

Bringing hidden treasures to light: illuminating DSpace

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Abstract:

The Open Archives Initiative (OAI) has gained momentum since eprints.org was released in 2000. An alternative to eprints.org is the recently released DSpace, the open source software developed at MIT. The paper will trace the history and development of DSpace initiatives, such as the joint project between MIT and University of Cambridge. It also discusses the impact and benefits of repositories for research institutions and libraries.

Introduction

The importance of an integrated approach to content management is becoming increasingly apparent to those in university environments. Institutions need to manage and preserve their own digital assets, provide open access and foster national and global research communities. Academic content, which may not be published by traditional means, represents a considerable institutional asset, but the ongoing challenge is the management, organisation and preservation of those resources, hence the need to establish digital repositories which perform this role.

DSpace is an open source system that offers the basic features required to implement a digital repository service. The paper covers the main features of DSpace. For further details on the technical aspects of DSpace, see < <http://dspace.org/technology/system-docs/> >.

Background

The MIT Libraries was one of the invited participants at the Universal Preprint Service (UPS) forum in October 1999. The forum was set up to discuss means for enhancing access to already existing eprint repositories, which were viewed as valuable but under used resources. Sponsors of the forum were the Council on Library and Information Resources (CLIR), the Digital Library Federation (DLF), the Scholarly Publishing and Academic Resources Coalition (SPARC), the Association of Research Libraries (ARL) and the Research Library of the Los Alamos National Laboratory (LANL). The participants at the initial meeting were academic librarians and computer scientists interested in archiving, metadata, and interoperability. By the end of October the initiative had changed its name to the Open Archives Initiative (OAI). This change of name reflected the wider potential usage of the relevant software, which was no longer seen as restricted to eprint repositories.

Open Archives Initiative (OAI)

The OAI is based at Cornell University and is supported by the Coalition for Networked Information (CNI) and the Digital Library Federation (DLF). The development of standards and tools that facilitate interoperability between multiple repositories (Day 2003) ensures that distributed documents in OAI compliant databases can be searched as though they are one large aggregated database. To support interoperability with other OAI compliant digital repositories, DSpace complies with the protocols and interoperability standards of the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). Compliance to these standards is a requirement to register successfully with the OAI as a data provider (Smith et al 2003). For example, data providers must use unqualified Dublin Core metadata tags.

More and more pre-existing repositories are becoming OAI compliant, which demonstrates the increasing desire to expose the intellectual output of academics and institutions through the creation of institutional repositories (Wolpert 2002). In Australia, a number of subject-based gateways, for example Agrigate, are also exploring options for becoming OAI-compliant.

A snapshot of OAI compliant software platforms for data providers

A number of open source software tools are available, the best known being eprints.org <<http://www.eprints.org/>> and DSpace < <http://dspace.org/> >. The eprints software, developed at the University of Southampton, has many similar features to DSpace, but appears to work most effectively with document style materials such as working papers and research reports. DSpace aims to provide repositories for a wide range of institutional outputs, including images, programs and data sets, as well as research papers and theses (Day 2003). It provides a platform to begin work on long-term preservation strategies for digital material used in scholarly research. DSpace's submission user interface in particular draws on experience gained from the design and use of eprints' submission user interface (Tansley et al 2003b).

The Greenstone software from the New Zealand Digital Library Project at the University of Waikato <<http://www.greenstone.org/english/home.html>> is another open source digital library tool that has a focus on publishing. CERN (European Organisation for Nuclear Research) has developed the CERN Document Server Software (CDSware) <<http://cds.cern.ch/>> for its preprint server and this is available freely to other institutions (Tansley et al 2003b). Fedora (Flexible Extensible Digital Object and Repository Architecture) <<http://www.fedora.info/>> is another open source platform. It is a digital repository management system, which has been developed by the University of Virginia and Cornell University. It has been made freely available for downloading by the research and scholarly community.

The team was delighted that the Open Society Institute (OSI) released its *Guide to Institutional Repository Software*, describing five open source, OAI-compliant systems currently available. The guide includes brief overviews of each system, followed by a table comparing the technical features of each. The table has been helpful in focusing the team effort. To view the guide, please see <<http://www.soros.org/openaccess/software/>>.

DSpace and the open source community

In the (northern) spring of 2000, the project team of Hewlett Packard software developers, MIT administrators, and a faculty advisory committee started to develop the DSpace system (Atwood 2003). In November 2002 DSpace was released and the source code made publicly available from SourceForce™ <<http://sourceforge.net/projects/dspace/>>. HP and MIT designed the system to be run by institutions other than MIT, and since its launch has been offered to other institutions to run as-is, or to modify and extend as required to meet local needs (Smith et al 2003). The intention is to encourage the formation of an open source community around DSpace. It is envisaged that developers at institutions that adopt DSpace will add features over time to

improve the different functions of the system in response to user requirements (Smith et al 2003). These new features will subsequently be added into the DSpace software.

DSpace enables institutions to:

- ❑ capture and describe digital works using a submission workflow module
- ❑ distribute an institution's digital works over the web through a search and retrieval system
- ❑ preserve digital works over the long term (Tansley et al 2003a).

DSpace content

DSpace focuses on preservation and management of institutional digital content such as general administrative material, courseware and research output.

An institutional repository may contain the intellectual works of academics and students as well as administrative records, such as course calendars and publications which document the activities of the institution (Lynch 2003). The academic content may be research output or teaching materials. Experimental and observational data that support the scholarly activities of researchers could also be housed.

DSpace enables the long-term preservation of data that researchers are likely to have stored exclusively on personal computers, web sites, and departmental servers. The data needing to be stored are no longer confined to text. Datasets, computer programs, experimental results, images, video, sounds, simulations and animations as well as more conventional document-based material such as articles and reports may form content for the repository (Wolpert 2002).

DSpace can also support storage and preservation of educational materials, or "Re-usable Learning Objects". As course web sites and online teaching and learning environments proliferate, academics are increasingly creating valuable digital material to support their teaching activities (Smith et al 2003). DSpace at MIT is collaborating with the major educational technology initiatives at the Institute, including OpenCourseWare <<http://ocw.mit.edu/>> and Open Knowledge Initiative < <http://web.mit.edu/oki/> >, which aim to globally disseminate extensive teaching and learning materials, so that storing, relocating and reusing course content becomes reliable and easy (Smith et al 2003). DSpace has the capacity to maximize the value of existing educational assets such as these digital course materials, through the implementation of a long-term preservation strategy <<http://www.lib.cam.ac.uk/dspace/doc/proposal.htm>>.

Communities and collections

DSpace is designed with a "flexible storage and retrieval architecture adaptable to a multitude of data formats and distinct research disciplines" (Branschofsky 2003a).

DSpace addresses issues inherent in the creation of a multi-disciplinary archive and is designed to operate as a centralised, institutional service, reflecting the structure of the organisation by

organising content into “communities.” DSpace communities typically correspond to an organisational entity, such as research centre or department or faculty (Bass 2002).

The DSpace developers have recognised in their current enhancement short list that there is a need to support the creation of sub communities to reflect a more complex organisational structure (Rodgers 2003). A customized user portal can be created for each community to meet its individual needs and manage its own data submission procedures, promoting an environment closely matching the community’s practices and terminology. It can work as well for a research scientist as for an economist or an historian or a musicologist

<<http://www.lib.cam.ac.uk/dspace/doc/faq.htm> >.

Schools, departments, research labs and centres have different cultures and practices. Some faculties may desire a greater degree of control over the submission process (Smith 2002). To meet these varying requirements, each community can adapt the system to meet its distinctive information needs and manage the submission process itself, setting standards for content, deciding who will be authorised to upload its documents and who may view them. A workflow that reflects these decisions is then set up for each collection (Smith et al 2003).

Preservation and formats

DSpace is intended to provide storage and preservation management services to ensure deposited materials are accessible far into the future (Smith et al, 2003). Content submitted in supported formats will be accessible even when the original application in which it was created is obsolete and the means to access it are inoperable <<http://libraries.mit.edu/dspace-mit/mit/services.html> >.

MIT plans to provide functional preservation for a list of "supported" formats, listed on the web site and shown to users during the deposit process. Supported formats include those that are documented standards (e.g., TIFF, AIFF, XML, htm) or have published specifications (e.g., PDF, RIFF). The other two categories of support for MIT's DSpace are "known" and "unsupported". "Known" formats are those that are common enough to be familiar and usually quite popular, but which are proprietary in that there are no published specifications on which to base functional preservation. "Unsupported" formats are those that are either unknown or are extremely rare (e.g., a compiled program, a commercial CAD/CAM file, etc.). The reason for distinguishing between "known" and "unsupported" is that for the former, there is an expectation that commercial conversion programs will become available as these formats become obsolete. MIT has undertaken to move these formats into the "supported" category and offer functional preservation for them if such commercial conversion programs are developed (Smith et al 2003).

For each submission, DSpace:

- ❑ provides persistent storage
- ❑ assigns a unique persistent identifier that will not change and is appropriate to cite in other works
- ❑ stores provenance information and
- ❑ maintains an auditable history and record of changes to the archive <<http://libraries.mit.edu/dspace-mit/mit/services.html>>.

In terms of how exactly these digital objects will be preserved and regenerated, Smith explained: 'The DSpace system at MIT has policies for what we promise to preserve (i.e. open, popular, standards-based formats like TIFF and ASCII), and those that we will try our best to preserve but can't promise (e.g. Microsoft, etc). Lots of formats fall somewhere in between (e.g. Adobe PDF) so there we make judgment calls. As for how to preserve them, it's going to vary from format to format. Some will be possible, cheap even, to mass-migrate forward with time. Others will have to be emulated because they aren't really formats (video games or simulations, for example). It's going to be years before we really understand how to preserve these things' (Spedding 2003).

Metadata

Metadata is machine readable and searchable descriptions of data that can be systematically created, according to the definition in the *Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure* (Atkins et al 2003). Identifying and establishing the most advantageous metadata schemas and taxonomies is an area where administrators of communities can draw on the experience and knowledge of librarians.

DSpace uses the qualified Dublin Core metadata standard for describing items intellectually. Only three fields are required: title, language, and submission date. All other fields are optional. There are additional fields for document abstracts, keywords, technical metadata and rights metadata, among others. This metadata is displayed in the item record in DSpace, and is indexed for browsing and searching the system (within a collection, across collections, or across Communities. The exact Dublin Core elements and qualifiers that are used can be configured by editing the Dublin Core registry. This activity can either be done at install time, by editing /dspace/config/registries/dublin-core-types.xml, or at run-time using the administration web user interface < <http://www.dspace.org/technology/system-docs/configure.html> >.

As previously mentioned, in order to support interoperability with other digital repositories, the DSpace platform supports the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) version 2.0 as a data provider, using the OAICat framework from OCLC. This allows sites to programmatically retrieve or harvest the metadata from several sources, and offer services using that metadata, such as indexing or linking services, eg., SFX system (Tansley et al 2003a).

The DSpace metadata services will focus on descriptive metadata in the initial services offering. It is the intention that metadata services will encompass administrative structural technical, rights and preservation metadata as these schemas further develop and evolve (Barton 2002).

Each item in the DSpace system will have its own metadata record that is entered by end users when content is submitted, or it might be derived from other metadata as part of an ingest process (Tansley et al 2003a).

With the emergence of the METS (Metadata Encoding and Transmission Standard) standard for digital object encoding < <http://www.loc.gov/standards/mets/>>, DSpace developers are adding support for the importing and exporting of items with METS metadata as an enhancement to the DSpace software (Rodgers 2003).

Administration section

The administration section comprises pages intended for use by central administrators. According to Robert Tansley (one of the system developers), this part of the web user interface is very basic. In the future, it is envisaged that this subsystem will be improved, and that it will be possible to pass more responsibility for administration to individual communities (Tansley et al 2003b).

E-people

Many of DSpace's features, such as document discovery and retrieval, can be used anonymously. But in order to perform functions such as submission, email notification of research alerts or administration, users must be authenticated. Some users may be computerised systems rather than actual people, so users are referred to as *e-people* in the DSpace documentation (Tansley et al 2003a). Registered e-people are assigned "roles" in the workflow of a particular community in the context of a given collection.

Authorisation

DSpace has a flexible rights management system to control access. Policies can be defined to restrict access to an object based on a user's identity, membership in a group of users, a period of time having elapsed, or having special permission (Bass 2002). Functions such as depositing and reviewing can be restricted to appropriate individuals.

Workflow

When an item is submitted to a particular collection, workflow processes can be started. That workflow will depend on the policy of the collection. The reviewer, metadata editor and coordinator roles are defined by the system administrator when the collection is first established, and apply to every item submitted to that collection <<http://libraries.mit.edu/dspace-mit/mit/services.html>>. In addition, in an enhancement to the DSpace software, a "collection-editor" role will be established, which will enable that person to edit item metadata within a collection after items have been submitted (Rodgers 2003).

Submission procedures

DSpace offers its contributors a flexible, easy-to-use web interface for the submission process (Barton 2002). The contributor simply completes a brief web based form and grants permission to distribute and preserve the work <<http://libraries.mit.edu/dspace-mit/mit/services.html>>.

An authorised contributor to DSpace can:

- ❑ Register with DSpace and edit his/her user profile;
- ❑ Post a submission to a specified collection;
- ❑ Enter metadata for a submission, using standard forms with community-specific default values;
- ❑ Bundle multiple files of various formats in a single submission;
- ❑ Allow the system to identify formats of submitted files;
- ❑ Grant a non-exclusive license to the host institution to distribute a submission in accordance with the specified distribution policy and translate it for the purposes of preservation;
- ❑ Receive updates on the progress of an item through the submission workflow process;
- ❑ View past and pending submissions in a personalized My DSpace page. <<http://libraries.mit.edu/dspace-mit/mit/services.html>>.

Reviewing submissions

A collection's review process may have an associated e-person group performing each step. One member of that group takes the task from the pool, and it is then removed from the task pool. If no group is associated with a certain step, that step is skipped. If a collection has no e-person groups associated with any step, submissions to that collection are installed straight into the main archive. Through the submission workflow process, reviewers, metadata editors, and coordinators can review the content of the submission for appropriateness to the collection and make the decision to return a submission to the submitter or give approval. If a submission is rejected, the reason (entered by the reviewer) is e-mailed to the submitter, and it is returned to the submitter's workspace. The submitter can then make any necessary modifications and resubmit, whereupon the process starts again.

The metadata editor checks the submission's metadata, augments it as required, edits errors, and makes the decision to route a submission back to the submitter or grant approval. One last possibility is that a workflow can be 'aborted' by a DSpace site administrator (Tansley et al 2003a).

Persistent Identifiers (Handles)

A core DSpace feature is the creation of a unique persistent identifier for every item, collection and community stored in DSpace. DSpace uses the CNRI Handle System for creating these identifiers (Tansley et al 2003b).

Searching

It is possible to search across the entire repository or within an individual community or collection. Once an item is located in the system, retrieval is accomplished by clicking a link that causes the archived material to be downloaded to the user's web browser. "Web-native" formats (those which will display directly in a web browser or with a plug-in) can be viewed immediately; others must be saved to the user's local computer and viewed with a separate program that can interpret the file (e.g., a Microsoft Excel spreadsheet, or a CAD/CAM file) (Smith et al 2003). The latest list of enhancements to the software includes support for indexing and searching of the full text of item documents (Rodgers 2003).

Browsing

The entire DSpace repository can be browsed by item title, item author, or item issue date, or browsing may be limited to items within a particular collection or community (Tansley et al 2003b). In any browse, all entries are hyperlinked to a brief record for the item, which includes its title, author(s), assigned keywords, issue date, abstract, Uniform Resource Identifier (URI), and collection identifier. The names of associated files, their size, and format are listed beneath the record data. The associated file can be retrieved by clicking on the "View/Open" link found in the lower right-hand side of the display. The full record can be displayed in the Dublin Core format by clicking on "Show full item record."

Statistics

Statistics available include electronic reports on the size of collections and communities, number of viewings, number of content downloads by item, collection or community and number of items added by community, collection or author (Barton 2002).

Research alert service

Researchers may choose to be alerted by email when new submissions in their area of interest are added to the collections. Subscribers will receive an e-mail giving brief details of all new items that appeared in any of those collections the previous day (Tansley et al 2003a).

Federation and International take up

A federation of seven DSpace partners has been formed to test the application in a variety of academic settings. Large academic research institutions in the US, Canada, and the UK form the current federation. Members of the group are sharing views and experiences on technical, service, and business issues. This feedback will guide refinements and improvements and should lead to a far more valuable resource than is possible through individual implementations (Branschovsky 2003b).

In addition, outside of the federation, there has been extensive international interest in the DSpace product. In the initial nine months since its release, DSpace has been downloaded by more than 2,500 organisations and individuals world-wide. At the same time, feedback from these institutions about their plans and experiences is providing further information for DSpace support requirements. Two examples where DSpace is being implemented are the University of Oregon, <<https://ir.uoregon.edu:8443/dspace/index.jsp>> and Erasmus University <<https://dspace.ubib.eur.nl/index.jsp>>. Many institutions using DSpace are providing tools to assist their academic staff, for example, University of Oregon, <<http://ir.uoregon.edu/dspace-submit.html>>.

DSpace@Cambridge

University of Cambridge library and computing staff have received a grant from the Cambridge-MIT Institute to install DSpace and test the system before it is made available to the university at large (Tarleton 2003). DSpace@Cambridge <<http://www.lib.cam.ac.uk/dspace>> will focus on preserving digital content. The DSpace software will be used to capture, index, store, disseminate and preserve academic digital materials. In addition, it is envisaged that historical material that is being digitised from the University Library's printed and manuscript collections will be added (Preserving our past 2003).

They also aim to explore DSpace's ability to support learning management systems in collaboration with academic departments and the Open Knowledge Initiative <<http://www.lib.cam.ac.uk/dspace/doc/proposal.htm>>.

Partnerships

Providing services for the long-term stewardship of digital material is a natural extension of the role of academic research libraries, which have traditionally stored print materials (Smith et al 2003). The creation of digital repositories offers a significant extension to traditional roles of academic libraries. One key role of an academic research library is to provide a central repository of knowledge supporting the teaching, learning and research of its host institution. As Clifford Lynch, Executive Director, Coalition for Networked Information, notes,

An effective institutional repository of necessity represents a collaboration among librarians, information technologists, archives and records managers, faculty and university administrators and policymakers (Lynch 2003).

Susan Gibbons, Director, Digital Library Initiatives, University of Rochester, said "DSpace enhances learning by sharing information as it develops and is exchanged through informal communication by the academic community. Perhaps most exciting is DSpace's potential to create and enhance partnerships between libraries and those who generate new knowledge on a university or college campus" (Branschovsky 2003a).

Library staff have well-developed expertise in collection management, cataloguing and digital asset access. The DSpace services will provide a less expensive and higher quality alternative to multiple systems of services maintained in departments and research centres (Barton 2002).

The ease of submitting documents to DSpace lowers barriers to adoption as minimal metadata insertion is required and library staff can add any extra metadata.

Testing DSpace at the University of Melbourne

In 2002, the Information Division established a repository for the University's text-based research output using eprints.org software <<http://buffy.lib.unimelb.edu.au/eprints/home.htm>>. Following this success, the University of Melbourne Information Division decided to trial and evaluate DSpace for creation of a database suitable for storage and international dissemination of the resources located in the Percy Grainger Museum.

<<http://buffy.lib.unimelb.edu.au/collections/grainger/>>.

These resources are an extremely rich resource for researchers. An OAI search service will enable users to cross search the range of collections.

The decision to trial DSpace was made for a number of reasons. In terms of hardware and technical support, we were able to run both eprints and DSpace. The DSpace model offers a different model of administrative control over collections and communities, and the digital preservation component made it worth exploring.

Installation of DSpace

A cross-functional project team was formed to cover the range of skills required to download and test the software. These included library and information systems staff in the Division. The project team downloaded and configured the software and created a number of distinct communities with associated collections. Metadata templates were prepared for each collection and appropriate workflows and administrative privileges created. A number of objects requiring different formats were then loaded into the collections. The Grainger Museum was chosen because of the range of formats available to us through the Museum, eg, text, pictures, and music.

Disadvantages

The experience to date indicates that the complexity of the software necessitates more involvement of the technical staff than the earlier downloading and testing of the eprints.org software. There are still a number of bugs. On-screen instructions are not intuitive and the help screens require further work. For example, a help page for the Administration interface that is similar to that on the user's interface which explains how to create and delete communities, collections and set policies would be of value. In the Administration mode, an advantage would

be the ability to search by author and title as well as handle. At present, you can only search by handle (which assumes that you have recorded the number). Others who are implementing DSpace suggest that full-text searching would be a highly desirable feature.

The team has spent considerable time working out how to create suitable workflows for the collections. In recognition of the level of difficulty, workshops in use are being held within UK and Europe to assist DSpace implementers in academic institutions. Such a workshop would be of great benefit to people in Australia evaluating DSpace.

A more complex metadata template has to be created in a two-part process. A major disadvantage of the DSpace software is the fact that metadata-only records cannot be created. A further detracting feature is that it is not possible to load documents from a URL, which is a major advantage of eprints.org. Insufficient fields are available for various formats, such as theses. Problems dealing with theses are also related by University of Edinburgh, but it is observed that the DSpace approach is more flexible than the ETD software developed at Virginia Tech (Jones, 2003). At present, DSpace does not support the use of thesauri directly into the system. Email lists and others report difficulties in downloading, configuring and using the software. For example, Richard Jones from Edinburgh reports a number of difficulties with the installation of DSpace, such as the difficulty with the installation and configuration of Tomcat (Jones, 2003). University of Melbourne implementers encountered similar difficulties.

Advantages

The records were easy to create, and at the top of each screen you can follow your progress through the process. Creation of communities and collections is straightforward. You can have different levels of complexity to suit the needs of a community. Any or all steps in the “workflow” can be eliminated.

Interest group

The project team created and fostered a Victorian interest group for use of DSpace software and established an email discussion list for this group. These included State Library of Victoria, Deakin and Monash universities, and DSTO.

Future plans

We plan to liaise with Records Management and the Web Archiving Group to leverage synergies within the University.

Now that the software has been installed and configured, and records added, the next step we plan is to experiment with bulk uploading.

Conclusion

The conference presentation will report more fully on the work of the project team in implementation, testing and evaluation.

DSpace offers the research community the opportunity to influence the future of digital preservation and scholarly communication, both of which have the potential to have far-reaching effects on the academic environment (Barton 2002). As seen, DSpace is more than a digital repository; it is also a platform for preservation. Given the thousands of downloads of the DSpace software, it is a clear indication that it represents an exciting development for academics, librarians and researchers worldwide. It will be interesting to monitor developments of DSpace and to see how participants take up the option to contribute enhancements. DSpace indeed offers an opportunity to illuminate previously hidden treasures.

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Web sites

Budapest Open Access Initiative – A guide to institutional repository software

<http://www.soros.org/openaccess/software/>

CERN Document Server (CDS) <http://cds.cern.ch>

DSpace <http://dspace.org>

DSpace@Cambridge <http://www.lib.cam.ac.uk/dspace>

DSpace@Cambridge Project Proposal <http://www.lib.cam.ac.uk/dspace/doc/proposal.htm>

DSpace@Cambridge Frequently asked questions <http://www.lib.cam.ac.uk/dspace/doc/faq.htm>

DSpace at Erasmus <https://dspace.ubib.eur.nl/index.jsp>

DSpace MIT Libraries MIT services <http://libraries.mit.edu/dspace-mit/mit/services.html>

DSpace System Documentation: Configuration and Customization

<http://www.dspace.org/technology/system-docs/configure.html>

DSpace System Documentation: Contents <http://dspace.org/technology/system-docs/>

DSpace at the University of Oregon <https://ir.uoregon.edu:8443/dspace/index.jsp>

Eprints.org <http://eprints.org>

The Fedora Project: an open-source digital repository management system

<http://www.fedora.info/>

Greenstone Digital Library software <http://www.greenstone.org/english/home.html>

OCLC Research <http://www.oclc.org/research/software/oai/cat.shtm>

OpenCourseWare Massachusetts Institute of Technology <http://ocw.mit.edu/>

Open Knowledge Initiative <http://web.mit.edu/oki/>

The Open Archives Initiative Protocol for Metadata Harvesting protocol version 2.0

<http://www.openarchives.org/OAI/openarchivesprotocol.htm>

SourceForge.Net <http://sourceforge.net/projects/dspace/>

Submitting to DSpace at University of Oregon <http://ir.uoregon.edu/dspace-submit.html>