation on collection development is not a particularly new concept. In the research and national library domain, it dates back at least to the Farmington Plan, a co-operative acquisitions program that emerged in the 1940s to ensure the continued availability of foreign materials in US research libraries. The collective role of national libraries as guardians of the world's published information was underlined in the 1980s by IFLA's core programme on Universal Availability of Publications (UAP), which proposed that "every country must be able to supply its own publications ... to any other country in the world" (Line & Vickers, 1983, p. 24). Historically, libraries and other custodial institutions have successfully co-operated on developing shared approaches to things like bibliographic control, document supply and preservation reformatting, e.g., through the development of union catalogues, national bibliographies and registers of microform and digital masters. Preservation itself has been a major focus of library co-operation. For example, a survey of UK preservation activities in the late 1990s revealed that libraries co-operated on acquisitions, on sharing conservation skills and facilities, and on disaster management (Eden & Gadd, 1999).

In the digital era, all organizations with responsibilities for long-term preservation will need to consider the potential benefits of co-operating on collection development. For example,

managed co-operation could help to avoid unnecessary duplication of effort while retaining a sufficient level of technical or geographical redundancy to ensure that digital objects can be curated and preserved. In practice, however, it is going to be extremely difficult to achieve the right balance between these extremes. To take a relatively simple example, it is not entirely clear just how many institutions will need to keep and preserve electronic journal content from large international publishers like Elsevier or Springer-Verlag. At the present time, preservation services like Portico, PubMed Central and the National Library of the Netherlands e-Depot are beginning to maintain a growing number of e-journal titles issued by such publishers, but it remains to be seen just how much duplication of effort will be promulgated in the future. Without the development of networks of trust that go well beyond anything currently proposed by repository audit and certification frameworks, it is difficult to see any real progress in this area. In the interim, alternative approaches, like the peer-to-peer LOCKSS (Lots of Copies Keeps Stuff Safe) system (Maniatis, *et al.*, 2005), might prove to be useful alternatives.

#### **4. Collection development issues for institutional repositories**

All institutional repositories need to consider and define collection development policies. The basic scope of institutional repositories has been defined by Crow (2002, 16) as digital archives of "the intellectual product created by the faculty, research staff, and students of an institution." However, within this definition there is room for a wide range of interpretations. At the very least, the developers and implementers of repositories need to have a clear understanding of the basic functions the system needs to support, e.g. with regard to content, ingest workflows, OAI-PMH interoperability, the export of metadata to research assessment support systems, etc. Different repositories may well require a different range of functions. However, most will need to make decisions on the following range of collection development issues.

##### *4.1 Selection - content types*

A basic collection development decision concerns the types of content that will be collected. Many current implementations of institutional repositories have focused on peer-reviewed research papers and theses. However, some repositories have been developed to store a much wider range of material than this, including scientific datasets, learning resources and administrative records. Lynch (2003) suggests that mature repositories might eventually contain "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." Different content types are likely to have different requirements with regard to metadata and with external access. Indeed, some classes of content, e.g. some theses or administrative records, may not need to be made available outside the institution at all.

##### *4.2 Selection - object types*

Separate decisions will need to be made on the object types (or file formats) needed by the repository. For example, a collection policy could require research papers, wherever possible, to be deposited in a dissemination format (like PDF) together with the source files produced by an editor or word processing program. Other policies may leave it up to depositors to decide what formats should be deposited, but the repository may reserve the right to convert it to a 'standard' form, if possible. Decisions may also have to be made on whether the repository should attempt to identify and validate the formats of deposited resources. The levels of 'post-processing' required for this will vary depending on the number of items deposited, so careful consideration will need to be given to the scalability of the technical approaches adopted. For this reason, quite different deposit rules may need to apply to more complex object types, e.g. multimedia presentations or learning objects.

The number and variety of different object types accepted by the repository will have a direct impact on the level of preservation service that can be provided. It is a general principle of

digital preservation that limiting the range of file formats to be kept simplifies management and reduces overall costs in the long-term, while over-tolerant acquisition policies will have the opposite effect. (Jones & Beagrie, 2001, p. 88).

#### 4.3 *Acquisition - ingest workflows*

Once the collection scope has been carefully defined, consideration can then be given to the deposit workflows. This will to some extent be dependent on the particular repository software being used, but may need to include facilities for manually checking conformance with submission rules, for validating file formats, and for the addition of appropriate metadata. The ePrints UK project investigated the possibility of providing automated tools that would help to enhance metadata during the submission process. These included modular Web services that might help provide consistent subject classification and identify authoritative forms of name from national name authority files (e.g., Dempsey, *et al.*, 2005).

#### 4.4 *Storage - retention or disposal*

Not all content in repositories will need to be kept forever. For example, some existing repositories (e.g. arXiv.org) allow depositors to withdraw content, although they usually require some explanation for this to be provided. The withdrawal of papers from the scholarly record remains a contentious issue for many scientists (e.g., Klarreich, 2001), but there may be a need for repository policies and workflows to support the withdrawal of content (or possibly just access to it) where there may be cases of scientific misconduct or questions over the legality of content.

In addition, the repository may itself need to review the value of content over time. While the initial presumption might be to preserve most content for as long as possible, certain classes of object may be subject to more frequent review and potential disposal. This may include information that is superseded or inaccurate, or is available in a better form elsewhere (Jones & Beagrie, 2001, p. 86). In these cases, disposal may not necessarily mean the destruction of content. Instead, it could mean its transfer to a third party preservation service provided by a national library or the commercial sector.

#### 4.5 *Preservation - different service levels*

Repositories will need to define their preservation service levels for the different content and object types held. For some kinds of content, the repository could commit to bit-level preservation, e.g. just promising to return the submitted bit sequence to depositors on request. For other types of content it could either attempt to apply digital preservation strategies (like migration) itself or work in concert with other repositories or third party organizations.

The freely available third party service provided by the SHERPA OpenDOAR policy tool facilitates consistent policy development across networks of IRs for several of these collection development issues (<http://www.opendoar.org/tools/en/policies.php>). The tool helps repository administrators to formulate, present and integrate repository policies on metadata, data access and re-use, content types, submission issues, and preservation issues. Further collaboration between repository managers to retain the standardised terminology and rights expressed in OpenDOAR-generated policies can also have a positive impact on subsequent user experience and expectations.

### **5. Collaboration on preservation for institutional repositories**

Almost all of these collection development areas could lead to some level of co-operation with other repositories or with third party service providers. For example, while the types of content collected by different repositories may vary, aggregators (service providers) using OAI-PMH may require sufficient supporting information (i.e. as part of the metadata) to enable the filtering of content based, e.g. on type, peer-review level, subject or geographical origin. As has been

demonstrated time after time in studies of OAI harvesting (Halbert, Kaczmarek & Hagedorn, 2003; Ward, 2003), the quality of the metadata provided by data providers has a huge impact on the level of service that can be provided by service providers. The same is likely to be true of the preservation metadata generated by repositories.

Collection development decisions on object types is an area that has more potential for collaboration, not least because shared services like registries of representation information (e.g. Abrams & Seaman, 2003; Giaretta, *et al.*, 2005) may provide a means of characterizing or validating formats on ingest and for providing additional documentation when specific format information has not been collected by the repository. Repositories dealing with the same classes of material could also join together to make common decisions on which particular object types should be collected. Successful collaboration may help to identify best practice in this area and help support the longer-term scalability of preservation activities.

The development of ingest workflows would most normally be a matter for individual repositories, but there are a number of areas, e.g. with regard to format validation tools, metadata quality control procedures, automated metadata capture, or the use of third party metadata enhancement services, where inter-repository collaboration could be very useful.

There will be other potential collaboration opportunities in defining preservation service levels as well as in making retention and disposal decisions. As suggested above, disposal may involve the transfer of objects or classes of objects to third party preservation services. The preservation services offered by repositories could also be contracted out to third parties specializing in, for example, bit-level preservation. Alternatively repositories could work collaboratively to replicate content or to develop peer-to-peer replication preservation networks based on tools like LOCKSS.

## **6. Conclusions**

This paper has attempted to outline some of the areas where institutional repositories may need to collaborate with each other or with third party services in organizing the provision of long-term preservation of content. As stated before, collection development is a natural area for organizational co-operation, and one that has particular benefits for institutional repositories. For example, successful co-operation can help to reduce overall duplication of effort while also enabling coordinated decisions to be made about the replication and distribution of content, or the scalable adoption of multiple preservation strategies. In the longer term, successful co-operative approaches to collection management may also facilitate the identification of collections that are 'at risk' and then actively support their rescue. However, it is not entirely clear in all cases what would be the most appropriate levels for co-operation - e.g., whether this should be based on subject, professional domain or geographical location - the exact form that co-operation should take (e.g., inter-institutional agreements, regional consortia), or what forms of additional policy-level co-ordination (national or international) might be necessary.

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## **8. References**

Abrams, S. L., & Seaman, D. (2003). Towards a global digital format registry. In Proceedings of the 69th IFLA General Conference and Council, Berlin, Germany, August 1-9, 2003. Retrieved March 12, 2007, from: [http://www.ifla.org/IV/ifla69/papers/128e-Abrams\\_Seaman.pdf](http://www.ifla.org/IV/ifla69/papers/128e-Abrams_Seaman.pdf)

- Biblarz, D., Tarin, M. J., Vickery, J., & Bakker, T. (2001). Guidelines for a collection development policy using the Conspectus model. International Federation of Library Associations and Institutions, Acquisition and Collection Development Section. Retrieved March 12, 2007, from: <http://www.ifla.org/VII/s14/nd1/gcdp-e.pdf>
- Branin, J., Groen, F., & Thorin, S. (2000). The changing nature of collection management in research libraries. *Library Resources & Technical Services*, 44(1), 23-33.
- Crow, R. (2002). The case for institutional repositories: a SPARC position paper. Washington, D.C.: Scholarly Publishing & Academic Resources Coalition. Retrieved March 12, 2007, from: [http://www.arl.org/sparc/bm~doc/ir\\_final\\_release\\_102.pdf](http://www.arl.org/sparc/bm~doc/ir_final_release_102.pdf)
- Dempsey, L., Childress, E. R., Godby, C. J., Hickey, T. B., Houghton, A., Vizine-Goetz, D., & Young, J. (2005). Metadata switch: thinking about some metadata management and knowledge organization issues in the changing research and learning landscape. In Shapiro, D. (Ed.), *EScholarship: a LITA guide*. Chicago, Ill.: American Library Association.
- Eden, P., & Gadd, E. (1999). Co-operative preservation activities in the UK: findings of a research project. *Library Management*, 20(4), 220-227.
- Fielden, J., Harris, C., Hayes, H., & Schofield, A. (2005). Optimising storage and access in UK research libraries. *New Review of Academic Librarianship*, 11(2), 97-152.
- Giarretta, D., Rankin, S., McIlwrath, B., Rusbridge, A., & Patel, M. (2005). Representation Information for interoperability now and with the future. In *Proceedings of Local to global data interoperability - challenges and technologies*, Sardinia, Italy, June 20-24, 2005 (pp. 42-46). Piscataway, N.J.: Institute of Electrical and Electronics Engineers.
- Greenstein, D. (2004). Library stewardship in a networked age. In *Access in the future tense* (pp. 9-23). Washington, D.C.: Council on Library and Information Resources.
- Halbert, M., Kaczmarek, J., & Hagedorn, K. (2003). Findings from the Mellon Metadata Harvesting Initiative. In *Proceedings of Research and Advanced Technology for Digital Libraries, 7th European Conference, ECDL 2003, Trondheim, Norway, August 17-22, 2003* (pp. 58-69). Lecture Notes in Computer Science, 2769. Berlin: Springer-Verlag.
- Hitchcock, S., Hey, J., Brody, T., & Carr, L. (2007). Laying the foundations for repository preservation services: final report from the PRESERV project. Southampton: University of Southampton. Retrieved March 12, 2007, from: <http://preserv.eprints.org/JISC-formal/preserv-final-report10.pdf>
- Hunter, J., & Choudhury, S. (2006). PANIC: an integrated approach to the preservation of composite digital objects using Semantic Web services. *International Journal on Digital Libraries*, 6(2), 174-183.
- Jones, M., & Beagrie, N. (2001). *Preservation management of digital materials: a handbook*. London: British Library.
- Klarreich, E. (2001). Genetics paper erased from journal over political content. *Nature*, 414, 382.
- Knight, G. SHERPA DP: establishing an OAIS-compliant preservation environment for institutional repositories. In *Digital repositories: interoperability and common services*, 9th DELOS thematic workshop, Heraklion, Crete, May 11-13, 2005 (pp. 43-48).
- Lavoie, B., & Dempsey, L. (2004). Thirteen ways of looking at ... digital preservation. *D-Lib Magazine*, 10(7/8), July/August. Retrieved March 12, 2007, from: <http://www.dlib.org/dlib/july04/lavoie/07lavoie.html>
- Lavoie, B., Henry, G., & Dempsey, L. (2006). A service framework for libraries. *D-Lib Magazine*, 12(7/8), July/August. Retrieved March 12, 2007, from: <http://www.dlib.org/dlib/july06/lavoie/07lavoie.html>
- Law, D. (1999). The organization of collection management in academic libraries. In Jenkins, C. and Morley, M. (Eds.), *Collection management in libraries*, 2nd ed (pp. 1-20). Aldershot: Gower.
- Line, M., & Vickers, S. (1983). *Universal Availability of Publications (UAP): a programme to improve the national and international provision and supply of publications*. IFLA Publications, 25. München: Saur.
- Lynch, C. A. (2003). Institutional repositories: essential infrastructure for scholarship in the digital age. *ARL Bimonthly Report*, 226. Retrieved March 12, 2007, from: <http://www.arl.org/resources/pubs/br/br226/br226ir.shtml>

Maniatis, P., Roussopoulos, M., Giuli, T. J., Rosenthal, D. S. H., & Baker, M. (2005). The LOCKSS peer-to-peer digital preservation system. *ACM Transactions on Computer Systems*, 23(1), 2-50.

Swan, A., & Awre, C. (2006). *Linking UK repositories: technical and organisational models to support user-oriented services across institutional and other digital repositories*. London: Joint Information Systems Committee. Retrieved March 12, 2007, from:  
[http://www.jisc.ac.uk/uploaded\\_documents/Linking\\_UK\\_repositories\\_report.pdf](http://www.jisc.ac.uk/uploaded_documents/Linking_UK_repositories_report.pdf)

Ward, J. (2003). A quantitative analysis of unqualified Dublin Core Metadata Element Set usage within data providers registered with the Open Archives Initiative. In *Proceedings of the 2003 Joint Conference on Digital Libraries, JCDL'03*, Houston, Texas, May 27-31, 2003 (pp 315-317). Los Alamitos, Calif.: IEEE Computer Society.