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Message from the Editor-in-Chief

Welcome to the inaugural issue of the *CALA Occasional Paper Series*. The contributor to this first issue is **Hong Xu**, who wrote "The Theory Analysis of Faculty Participation in Institutional Repositories" which discusses faculty participation in institutional repositories based on Rogers' Diffusion of Innovations theory.

The CALA Occasional Paper Series provides an opportunity for members of the Chinese American Librarians Association to publish a peer-reviewed article on any aspect of librarianship. We welcome your contributions.

I hope you will enjoy the *CALA OPS*.

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The Theory Analysis of Faculty Participation in Institutional Repositories

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BIOGRAPHICAL NOTES

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The Theory Analysis of Faculty Participation in Institutional Repositories

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Abstract

Institutional Repositories (IRs) are an innovative mode of scholarly communication, and IRs' diffusions will likely follow the general rule of innovation diffusion while maintaining their own characteristics. In order to provide a credible guide and theory basis for IRs' practical applications, this paper uses Rogers' Innovation Diffusion Theory to analyze IRs' adoption by faculty in the following areas: 1. IRs as an innovation in scholarly communication; 2. the current situation of faculty participation in IRs; 3. factors which affect faculty's attitude and participation in IRs; 4. strategies to increase faculty participation in IRs.
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Introduction

Institutional Repositories are "digital collections capturing and preserving the intellectual output of a single or multi-university community" (Crow, 2002a). As an innovative mode of scholarly communication, IRs can benefit not only faculty but also institutions. By providing low-barrier access to digital collections, IRs increase the dissemination and citation rate of faculty's scholarly works. This will enhance the visibility of faculty's professional achievements. By preserving teaching materials, IRs serve faculty as a resource supporting classroom teaching. By long-term preservation of universities' digital archives, IRs show the academic achievement of institutions and increase their prestige (Crow, 2002b).

IRs' advantages have been recognized now and many universities have built IRs. The Open Society Institution (OSI) stated that the software systems supporting IRs must meet three criteria: be available via an Open Source license; comply with the Open Archives Initiative Protocol for Metadata Harvesting (OAIPMH); and be recently released and publicly available (Crow, 2004). DSpace and Eprint are the most widely used OSI software for developing institutional repositories. DSpace has the most installations in North America, while Eprint is the largest installed base in institutions worldwide (Singarella, 2005).

DSpace is a digital library system that captures, stores, indexes, preserves, and redistributes the intellectual output of a university's research in digital formats. It was developed jointly by MIT Libraries and Hewlett-Packard (HP) and is freely available to research institutions worldwide. As an open source system, it can be customized and extended. The DSpace Federation includes all the research institutions, libraries, and other institutions that are using the DSpace digital repository system (Singarella, 2005).

 Eprint is free and open source software developed at the University of Southampton in Britain and dedicated to opening access to the refereed research literature online through author/institution self-archiving, and it allows a library to mount software and have the faculty self-archive their articles onto a library server (Singarella, 2005).

According to a survey of 13 countries (Westrienen & Lynch, 2005), 100% of universities in Germany, Norway, and The Netherlands have implemented IRs, 95% in Australia, 27% in France, 22% in Italy and UK, and nearly 50% doctoral research universities in the United States.

However installing the software is like preparing a set of bookshelves. Without content, an institutional repository is only a set of empty shelves. Arthur Sale (2006) made a risk analysis of institutional open access repositories (OARs) (See Table 1). In the table Impact means the negative effects of an event to an institution, which is measured by 5 levels from low to high. Probability is the probability of an event occurring, which is rated on 5 levels from low to high too. The risk level is calculated by probability multiplying by impact. The more severe the impact of an event is, the higher the risk is; the more probable an event occurs, the higher the risk is. According to the analysis, the highest risk is that IRs are empty or IRs can not attract research output created in institutions, which means it is very possible that an institutional repository is empty and this situation will have more negative affects to the institution which owns the institutional repository. So to minimize the risk, an institutional repository needs plenty of content which becomes an important indicator of successful institutional repositories.

Table1. Institutional Open Access Repository (OAR) Risk Summary (Sale, 2006)

Event	Time Frame	Probability		Impact		Risk	
2.1 All universities have OAR	Short-term	low	2	low	1	negligible	2
	Long-term	very high	5	moderate	3	moderate	15
2.2 No universities have OAR		very low	1	moderate	2	negligible	2
2.3 OAR is empty		high	4	severe	5	high	20
2.4 Journals will fail		very low	1	severe	5	low	5
2.5 Refusal to accept our research		very low	1	severe	5	low	5
2.6 No benefit to us		very low	1	moderate	3	negligible	3
2.7 Regarded as second class		very low	1	severe	5	low	5
2.8 Costs too high		moderate	3	moderate	3	low-mod	9
2.9 Future high costs		very low	1	low	2	negligible	2
2.10 Copyright litigation		very low	1	severe	5	low	5
2.11 Refusal to collaborate		very low	1	severe	5	low	5
2.12 Insurrection in the ranks		low	2	moderate	3	low	6

According to the survey of 45 IRs made by Ware (2004a), the average number of documents per archive was just 1,256 with a median of 290. A statistical analysis of 213 Eprints shows that until May 2006, the average number of items per archive was 1,067 with a median of 174 (University of Southampton, 2006). The author studied 40 DSpace implementations supporting IRs in October 2006, and the analysis showed the average number of items per archive was about 3,222 with a median of 921 (Table 2). Does this number mean IRs have attracted most scholarly content? Hajjem, Harnad, and Gingras (2005), and Sale (2006) show only 5% to 15% of the institution's research output is deposited in institutional OAR (IRs are one type of OAR). Although an institutional repository benefits faculty and institutions, it can not bring about its advantages and functions without rich content that is owned mostly by faculty of the academic institution. Many organizers of IRs report that a key obstacle for IRs' development is securing the engagement and participation of faculty (Ware, 2004b). So encouraging faculty to participate in IRs in order to increase IRs' content becomes a very important and challenging task in the next stage of IRs' development.

Table 2. The Size and Faculty Participation Rate of 40 DSpace Implementation Supporting IRs in U.S.A. (10/2006)

DSpace Implementation Case	Title	Faculty Author	Faculty	Rate	Note
Boston University	500	4	3812	0.001	f+sf+s
Brigham Young University	308	114	2150	0.053	f+sf
Chapel Hill School of Information and Library Science Electronic Theses and Dissertations	295			N/A	s
Cornell University	2631	218	2633	0.083	f+sf+s+a
Digital Repository at the University of Maryland	3643	99	3672	0.027	f+sf+s
DLEARN at the University of Arizona	52	5	2667	0.002	f+sf+s
Drexel University	752	51	1413	0.036	f+sf+s
Dspace at Indiania University Of Pennsylvania	19		778	0.000	f+sf+s
DSpace at MIT	21213	97	1620	0.060	f+sf+s
Ecological Restoration Institute, Northern Arizona University	261	1	2	0.500	f+sf+s (15 of 30 sf members participating in)

George Mason University (MARS)	1274	13	2181	0.006	f+sf+s
IDeA, Indiana University Purdue University Indiana	382	44	2167	0.020	f+sf+s
Indiana University Bloomington (USA) IUScholarWorks	256	20	2174	0.009	f&sf
KU Medical Center (University of Kansas)	90	20	786	0.025	f+sf+s
KU ScholarWorks (University of Kansas)	773	401	2201	0.182	f+sf+s
Ohio State University Knowledge Bank	22378	30	3493	0.009	f+sf+s
Portfolio@Duke University	898			N/A	s
Rice University	4263	9	979	0.009	f+sf+s
School of Forestry, Northern Arizona University	195	13	55	0.236	f+sf+s
SMARTech Scholarly Materials and Research at Georgia Tech	9540	159	4000	0.040	f+sf+s
Texas A&M University Libraries Institutional Repository	3388	10	2500	0.004	f+sf+s
University of Delaware	2026	90	2446	0.037	f+sf+s
University of Illinois at Chicago (USA)	22	13	2119	0.006	f+sf+s
University of Illinois, Urbana-Champaign - IDEALS	123	30	2047	0.015	f+sf+s
University of Michigan, Ann Arbor	32666	*219	5598	0.039	f+sf+s
University of New Mexico, DSpaceUNM	1487	153	3183	0.048	f+sf+s
University of North Texas	23	17	1770	0.010	f+sf+s
University of Oregon Scholars' Bank	2994	65	1666	0.039	f+sf+s
University of Rochester's UR Research	2877	58	1223	0.047	f+sf+s
University of Tennessee in Knoxville	944	2	1518	0.001	f+sf+s
University of Texas at Austin Libraries Digital Repository	1500	7	2700	0.003	f+sf+s
University of Texas at Austin, School of Information	1269	5	55	0.091	f+sf+s
University of Vermont	2697	6	1706	0.004	f+sf+s
University of Washington, Seattle	2226	60	1313	0.046	f+sf+s
University of Washington Health Science Libraries	242	*18	1827	0.010	f+sf+s
University of Wisconsin, Madison	1864	43	2053	0.021	f+sf+s
Vanderbilt University e-Archive	102	9	3004	0.003	f+sf+s
Washington University School of Medicine, St. Louis	515	6	1635	0.004	f+sf+s
Wesleyan University, Middletown, Connecticut	28	5	300	0.017	f+sf+s
Youngstown State Univeristy, Youngstown, Ohio	2134	4	857	0.005	f+sf+s

Note: s=student, sf=staff, f=faculty, a=alumni,   * the number obtained by literature analysis
Total titles: 128850, average: 3222, median: 921
Average faculty participation rate: 4.6%, median: 1.9%
The above 40 DSpace cases in America are selected from DSpace Federation website: http://wiki.dspace.org/index.php//DspaceInstances

Several researchers have explored this topic from practical perspectives. For example the DSpace team of University of Rochester tried to explore the misalignment between the benefits of an institutional repository with the actual needs and desires of faculty by interviewing faculty (Foster & Gibbons, 2005), and Swan and Brown studied the authors' self-archiving behavior in IRs by surveys (Swan & Brown, 2004; Swan & Brown, 2005). This paper discusses IRs as an innovation mode of scholarly communication based on literature review, calculates the average faculty participation rate in IRs, and then uses Rogers's innovation diffusion theory to interpret the faculty participation situation and identify factors affecting faculty's attitude to IRs. The advantages by theory analysis are: 1. IRs are an innovation and they will follow the regular patterns of innovation diffusion; 2. the diffusion theory can help institutional repository developers and researchers describe and understand IRs' developmental processes; 3. theory can be a guide in IRs' practical application.

This paper will explore the following areas: 1. IRs as an innovation in scholarly communication; 2.the current situation of faculty participation in IRs; 3. which factors affect faculty's attitude and participation in IRs; 4. strategies to increase faculty participation in IRs.

IRs are an Innovation in Scholarly Communication

Rogers (2003) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p.12). The concept of "institutional repository" is relatively new and it is being discussed as an innovation in scholarly communication.

While many researchers have heard the term scholarly communication, there is no single agreed-upon definition. Some writers narrow the definition of scholarly communication to the peer reviewed literature published upon completion of research, while others broaden the scope of scholarly communication to include all forms of communication between researchers (Birdsall et al., 2005). Focusing on processes, Gelfand (2003) defined scholarly communication as "the formal and informal processes by which the research, scholarship and creative output of the academic community, meaning faculty, researchers and independent scholars is created, organized, evaluated, edited, formatted, distributed, made accessible, archived used and transformed."

Scholarly communication modes can be classified into three kinds: formal, informal, and somewhere in between formal and informal. Journals and monographs form the core of the formal scholarly communication system, which are also the major modes for scholarly communication. Informal modes are flexible, including networks of personal contacts, exchange of personal communications, the sharing of reprints and preprints, and international exchange programs for graduate students and postdoctoral fellows, communicating online, etc. Academic conferences and meetings are somewhere in between the formal and informal modes (Birdsall et al., 2005).

Scholarly journals and monographs have acted as an important role in the scholarly communication. But since the end of the 1980s and the beginning of the 1990s, a crisis has arisen in the scholarly communication field. The crisis was mainly reflected in the high costs for print journals and books during the time university library budgets were challenged to keep up with the inflation of prices for these resources. Statistical data illustrate the rise in price of print documents. Academic libraries in the U.S. spent 152% more to purchase 7% fewer journal titles in 1998 than in 1986 and are purchasing 25% fewer monographs today than they did 15 years ago due to high journal prices and the costs for resources in new formats (Iowa State University, 2003).

The crisis in scholarly communication is not only a library problem, but a problem for the entire academic community. This situation raises the question of whether formal modes of scholarly communication can meet the requirements of scholars.

The crisis in scholarly communication provides a context for the emergence of IRs. Other factors also contribute to context in IRs. New developments in information technology and platforms for implementing an institutional repository have reduced costs for IRs adoption. Open source institutional repository platforms, such as DSpace and Eprints, have allowed most academic institutions to afford the repository. The implementation of standards like the open archives metadata harvesting protocol (OAI-MHP) makes access to the institutional repository easier. OAI-MHP is a protocol that allows the data provider to expose metadata records for harvesting by a service provider (Friesen, 2002). Based on metadata, OAI-MHP not only improves interoperability, but also enables IRs to share resources and thus enhance access to users. The need for long-term preservation is widely recognized and well defined (Lynch, 2003). The early 1990s preprint servers, for example arXiv.org, could be considered the catalyst for the evolution of the institutional repository today (Singarella, 2005). In America, almost every experimental high-energy physics research institute has organized its own research manuscript series. Strictly speaking, a manuscript is a document written by hand, but here a manuscript is an original copy of academic or research outputs of scientists and researchers. The research manuscript series represents the publications of research teams at those research institutions and is different from real publishing because it includes preprints (McKiernan, 2000).

All the above factors, combined with the desire of faculty and researchers to advance scholarly communication, serve as a context for the emergence of IRs.

Almost at the same time as the crises of scholarly communication, another movement, the Knowledge Management movement (KM), attracted attention from knowledge organizers and producers. In 1988, Peter Drucker published his milestone paper, The Coming of the New Organization, in which he discussed the

importance of knowledge as an asset of organizations. He also emphasized that every member in an organization has a responsibility to the knowledge generation. A successful organization should change the knowledge asset into information by managing and exploring it (Drucker, 1988). During this movement, many kinds of repositories emerge out: "Repositories, and that is the name commonly used in the knowledge management field, play an important, but supporting, role in a knowledge management system. Davenport and Prusak, for example, in their 1998 book Working Knowledge: How Organizations Manage What They Know, lit Knowledge repositories first in their review of knowledge management projects in practice" (Branin, 2003). KM movement is credited not only with the inspiration for the idea of IRs but also with the nomenclature (Branin, 2003; McLendon, 2005).

Institution has a very broad sense, which can be a group, an organization, or a group of organizations. Although in a broad sense any organization that generates research and wishes to capture and openly disseminate its intellectual products can implement an institutional repository, much of the literature about IRs now refers to academic institutions (Roosendaal & Geurts, 1997). For the purposes of this study, we adopt the definition coined by the Scholarly Publishing for Academic Resources Coalition (SPARC) which stated that IRs are "digital collections capturing and preserving the intellectual output of a single or multi-university community" (Crow, 2002a).
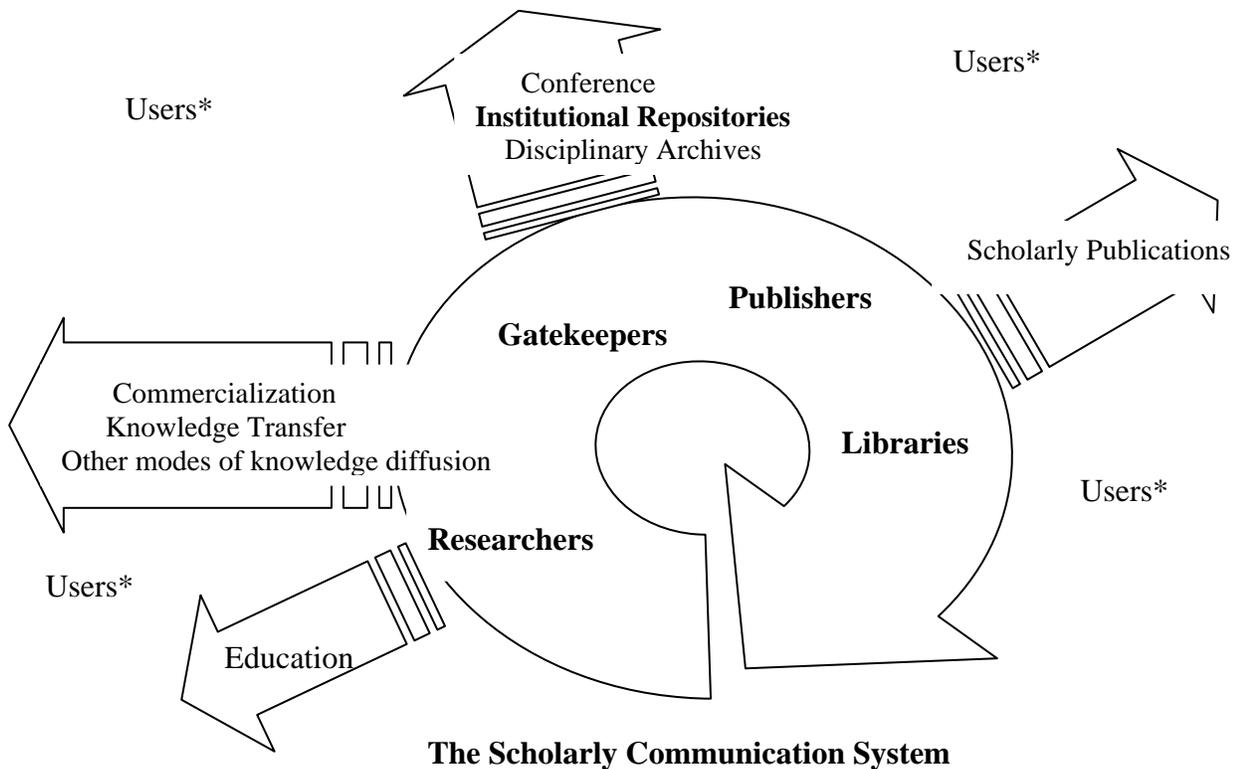
As an innovation in scholarly communication, IRs are not only new but also can meet all the functional requirements of the communication system at different levels. A scholarly communication system should have five basic functions (Roosendaal & Geurts, 1998; Van de Sompel et al., 2004; Birdsall et al., 2005):

1. Registration that allows claims of precedence for a scholarly finding and establishes ownership priority over a particular discovery or advance.
2. Certification that establishes the validity of a registered scholarly claim through peer review and other processes.
3. Awareness that allows actors in the scholarly system to remain aware of new claims and findings.
4. Archiving that preserves the scholarly record over time.
5. Rewarding authors for their performance in the communications system based on metrics derived from that system, for example, providing formal recognition for authors, raising their prestige and the like.

By relying on peer review, journals and monographs fulfill all the certification and rewarding requirements successfully, except for Awareness because of lag times in print publication. Because IRs are institutionally defined, and because low-barrier access and long-term preservation are characteristic, when a document is deposited in a local institutional repository the registration, awareness, and archiving functions are met immediately (Prosser, 2003). Taking advantage of open access, articles in IRs have a higher citation rate than offline articles. Through this IRs meet the rewarding function by increasing authors' prestige and distributing their academic achievements widely (Johnson, 2002).

IRs have been recognized as an innovation in scholarly communication by many researchers in information and scholarly communication. "IRs can help create a new infrastructure to support scholarly communications" (Walters, 2006); they act as a "new scholarly publishing paradigm" (Johnson, 2002). Crow (2002a), the senior consultant of the Scholarly Publishing & Academic Resources Coalition, stated that IRs "play a meaningful role in an evolutionary restructuring of scholarly communication" (p.7). The research team led by Birdsall (Birdsall et al., 2005) integrated IRs into their scholarly communication model (See Figure 1.).

Figure 1. Scholarly Communication Model (Birdsall et al., 2005)

The Scholarly Communication System

Based on the above discussion, we characterize IRs as an innovation in scholarly communication.

The current situation of faculty participation in IRs

IRs are an innovation in scholarly communication but that does not mean IRs will be adopted by faculty widely, rapidly, and automatically. Several influential papers point out that it is very difficult to recruit faculty to contribute to IRs' content (Lynch, 2003; Ware, 2004b; McLendon, 2005; Mark & Shearer, 2006; Markey, Rieh, Jean, Kim, & Yakel, 2007). Launched in November 2002 at MIT, DSpace was expected to provide service to MIT faculty at a great level. But at the end of 2003 there were only about 3000 documents in DSpace, most of which had originated from pre-existing collections of grey literature (Ware, 2004a). In October 2006, more than 21,000 documents were in MIT DSpace (See Table 2). It has grown more than 7 times in 3 years. The increase, however, comes mainly from dissertations, theses, and pre-existing collections of grey literature. About 75% of MIT DSpace contents are dissertations and theses, 20% are pre-existing working papers or technical reports (archiving from 1900 to now). Mcdowell (2007) makes a statistic about the content of 102 American IRs. The result shows that 41.5% of the contents are student works, 13% are pictures, 4.5% are non-scholarly publications, 3% are historical textual materials, and 37% are scholarly communications which include 24% gray literature and 13% peer reviewed articles. In order to learn the situation of faculty participation in IRs in more detail, the author did the following study.

The author studied 40 DSpace implementations supporting IRs in the U.S. that are listed in DSpace Federation website as of October 2006. Table 2 presents the results. In Table 2 the Title column shows the size or the total number of items in every repository; the Faculty Author column shows the number of faculty members who have at least one document deposited in a repository; the Faculty column shows the number of faculty members in each institution; the faculty participation rate is defined as the proportion of Faculty Author to Faculty; the Note column shows persons who have right to participate in a repository. In order to collect data, the author browsed every repository website and the institution to which the repository belongs. The size of each repository

and the faculty number of each institution can be obtained directly from its website and the related institution website respectively, but it is difficult to identify the faculty author. For the repositories that have established faculty communities, or marked collections by published articles or preprints, the authors counted the faculty numbers in those communities or collections directly. For the repositories in which the faculty authors could not be identified directly, the author got the author list of every community in a repository, and the faculty list of the community from the related institution, and then identified the faculty author by comparing names on both lists. For the other two IRs, University of Michigan's Deep Blue and University of Washington Health Science Libraries, it was impossible to identify faculty authors by the above methods. The author arrived at the number of faculty authors by analyzing literatures in these repositories. Provided that in 2006 every faculty member in a university produced one document and provided every document of 2006 in the scholarly document collections in the university's institutional repository belonged to one faculty member, then the total number of scholarly documents of 2006 in the repository would be defined as the number of faculty authors.

The study shows that the average number of items per archive is about 3222 with the median of 921, and for 38 DSpace cases the average individual participation rate is about 4.6% per archive with a median of 1.9%. The other two IRs only collect students' theses and dissertations.
What does this number mean?

In the discussion above, IRs are discussed as an innovation in scholarly communication. Since 1900 professionals have investigated the diffusion of innovations. Rogers first elaborated his diffusion of innovations theory in 1963 in Diffusion of Innovations, and now this book is in its fifth edition (2003). Rogers (2003) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p.11). Rogers applied a bell curve to his innovation adoption research (See Figure 2) to interpret adoption categorization of an innovation.

Figure 2. Adopter categorization curve (Rogers, 2003)

Rogers classified adopters into five categories: Rogers (2003) of an innovation
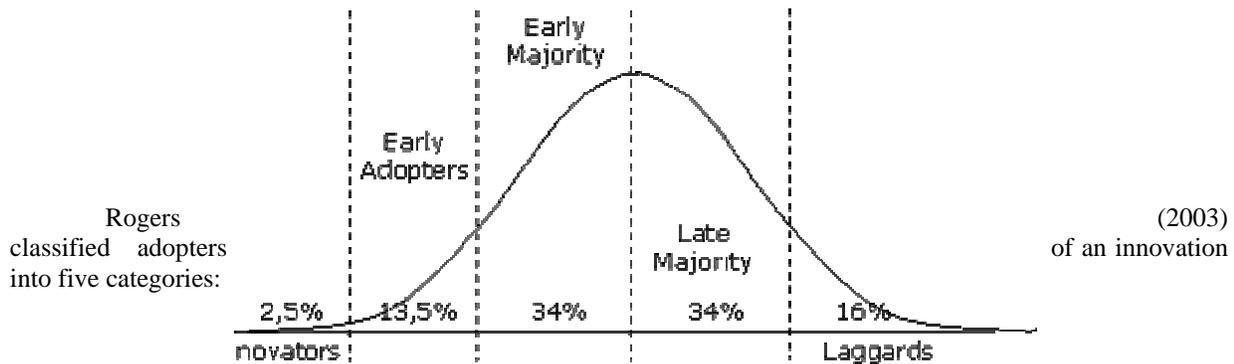
- Innovators: the first 2.5% percent of the individuals in a system to adoption an innovation, and their special characteristic is venturesome;
- Early Adopters: the next 13.5% to adopt the innovation, and they are usually opinion leaders and respected in their social system;
- Early Majority: the next 34% of the adopters, and they are labeled as deliberate;
- Late Majority: the other 34% followed early majority, and their characteristic is skeptical.
- Laggards: the last 16%, and they are relatively traditional.

According to Rogers's innovation adoption curve, currently faculty members who have participated in IRs belong to the innovators and early adopters, and most faculty members are still not participators in IRs.

Rogers' Diffusion of Innovations Theory

Rogers (2003) not only applied the innovation adoption curve to explain the diffusion stages of an innovation, but also pointed out one of the main methods of speeding the diffusion of an innovation among individuals was shortening the innovation-decision period. He defined the innovation-decision process as "the process through which an individual (or other decision-making unit) passes from gaining initial knowledge of an innovation, to forming an attitude toward the innovation, to making a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision" (Rogers, 2003, p. 168). And he depicted this process into a model of five stages as illustrated in Figure 3.

Figure 3. A Model of Five Stages in the Innovation-Decision Process (Rogers, 2003, p.170)
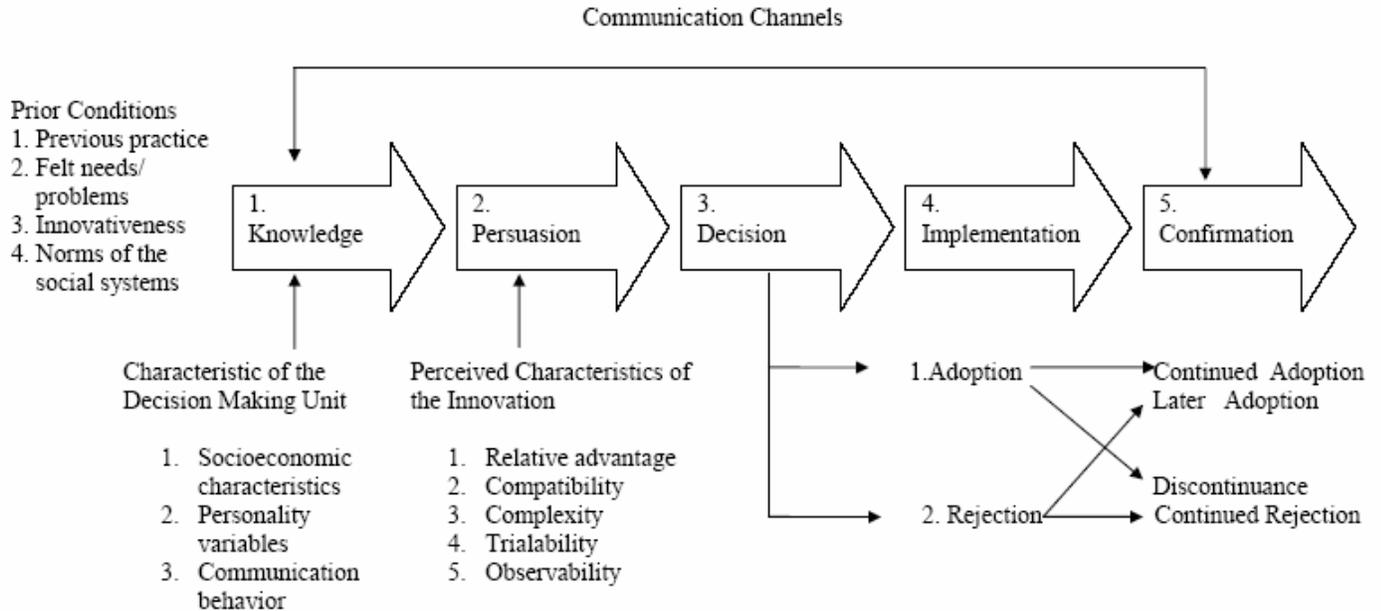
Attitude is formed in the persuasion stage. Rogers (2003) defined attitude as "a relatively enduring organization of an individual's beliefs about an object that predisposes his or her actions" (p. 174). According to the model of five stages in the innovation–decision process there are many factors which can shape attitudes, such as knowledge about the innovation, perceived characteristics of the innovation, the communication channels in the process, etc., of which the perceived characteristics of the innovation in the persuasion stage play an important role in the attitude forming.

Communication Channels are "means by which messages get from one individual to another" (Rogers, 2003, p. 36), which are classified into mass media channels as opposed to interpersonal channels, and cosmopolite channels as opposed to localite channels. Different channels have different effects on the innovation diffusion.

Faculty's attitude and participation in IRs and the innovation-decision process

Rogers used the innovation adoption curve to research the individual adoption of an innovation. In this paper the faculty's adoption of IRs is defined as faculty participation in IRs. Based on the innovation adoption curve, the current faculty participation in IRs is in the early adoption stage, which means most faculty members who have participated in IRs are innovators and early adopters. Innovators are the developers or managers of an innovation. They introduce and establish IRs so that IRs can be known and adopted by others. Early adopters play the role of opinion leaders in institutions, and peers who would like to know more about the innovation communicate with and follow them. Their opinions about IRs have more influence on peers and their participation in IRs can encourage more faculty members to adopt IRs.

Although IRs can benefit all faculty and researchers, most faculty members do not know about IRs until innovators promote the relevant knowledge to them. Before that they may have some knowledge about scholarly communication, digital libraries, open access, and the like, which forms their background knowledge of IRs.

For the innovators of IRs, the characteristics of IRs are the reality, such as digital, institutionally defined, scholarly, cumulative and perpetual, open access, and interoperable (Crow, 2002a). However these are not faculty perceived characteristics of IRs. Faculty perceived characteristics of IRs are formed in the Persuasion stage during which faculty members interpret the information presented by institutional repository innovators, and accept the information that they think is credible, related, useful, and easy to understand. They are then in a position to assess or think about the characteristics of IRs which consist of relative advantage, compatibility, complexity, trialability, and observability. At what point are faculty perceived characteristics of IRs known after relative information is given? No systematic research about this question is found, and it should be a topic for future study.

According to Rogers's theory several factors affect the potential adopters' perception of the characteristics of an innovation, and then perception shapes their attitude (Rogers, 2003). Relative advantage is determined when an innovation is perceived as better than the idea it supersedes, and it can be interpreted as a ratio of the expected benefits to the costs of adopting an innovation. For faculty adopting IRs, the cost is time, and the benefits mostly enjoyed by faculty are long-term preservation and open access to content (Barton & Walker, 2002). Moreover, incentives and mandates can strengthen the perceived advantage. Sale (2006) indicated that about 95% of faculty and researchers expressed that they would collaborate on the self-deposit policy requirements issued by institutions.

Compatibility means whether an innovation is consistent with the existing values and beliefs, experiences, and needs of potential adopters. When potential adopters feel an innovation can meet their needs, they will adopt it faster. In 2005 Foster and Gibbons did a study to learn what are the actual needs and desires of faculty. The result shows faculty members need their academic products to be disseminated and shared, but they do not like additional work and time-consuming processes to gain that result. They need their time to do research (Foster & Gibbons, 2005). Naming and positioning an innovation are related to compatibility too. The naming of innovation should be compatible with potential adopters' sociocultural values. For example, the investigation of Foster and Gibbons (2005) shows that the term "institutional repositories" misleads faculty to believe that this kind of repository can be used only by institutions. Positioning an innovation is based on market research. It assumes that if an innovation A is perceived as similar to B but unlike C and D, customers who purchase B will buy A, and in the same environment A' customers will reach about one half of B's customers while not affecting C and D's customers (Rogers, 2003). Based on this positioning strategy, we assume that IRs are similar to subject repositories but unlike e-journals and traditional printed journals; then we expect that half of subject repositories participators will adopt IRs, and IRs' adoption will not affect the subscribers of e-journals and printed journals. Whether this assumption fits into IRs or not still needs to be confirmed. If it is true, it will be a strong argument to persuade journal publishers to give their authors the right to self-deposit articles in IRs. Covey (2004), and Barton and Walker (2002) point out that faculty do worry that depositing in IRs will prevent them from publishing papers in journals and cause copyright concerns. Another factor in compatibility is technology clusters that mean an innovation usually interrelates with a bundle of new ideas. IRs are closely related to Open Access Repositories, subject repositories, etc. Faculty's knowledge about these conceptions can affect their reorganization of IRs.

Complexity and trailability are two other factors affecting potential adopters' attitudes. It is easy for potential adopter to form a positive attitude to an innovation which is easily understood, used, and tried. Finally, high observability means that the results and advantages of an innovation are perceived as visible. This predisposes potential adopters to accept it.

During the persuasion stage, the advantages, cost, incentives, mandate, naming, positioning, technology clusters, existing values, experiences, needs of potential adopters, complexity, trailability, and obvservability all influence and shape the potential adopter's attitude. The potential adopter's background knowledge about the innovation can also influence his attitude. The innovation-decision is a process during which different communication channels affect the attitude at different levels. The Mass media channel and cosmopolite channel are more important at the knowledge stage. The interpersonal channel and localite channel are relatively more important in the persuasion stage, especially in attitude forming.

The above factors which affect a potential adopter's attitude to an innovation can be used for examining the factors affecting faculty's attitude to IRs.

A positive attitude predisposes an adoption decision. The decision is conformed by implementation. During the implementation stage the adopter experiences the innovation in person, perceives the characteristics of the innovation further, and then makes an evaluation. Based on the evaluation, he may adjust his attitude. So maintaining and improving the quality of IRs services will confirm faculty's positive attitude to IRs adoption.

Finally, in Rogers's Theory of Innovation Diffusion time is an important element in the process of innovation diffusion. So time becomes an inevitable factor affecting faculty's attitude and adoption of IRs. At the early stage of IRs adoption, relatively fewer faculty members hold positive attitudes toward IRs and their adoption. With time, IR's importance in scholarly communication fields has already shown up. There had been about 1,550,744 full-text downloads from the California Digital Library (CDL) eScholarship, an Institutional Repository, from its launch in April 2002 to August 2005 (University of California, 2005), and the number of full-text downloads increased to 5,064,448 through November 2007, and 31,441 full-text downloads of repository content in only a single week in 2007 (University of California, 2007). The DSpace website statistic shows that DSpace, the prime example of the most robust software backbone for IRs, has had about 291 installations in 48 countries with 1,413,354 documents since its release in 2002 (Dspace.org., 2007). IRs' benefits (such as free access, long-term preservation of scholarly documents) will be recognized by more and more faculty members. Then more and more faculty members will be interested in IRs and adopt them.

Now faculty participation in IRs is still in the early stages. In fact many innovations with obvious benefits diffuse at a very slow rate and some are not even adopted. Gabriel Tarde, the forefather of diffusion research, recognized one hundred years ago that for different innovations 10% would be spread while 90% would be forgotten (Rogers, 2003). So the innovators of IRs must design effective methods to promote and improve IRs, and help faculty to form a positive attitude to IRs so as to effectively shorten the innovation-decision process of IRs, and speed the diffusion of IRs among faculty. This is very important not only to IRs' diffusion but also to IRs' survival.

Strategies to Increasing Faculty participation in IRs

Rogers (2003) gave some suggestions to getting more adopters for innovations, which can be summarized as 1. targeting highly-respected individuals; 2. shaping individual's perceptions of innovations; 3. introducing the innovation to intact groups; 4. encouraging early adoption by incentives. These strategies can be used to address IRs' participation.

1. The administrators of institutions, the deans, chairs of departments, leaders of projects and programs, and famous professors play a very important role in IRs' adoption. Their confirmation and support can effectively trigger faculty participation in IRs. The Libraries of the University of Carnegie Mello gave a presentation about the plan of establishing an institutional repository at the academic department heads meeting and tried to get their support. The meeting attendants agreed that university administrators should act as stewards for the university's digital assets and commit time and resources to the institutional repository in perpetuity to gain faculty trust (Covey, 2004).

2. Faculty's perceptions of IRs can be shaped by promoting IRs' advantages, benefits, and knowledge. In order to help faculty understand and experience IRs' benefits easily, the River Campus Libraries of the University of Rochester described the institutional repository in language drawn from faculty interviews instead of professional terms, and developed a researcher page to overcome the inconvenience resulted from organizing information by institution communities instead of subjects in IRs (Foster & Gibbons, 2005).

3. Conduct a pilot study to introduce an institutional repository to a whole group or community, then use the experiences to recruit more adopters. Table 2 shows a DSpace implementation, the EIR Library, is introduced only to the Ecological Restoration Institute of North Arizona University (NAU), and its faculty participation rate is 50%. In this institute there are only two faculty members. One of them participating in the repository dose not mean anything, but 15 of 30 staff members participating in the repository does confirm this faculty participation rate. The SoF Library, another DSpace implementation in NAU, is introduced only to the School of Forestry, and

its faculty participation rate reaches 23.6%. Community of Physics, mathematics, or computer science is a good choice. Because there have been preprint cultures in these disciplines already, it is easy for more faculty members to accept IRs (Mark Ware Consulting Ltd., 2004).

4. Encouraging early adoption is very important. Early adopters are often respected in their academic circles and they usually act as opinion leaders in their academic communities, they can set a model for other faculty members. By their evaluation and interpersonal networks, more faculty members will be encouraged to engage in the adoption. Saving faculty's time is the best incentive to encourage faculty to participate in IRs. The institutional repository team of University of Kansas (KU) sent emails to faculty who had articles published in green journals which give their authors the right to self-deposit articles in IRs, and approached them for permission to deposit on their behalf articles published in KU ScholarWorks. Faculty responded at a high rate (over 25%), and 78% of the responding faculty gave the permission with favorable feedback (Mercy & Emmett, 2005). In ScholarWorks the faculty participation rate has reached 18.2% (see Table 2).

In addition to these strategies to attract faculty participation, the innovators should pay more attention to faculty's feedback to customize IRs and make them more faculty-friendly in meeting the needs of faculty at the highest degree. Getting support from universities or academic communities by issuing a policy that requires or encourages faculty adoption of IRs is another effective way to encourage faculty participation. For example the KU university council passed RESOLUTION on Access to Scholarly Information in 2005 and sent email to all faculty members to call for participation in KU ScholarWorks, the institutional repository of KU (The University of Kansa, 2006). It is not only a promotion of institutional repository but also an effective encouragement to faculty participation.

Future Research

This paper is only a preliminary analysis of faculty participation in IRs through a theoretical perspective. In the next step the author plans to interview both faculty members and IRs providers who are mostly credited to librarians, and then to use the grounded theory method to analyze the data. The research will focus on the factors encouraging and impeding faculty participation in IRs, and the strategies to promote IRs.

Conclusion

IRs are discussed as an innovative mode of scholarly communication. The faculty is considered to be the main content contributor to IRs, but now most faculty members are not yet participating in IRs. According to Rogers's innovation diffusion theory, IRs are on the early stage of diffusion. This paper discovers the factors which affect faculty's attitude toward IRs and strategies to increase faculty participation in IRs based on Rogers' innovation diffusion theory.

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References

Barton, M. R., & Walker, J. H. (2002). *MIT libraries' DSpace Business Plan Project Final Report to the Andrew W. Mellon Foundation*. Retrieved November, 16, 2006, from http://www.dspace.org/implement/mellon.pdf

Birdsall, W. F., et al. (2005). Scholarly communication. In *Towards and Integrated Knowledge Ecosystem: A Canadian Research Strategy--A Report Submitted to the Canadian Association of Research, Part I*. Retrieved November 15, 2006, from http://www.carl-abrc.ca/projects/kdstudy/public_html/2005/finalreport.pdf

Branin, J. (2005). Institutional repositories. In M. A. Drake (Ed.), *Encyclopedia of Library and Information Science*. Boca Raton, FL: Taylor & Francis Group, LLC. Retrieved November 2, 2007, from https://kb.osu.edu/dspace/bitstream/1811/441/1/inst_repos.pdf

Covey, D. T. (2004). Does CMU need an institutional repository? *Focus, 33,* 1, 7. Retrieved December 12, 2006, from http://www.cmu.edu/focus/archive/FOCUS_2004_04.pdf

Crow, R. (2002a). *The Case for Institutional Repositories: A SPARC Position Paper*. Retrieved Feb.16, 2005, from http://www.arl.org/sparc/IR/IR_Final_Release_102.pdf

Crow, R. (2002b). *SPARC Institutional Repository Checklist & Resource Guide*. Retrieved Nov.16, 2006, from http://www.arl.org/sparc/IR/IR_Guide_v1.pdf

Crow, R. (2004). *A Guide to Institutional Repository Software*, 3rd ed. Retrieved April 19, 2005, from http://www.soros.org/openaccess/pdf/OSI_Guide_to_IR_Software_v3.pdf

DSpace.org. (2007). *Who's Using DSpace?* Retrieved November 2, 2007, from http://wiki.dspace.org/index.php/DspaceInstances

Drucker, P. (1988). The coming of the new organization. In *Harvard Business Review on Knowledge Management*. Cambridge, MA: Harvard Business School Press.

Foster, N. F., & Gibbons, S. (2005). Understanding faculty to improve content recruitment for institutional repositories. *D-Lib Magazine*, *11*(1). Retrieved December 11, 2006, from http://www.dlib.org/dlib/january05/foster/01foster.html

Friesen, N. (2002). *Metadata Harvesting: Tools and support for the Canadian Elearning Infrastructure*. Retrieved July 29, 2005, from http://www.cancore.ca/harvesting.doc

Gelfand, J. (2003). Scholarly communication. *Social Sciences Workshop Series*. Retrieved March 15, 2005, from http://course.lib.uci.edu/ed/socialscience/scholcomm.pdf

Hajjem, C., Harnad, S., & Gingras, Y. (2005) Ten-year cross-disciplinary comparison of the growth of open access and how it increases research citation impact. *IEEE Data Engineering Bulletin 28*(4), 39-47.

Iowa State University. (2003). *The Crisis in Scholarly Communication*. Retrieved March 17, 2005, from http://www.lib.iastate.edu/libinfo/reptempl/origins.html

Johnson, R. K. (2002). Institutional repositories: Partnering with faculty to enhance scholarly communication. *D-Lib Magazine, 8*(11). Retrieved Feb. 16, 2005, from http://www.dlib.org/dlib/november02/johnson/11johnson.html

Lynch, C. N. (2003). *IRs: Essential Infrastructure for Scholarship in the Digital Age*. Retrieved July 20, 2005, from http://www.arl.org/newsltr/226/ir.html

Mark, T., & Shearer, K. (2006). Institutional repositories: A review of content recruitment strategies. Paper presented at World Library and Information Congress: 72ND IFLA GENERAL CONFERENCE AND COUNCIL*,* Seoul, Korea. Retrieved October 31, 2005, from http://www.ifla.org/IV/ifla72/papers/155-Mark_Shearer-en.pdf

Mark Ware Consulting Ltd. (2004). *Pathfinder Research on Web-based Repositories: Final Report*. Retrieved November 20th, 2006, from http://www.palsgroup.org.uk/palsweb/palsweb.nsf/0/8c43ce800a9c67cd80256e370051e88a/$FILE/PALS%20report%20on%20Institutional%20Repositories.pdf

Markey, K., Rieh, S. Y., Jean, B. S., Kim, J., & Yakel, E. (2007). *Cense of Institutional Repositories in the United States: MIRACL Project Research Findings*. Washington D.C.: Council on Library and Information Resources. Retrieved October 25, 2007, from http://www.clir.org/PUBS/reports/pub140/pub140.pdf

Mcdowell, C. S. (2007). *A Statistical Analysis of Institutional Repositories in American Academe*. Paper presented at The 2nd International Conference on Open Repositories, San Antonia, TX.

McKiernan, G. (2000). arXiv.org: the Los Alamos National Laboratory e-print server. *The International Journal on Grey Literature, 1*(3), 127-138. Retrieved April 3, 2005, from http://www.public.iastate.edu/~gerrymck/arXiv.org.pdf

McLendon, W. (2005). *Institutional repositories: A white paper for the UNC-Chapel Hill Scholarly Communications Convocation*. Retrieved October 31, 2007, from http://www.unc.edu/scholcomdig/whitepapers/mclendon.html

Mercy, H., & Emmett, A. (2005). RoMEO Green at the University of Kansas: An experiment to encourage interest and participation among faculty and jumpstart populating the KU ScholarWorks Repository. *ASIST 2005: Proceedings of the 68th ASIS&T Annual Meeting*, Charlotte, NC, 1433-1441.

Prosser, D. C. (2003). *Scholarly communication in the 21st century - the impact of new technologies and models.* Retrieved October 10, 2006, from http://www.sparceurope.org/resources/SPARC_europe_serials_paper.doc

Rogers, E. M. (2003). *Diffusion of innovations*. (5th ed.). New York, London: Free Press.

Roosendaal, H., & Geurts, P. (1997). Forces and functions in scientific communication: An analysis of their interplay. *Cooperative Research Information Systems in Physics*. Retrieved January 29, 2008, from http://www.physik.uni-oldenburg.de/conferences/crisp97/roosendaal.html

Sale, A. (2006) Generic risk analysis - Open access for your institution. *Technical Report*. Retrieved October 27, 2006, from http://eprints.utas.edu.au/266/01/Risk_Analysis-v1.0.pdf

Singarella, T. (2005). *An Overview of Institutional Repositories; AAHSL White Papers*. Retrieved April. 15, 2005, from https://kuscholarworks.ku.edu/dspace/bitstream/1808/216/3/IR_AAHSL.pdf

Swan, A., & Brown, S. N. (2004). Authors and open access publishing. *Learned Publishing, 17*(3), 219-224. Retrieved November 3, 2007, from http://cogprints.org/4123/1/Authors_and_open_access_publishing.pdf

Swan, A., & Brown, S. (2005). *Open access self-archiving: An author study*. Cornwall, UK: Key Perspectives Limited. Retrieved November 3, 2007, from http://cogprints.org/4385/1/jisc2.pdf

University of California. (2005). University of California eScholarship Repository. Retrieved August 5, 2005, from http://repositories.cdlib.org/escholarship/

University of California. (2007). University of California eScholarship Repository. Retrieved November 2, 2007, from http://repositories.cdlib.org/escholarship/

The University of Kansas. (2006). KU ScholarWorks. Retrieved October 20th, 2006, from https://kuscholarworks.ku.edu/dspace/

University of Southampton. (2006). *GNU EPrints*. Retrieved September 30th, 2006, from http://archives.eprints.org/index.php?action=browse

Van de Sompel, H., et al. (2004). Rethinking scholarly communication: Building the system that scholars deserve. *D-Lib magazine 10* (9). Retrieved March 24, 2005, from http://www.dlib.org/dlib/september04/vandesompel/09vandesompel.html

Walters, T. O. (2006). Strategies and frameworks for institutional repositories and the new support   infrastructure for scholarly communications. *D-Lib Magazine, 12*(10). Retrieved in November 1, 2006, from http://www.dlib.org/dlib/october06/walters/10walters.html

Ware, M. (2004a). IRs – the state of play. Paper presented at Publishers and Libray/Learning Solutions Conference, London, UK.

Ware, M. (2004b). *Universities' Own Electronic Repositories Yet to Impact on Open Access*. Retrieved April.16, 2005, from http://www.nature.com/nature/focus/accessdebate/4.html

Westrienen, G.V., & Lynch, C.A. (2005). Academic institutional repositories: Development status in 13 nations as of mid 2005. *D-Library Magazine*, *11*(9). Retrieved July 8, 2006, from http://www.dlib.org/dlib/september05/westrienen/09westrienen.html