Studying Scholarly Communication: Can Commons Research and the IAD Framework Help Illuminate Complex Dilemmas?

by

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Abstract

This paper presents a framework for analyzing the complex resource of scholarly communication as a *commons*. Previously* we have argued that the dilemmas associated with managing shared information are quite similar to those associated with managing natural and human-constructed common-pool resources (CPRs), where we can observe how the development of new technologies has changed the structure and processes involved in managing these types of resources over time. We concluded that collective action and institutional design play key roles in shaping economic and social aspects of information.

However, applying insights from the CPR literature on physical resource management to information management highlights the complexity of the issues involved in managing these particular processes and outcomes: there are many, diverse participants in producing and consuming information who often have conflicting interests; the nature of production and provision is often difficult to analyze and describe with the kind of specificity that is required to manage these processes effectively; digital technologies continue to evolve and are not always well-understood; production and consumption occurs in local and global arenas.

Whereas earlier we focused on applying the language, definitions, methodology, and outcomes of research on common-pool resources to understanding information management, in this paper we will extend and refine this analysis to develop a framework for analyzing the governance issues that arise from scholarly communication and the implications for further research.

Publicly and privately supported colleges and universities and the endowed research institutes must furnish both the new scientific knowledge and the trained research workers. These institutions are uniquely qualified by tradition and by their special characteristics to carry on basic research. They are charged with the responsibility of conserving the knowledge accumulated by the past, imparting that knowledge to students, and contributing new knowledge of all kinds.

–Bush, Vannevar. 1945. "Science The Endless Frontier: A Report to the President." Washington, DC: U.S. Government Printing Office. http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm

Introduction

Technological and institutional changes are reshaping access to scholarly information as well as the way that scholars communicate. In turn, "hyperchange"[1] in scholarly communication (SC) is touching every corner of how the scholarly record is managed and governed, including how it is generated, stored, and preserved. New literatures and new studies of these changes, which draw attention to the tension between the public or shared character of scholarly communication and an increasing privatization or enclosure of academic information, are emerging.

There are a vast number of perplexing dilemmas with scholarly communication today. Market forces continue to drive journal prices up. Scholarly self-publishing is increasing. Library collection budgets continue to decline. New legislation extends copyrights and threatens fair use. Overpatenting threatens future open science. Universities gravitate toward corporate models. Support for faculty tenure is declining. The "digital divide" is growing. International scholarly collaboration is increasing. Many of these trends threaten the collection and preservation of scholarly communication. Is the knowledge commons sustainable?

While a growing number of scholars[2] are describing information and or knowledge as a "commons," there remain sizable knowledge gaps in understanding the expanse of the scholarly communication ecosystem. The advantage of conceptualizing scholarly communication as a commons is that it allows us to keep the *jointness* of the resource in focus, to apply a *multidisciplinary* perspective, and to draw on the rich body

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[1] Barrett (1998: 288) defines "hyperchange" as "a combination of linear, exponential, discontinuous, and chaotic change."
[2] There are many interesting applications of the knowledge "commons" (see Benkler, 2003; Kranich, 2002; Waters, 2002; Bollier, 2002; Levine, 2003, 2004).

of research on natural resource commons. Understanding information as a commons draws attention to the need for *collective action, self-governance,* and *evolving rules* that are required for the successful management and sustainability of all shared resources. Applying institutional analysis enables a clearer understanding of the various human-technology-resource relationships, and how new technologies change the nature of the commons.

The contradictory, but parallel, trends in which there is unprecedented access to information through the Internet and, concomitantly, greater restrictions on access through IP legislation, overpatenting, licensing, withdrawal, and lack of preservation, indicate the deep and perplexing complexity of this resource. While an increasing number of voices call for survival of the knowledge commons, there are few rigorous studies or methodical analyses in this area. Many efforts tend to ignore governance issues, the need for new rules and processes, and fail to examine the complete life-cycle of information. There are so many factors, so many actors, such rapid change, such competing interests, it is, perhaps, impossible, to get one's hands around this gargantuan subject.

In this paper, we present a framework for analyzing the "elephant" of scholarly communication.[3] In our previous paper (Hess and Ostrom, 2003), we applied the language, methods, and outcomes of research on common-pool resources to develop some insights on collective-action initiatives that have developed along with new information technologies, legislation, markets, and practices. Clearly, the structure and processes involved in managing these types of resources are changing rapidly over a short period of time.

Since scholarly communication involves using and managing academic information, we use our earlier paper as a point of departure for a more refined analysis.

Specifically, we draw on the following insights from Hess and Ostrom (2003):
- Institutional analysis and design requires a precise characterization of the physical nature of producing and providing a good or service, community aspects, rules-in-use, typical action situations, and typical outcomes. A good

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[3] Referring to the poem of John Godfrey Sax (1816-1887), "The Blind Men and the Elephant:" "It was six men of Indostan/To learning much inclined/Who went to see the Elephant/(Though all of them were blind)…" At: http://www.wordfocus.com/word-act-blindmen.html

descriptive analysis includes mapping production and provision processes and identifying products and services.

- ▪ Scholarly information resources take three distinct forms: artifacts, facilities, and ideas. Information artifacts are "discreet, observable, nameable representations of an idea or a set of ideas," such as articles, research notes, books, databases, maps, computer files, and web pages. Information facilities are systems that store information artifacts and ideas. Traditional facilities include libraries and archives. Ideas, which are contained in information artifacts, include creative vision, intangible content, innovative information, and knowledge.

- ▪ The flow pattern of ideas to artifacts to facilities to users includes transition points where institutions and governance, including property rights, may change. Moreover, these rules and flow patterns are potentially affected by implementing new technologies.

This paper aims at opening a discourse on building a new research agenda to study scholarly communication as a *commons*. We believe that this area of study will be both challenging and beneficial, just as the multitude of international, interdisciplinary studies on forests or irrigation systems have been.[4] We hope to point the direction to new empirical research on the management and governance of our scholarly communication commons.

What is the Nature of the Scholarly Communication *Commons*?

In this paper, we use the term *scholarly communication* as defined by the Association of College and Research Libraries (ACRL, 2003):

> Scholarly communication is the system through which research and other scholarly writings are created, evaluated for quality, disseminated to the scholarly community, and preserved for future use. The system includes both formal means of communication, such as publication in peer-reviewed journals, and informal channels, such as electronic listserves.

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[4] Drawing on lessons learned from research on environmental commons research may also advance the construction of a new concept of a knowledge commons, urged by Boyle (2003: 70-3).

The focus on the concept of "scholarly communication" is relatively recent. The use of the term, writes Indiana University Dean of the Libraries, Suzanne Thorin, "has evolved to illustrate the breakdown of traditional scholarly publication; that is, as a means to disseminate research results, the present system of scholarly communication can no longer meet the needs of the scholarly community at large." (Thorin 2003)

Over the past 25 years, new technologies enabling electronic, interoperable exchange of information have changed virtually every aspect of the life-cycle of scholarly communication. We intend to illustrate that the scholarly communication commons (SCC) includes the entire ecosystem of academic information:

- multi-formatted information that is necessary for the creation of new knowledge (ideas, books, computer files, etc.);
- the facilities (library buildings, computer hardware, and the rest of the electronic infrastructure);
- the outcomes, rules, norms, laws, behaviors, and interactions;
- the externalities caused by the use of this commons (e.g., information pollution from spamming, lack of authority, etc.);
- issues of enclosure, loss, withdrawal, and degradation; and
- expanding and competing community of users.

This commons is a highly complex and rapidly-changing resource functioning on the local, state, national, and global levels. Libraries, universities, and individual scholars have become much more concerned with the provision, dissemination, and access to information. Perhaps it is this very shift in focus to the information *process,* rather than just the products, that has motivated the metaphor of the commons to so many disparate scholars.

Thus, the commons is an outgrowth of the change in emphasis from scholarly *product* (books and articles) with clear distinctions between the artifacts, facilities, and ideas, to scholarly *process* (Lougee, 2002). The term "commons" is not just a metaphor. Libraries are no longer able to manage the collection and preservation of the scholarly record all by themselves. Libraries have had to build close partnerships with their university's computer services and new collaborative arrangements with their faculty. Hundreds of new local, regional, and multi-national voluntary associations have

developed in order to create new standards for Internet protocols, metadata, etc. Scholarly authors are self-publishing their works and re-wording their copyright contracts with traditional publishers (see Odlyzko, 2002; Harnad, 2001). The successful organization, management, presentation, distribution, and preservation of electronically distributed information require unprecedented amounts of collaboration and collective action.

The commons reflects the need for self-governance and new governing institutions in order to manage, disseminate, and preserve the scholarly record. This SC commons includes all aspects of academic information that is shared, regardless of the specific property rights. As the Budapest Open Access[5] and the Self-Archiving Initiatives (see also Ewing, 2003; Ginsparg, 2000) emphasize, information can be copyrighted and still be available on an open access basis. Authors are urged to negotiate with publishers for more flexible copyright contracts. An increasing number of publishers are acquiescing. And authors are finally being convinced by the research, which shows that free online access substantially increases a paper's impact (see Harnad, 2001; Lawrence, 2001: 521). More and more individuals are beginning to see their individual role in this commons.

It is characteristic of all of the phenomena that are broadly linked under the term, "the commons," that multiple users are in some way sharing a resource—whether a facility or an artifact within the facility. Whenever multiple individuals share a resource, many potential problems exist. Other than resources that are provided by nature—such as the atmosphere, the oceans, and other natural resources—energy and work must be devoted to producing and maintaining any resource. Since a group of individuals will benefit, there can be incentives to free ride on the production process. Free riding[6] occurs in a variety of ways including: not contributing to the resource production and the provision process at all, contributing only a little, or finding ways of grabbing products-in-process in such a way that one can privatize them for one's own benefit in the long run. With distributed information, spamming, as a form of pollution, can also be seen as free riding.

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[5] See, for example, "Self-Archiving FAQ for the Budapest Open Access Initiative" (BOIA) at
http://www.eprints.org/self-faq/#copyright
[6] "Free riding" occurs when one person seeks their self-interest at the expense of others by not contributing to a joint effort when the person will benefit from the contributions of others..

The resulting products of the processes of provision and production of a shared resource can be divided into two very broad categories. The first is what is referred to in some literature as a "public good." For public goods, one person's benefit does not subtract from the benefits available to others. Knowledge and ideas are examples of such a pure public good. One person's use of scientific knowledge—say, Einstein's classic formula—does not subtract from the capability of another individual benefiting from using the same set of equations.

Alternatively, there is another broad class of events where one person's benefit subtracts from the products available to others. For example, in a fishery, one person's harvesting of fish subtracts that quantity of fish from what is available to others. These are called common-pool resources.

Individuals involved in the production of public goods face the problems of potentially perverse incentives related to the production process, but not related to the consumption or use process. For common-pool resources, on the other hand, there are perverse incentives on both sides of the equation. These differences in types of commons are illustrated in Figure 1.

Figure 1

Incentive Problems for Public Goods and Common-Pool Resources

	Public Goods	**Common-Pool Resources**
Production Processes	Free Riding Shirking	Free Riding Shirking
Use Processes	Cannot Overharvest Inappropriate Uses Pollution	Overharvesting Inappropriate Uses Pollution

It is important for an analyst to be clear what type of commons they are dealing with, given some of the differences in the problems and incentives facing participants. It is useful, however, to include both public goods and common-pool resources when thinking about intellectual commons in a university setting, as they share many attributes.

The scholarly communication commons comprises the areas of information traditionally required and used for the production and creation of new knowledge. The mission of the public research university is the creation and dissemination of knowledge.[7] But the nature of open science has been changed for good with the capacities of large data files.[8] Of course, some scientific knowledge, such as raw data, needs to be protected for a period of time. To produce scientific knowledge requires immense energy and creativity. If there were not some protections involved in the process of producing this knowledge, there could be very adverse consequences. But the focus of this paper is the knowledge *commons*, and what *is* shared, or, traditionally has been shared, in order to generate new knowledge and preserve the scholarly record.

Similar to natural-resource common-pool resources (CPRs), library and computer facilities are subject to various types of threats, from congestion (too many users, not enough bandwidth) (see Huberman and Lukose, 1997; Bernbom, 2000); overharvesting (too many unreturned books); pollution (physical, from toxic computer waste; and intellectual, from spamming, inaccuracy, lack of authority, etc.); withdrawal (as with presidential papers after EO13233) (see Evans and Bogus, 2004); inequity (as with the westernization of electronic knowledge, and the digital divide); and other forms of degradation. These types of outcomes to the SCC are cases where the outcomes are "bads" rather than goods (see Figure 3).

Designing institutions to enhance the production and use of all types of commons is a challenge. We have focused much of our earlier energies on analyzing this problem related to common-pool resources—irrigation systems, fisheries, forests, lakes, and other natural resources. Some of what we have learned from our past work is quite relevant for analysis of intellectual commons.

Analyses of natural-resource commons have illustrated, for example, the necessity to factor in more than the trees when studying a forest. In order to understand why one forest is becoming deforested and another is thriving, research would have to take into

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[7] See Sexton (2003). Also, as an example, the mission of the University of Michigan is "to serve the people of Michigan and the world through preeminence in creating, communicating, preserving and applying knowledge, art, and academic values, and in developing leaders and citizens who will challenge the present and enrich the future." http://www.umich.edu/pres/mission.html
[8] See Duderstadt et al. (2001: 46). The authors point out that electronic file sharing is not the same as traditional sharing in "significant ways."

account the user communities, the management systems, property rights, and the rules-in-use (Gibson, McKean, & Ostrom, 2000). It would look at climate conditions, soil composition, and wildlife. The researchers would take into consideration questions of multiple uses, conflict, equity, livelihood security, modes of production, and sustainability (see Berkes, 1989: 11-13; National Research Council, 2002). So, too, with scholarly communications will it be necessary to consider a multiple number of variables. When analyzing a particular outcome of scholarly communication commons (including forms of digital information), the nature of the physical resources need to be described, the artifacts (books, etc.), the facilities (libraries, the Internet), as well as the various layers of the networked information structure. The different communities of producers and users also need to be considered.

We have learned that successful commons governance requires an active community and rules that continue to evolve (Dietz, Ostrom, and Stern, 2003). We have learned that commons are more robust when users have some autonomy to make and enforce their own rules, and when they value the future sustainability of the resource. And conversely, when a resource is large and complex, users lack a common understanding of resource dynamics, and users have substantially diverse interests, the costs of sustaining that resource are much higher (Ostrom et al., 1999).
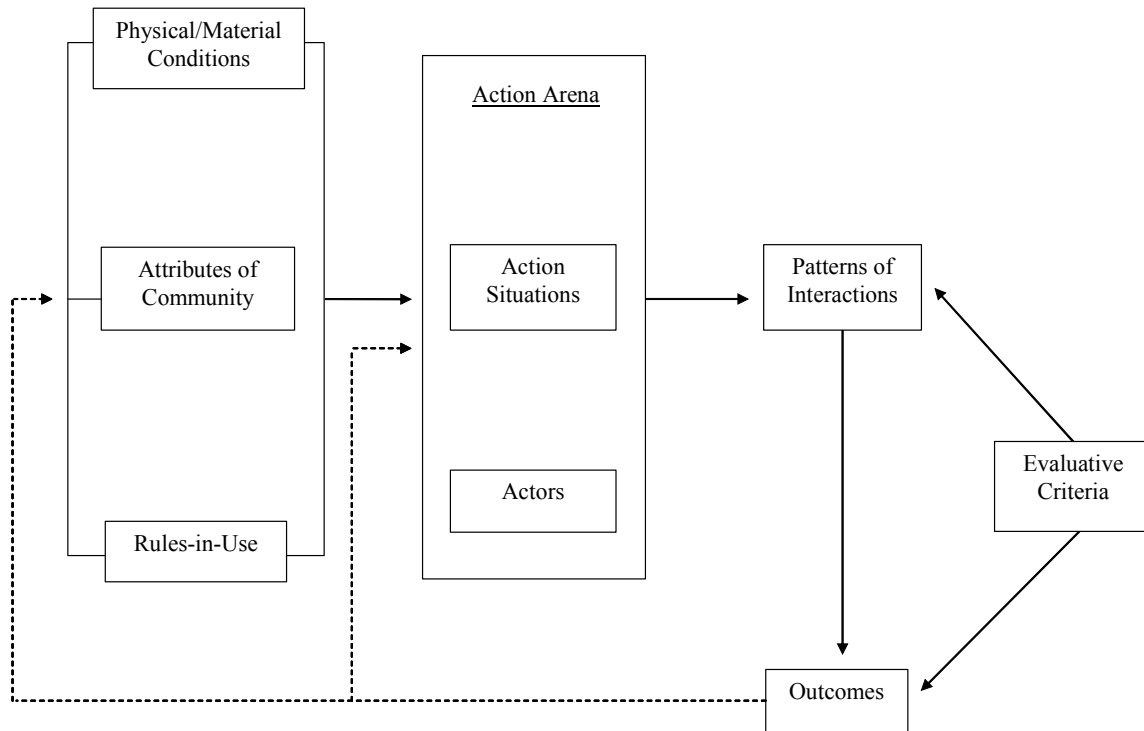
A Framework to Understand the Scholarly Communication Commons

As Ronald Oakerson (1978) wrote, "public problems, like all genuine problems, are surrounded by confusion." The two main resources required for problem solving, he continued, are *theory* and *information* (ibid.: 50). Scholars associated with the Workshop in Political Theory and Policy Analysis have found that employing a framework helps to organize analytical and prescriptive inquiry (Ostrom, Gardner, and Walker, 1994: 25). The Institutional Analysis and Development (IAD) framework (see Figure 2) has been used for over 40 years as the analytical method in a large number of interdisciplinary studies. This scaffolding orients the analyst to ask particular questions and to see

relationships, behaviors, and outcomes.[9] It provides a method of analyzing dilemmas and situations within the larger commons resource (Ostrom et al., 1999).

Figure 2

A Framework for Institutional Analysis

Physical/Material Conditions

Action Arena

Attributes of Community

Action Situations

Patterns of Interactions

Rules-in-Use

Actors

Evaluative Criteria

Outcomes

Source: Adapted from Ostrom, Gardner, and Walker (1994: 37).

The components shown on the left side of Figure 2—Physical/Material Conditions, Attributes of Community, and Rules-in-Use—are sometimes treated as exogenous factors. In other words, they are looked upon as fixed elements that affect the rest of the patterned interactions, but are not themselves the object of explanation and are assumed to be relatively fixed.   We cannot make such an assumption when analyzing SCCs, given the importance of all of these elements in affecting particular commons and given the speed of change in all three of these components. We will overtly look at situations where participants switch levels of analysis to change the rules operating at another level. Further, one cannot go very far in analyzing SC commons without

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[9] Ibid. pp. 25+ for an in-depth discussion of the historical roots of the IAD framework. The Workshop Research Library Commons Database contains over 250 records of studies applying the framework.

recognizing the rapid changes occurring in the physical world of computers given rapid technological change. Thus, the feedback arrows in Figure 2 are very important.

The components shown on the right side of Figure 2, particularly Outcomes, are frequently the major concern discussed in recent literature on SCC. Writers tend to point to Outcomes that they like—such as widespread access to scientific data—or, dislike—such as children having ready access to pornographic materials without much analysis of how these outcomes came into being. Pointing is not the same as analysis. We use the IAD framework to try to understand how patterns of interaction lead to outcomes, how the variables in an action situation lead to patterns of interaction, and how they all can be evaluated. Thus, while it is useful for some questions to focus in on one or another component of the framework, we will briefly review the entire framework for its relevance to an understanding of SCCs.

The IAD framework may not be able to make the whole "elephant" visible but it may help one see interrelated parts more clearly. Its foundations are drawn from the field of political economy, where understanding the effects of rules and decisions on performance is critical. A methodology such as the IAD framework can help better understand the knowledge gaps as well as the governance issues. The framework allows for the analysis of general knowledge with place and time exigencies (V. Ostrom, 1973). We define institutions as the rules, norms, and behaviors that two or more people use in interacting and making decisions that produce outcomes and consequences.

Physical Conditions

With the distributed nature of scholarly communication, the complexity of the physical characteristics may be daunting. With many natural resources, the physical characteristics can remain constant until the introduction of new technologies. The introduction of new technologies not only changes the nature of the resource, but it also allows the capture of resources that were previously inaccessible.[10]

The new technologies that have made electronic, distributed information possible are also *a part of* the evolving physical conditions of the knowledge commons. The

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[10] Such has been the case with the high seas, Antarctica, the atmosphere, and space. See Ostrom, *Foreword,* in Susan J. Buck, ed. *The Global Commons: An Introduction* (1998): pp. xiii.-xiv.

physical nature ranges from the OSI[11] layers to the buildings that house the books and computers. The knowledge ecosystem of the SCC contains a physical network infrastructure as well as information resources. The physical network infrastructure includes the optical fiber, copper wire switches, routers, host computers, and end-user workstations (Bernbom, 2000). It also includes the amount of bandwidth, free space optics, and wireless systems. Since many aspects of the physical attributes are changing rapidly, rules that fit well with one set of physical attributes may become outdated and even perverse in a relatively short time frame..

Hess and Ostrom (2003) argued the necessity for the distinction between ideas, artifacts, and facilities—all physical aspects of the resource. There are a broad range of idea-types (Samuelson, 2003b: 151). Artifacts are the expressions of the ideas presented in a myriad number of formats, from the traditional paper, binding, microfilm, video, etc., to state-of-the-art computer graphics, text files, holograms, MIDI files videos, searchable databases, and so forth. Facilities could range from the Internet as a whole, to institutional repositories, Library Internet Commons, traditional library buildings. Often, with electronic resources, distinctions can be blurred or overlap. For instance, from one perspective, a digital library could be an artifact; from another, a facility.

Often overlooked as a part of the scholarly communication commons is the computer waste that is generated by scholarly production and use. The pollution from computer waste is yet another factor in the overall sustainability question of electronic information.

Attributes of the Community

Any analysis of the scholarly communication commons needs to examine the community involved. Who, exactly, shares this resource? In most cases today, the community will be comprised of information *users,* information *providers*, and information *decision makers. Providers* are those who make information (the content) available. They are librarians, information technologists, formal and information website holders, self-publishing authors, departments, etc. This community is primarily local. Users are the faculty, students, and staff of the university. They are also the public at

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[11] Open Systems Interconnect.

large, and range from the local to the global. In the distributed information environment, they are often unknown, and not in communication with each other, although information about them can be ascertained. There are also information *decision makers* at every level of the SCC. The decision makers may be setting local standards or global policies. They can be a committee of technologists deciding on e-mail quotas, to librarians choosing which journal packages to buy, members of the Internet Engineering Task Force (IETF) determining a new standard, or the U.S. Congress voting a new law into legislation that will drastically change the future of access to scholarly information. The community within the distributed information ecosystem has exponentially expanded since the days of the library building as the central place of information access.

It is at this level that the values of the community reside. Formerly, academics were unified in their quest for the creation and production of new knowledge even if divided by discipline. Today, there are conflicting values within the academy.

This is also an era of rapid change in the values that individuals who participate in the SC commons pursue. In an earlier and slower world, the community using any of the components of the SC commons frequently did share common values related to the creation of new knowledge, teaching students the knowledge they would need in order to be productive members of a community, a society, and an economy, and providing general information necessary for the sustenance of a democratic society. If these values erode or change dramatically, the resulting physical conditions and action arenas are also strongly affected.

Rules-in-Use

Understanding rules is an important and demanding task. Too often, in environments with rapid technological change, the rules in place are out-of-sync. New rules or laws can be made based on lack of adequate information, awareness, or understanding of the true nature of the issues. Often the rules are hard to "see," as with protocols, standards, and computer code. Even more challenging is the occurrence "technological inversion," where the capabilities of technology contradict traditional missions, values, or even constitutional rights. Legal scholar, Lawrence Lessig, points out that this is what has happened with Copyright Law. Pre-1998 copyright law made clear exceptions in "fair use" and the right of "first sale" for educational purposes. It is not

clear whether the decision-makers who passed the Digital Millennium Copyright Act (DMCA) were uninformed or blinded to the extent of the wide ramifications of this, possibly inadvertent, rule change. With the DMCA, licensed software that restricts the number of copies does not know how to make exceptions for fair use. Circumnavigating the software, even for the sake of fair use, is against the law (Lessig, 2003). None of the statements by witnesses to the Congress discussed this aspect, which has evolved with Digital Rights Management (Russell, 2003). Legal and library scholars are beginning to examine the enforcement of the "new rules" of DRM as a type of private governance (Samuelson, 2003a; Madison, 2000, 2003; Mendelson, 2003).

One of the challenges of understanding how institutions affect action arenas and eventually patterns of interaction and outcomes is that several levels of analysis exist without clear boundaries among them. We have found that it is useful to distinguish three levels of rules—that in turn affect three levels of action arenas—and thus cumulatively affect the patterns of interaction that occur and the outcomes obtained (Kiser and Ostrom, 1982). These are:

(1) *Operational rules*, which directly affect day-to-day decisions made by participants in an operational action arena where actors provide or use scholarly communication. The rules that define who can access the computer system in a public library and who can put scholarly information on that system are operational rules.

(2) *Collective-choice rules,* which affect who is eligible and what voting rules must be used in decisions made about operational rules. Thus, when the director of a library system meets with an advisory council to decide upon new access rules, they are making a collective-choice decision using majority rule or some other collective-choice rule.

(3) *Constitutional-choice rules,* which are the rules used in collective-choice situations (which in turn affect operational situations). Constitutional rules provide the basic rules for who is eligible to use or make decisions about a SCC and the rules that will be used in making those decisions at the collective-choice level.

At each of these levels, one or several arenas may be involved and particular rules may be in use for one arena that are not in use for another arena. If one wants to change the outcomes—discussed below—of an arena, one has to dig into the incentives of the participants and examine which of these can be changed by rules. Trying to link specific rules to specific incentives is sometimes a substantial challenge and requires intensive research as well as experimentation.

In an era of rapid change, participants will move from operational situations into collective-choice situations—sometimes without self-conscious awareness that they have switched arenas. While members of a scientific research project are engaged in discussing an ongoing research project, for example, a member of a team may casually reflect that one of the ways they have been doing things in the past (the reflection of a rule) was not working very well. The staff member may say—"why don't we change our routine and do X next time rather than Y." Sometimes X is simply a jointly agreed upon strategy within a given set of rules. But other times, X is a new rule that may be adopted by the team without ever self-consciously recognizing that they have just made a new rule for themselves! Thus, most governance systems move dynamically over time across levels as changes in the physical environment and in the community produce outcomes that participants find less desirable than other outcomes they perceive to be feasible with a change from Y to X way of operating.

Action Arena

Action arenas are comprised of participants making decisions within a situation affected by exogenous factors of the physical and institutional characteristics that will then result in varying outcomes (Ostrom, 2004: 114-15). Action arenas can occur throughout all levels of the resource. The actions could be the determination of budget allocations in a university library, the U.S. Senate deliberations on copyright laws, or a University Computing director negotiating a large contract with a software company.

A good analysis needs to identify the participants and the specific roles they play within that situation. It must examine what actions are taken and how do those actions affect outcomes. How much control does each participant have and how much information do they have about the situation? Are decisions being made to address short-

term dilemmas or are long-term solutions being sought? What are the possible outcomes and what are the costs and benefits? (see Polski and Ostrom, 1998).

We take, as a hypothetical situation, the establishment of an institutional repository at a large research university (or librarians trying to encourage open access publication). Institutional repositories (IRs) are digital library systems *that capture, store, index, preserve, and redistribute the intellectual output of a university's research faculty in digital format*.[12] Such repositories, usually using open source software, have already been established or are in the process of being developed on many campuses in the U.S.[13] IRs are often heralded as a viable solution to the scholarly communication crisis because they provide open access distribution, capture diverse forms of knowledge and communication, and archive and preserve an institution's scholarly record. This new form of scholarly information collection benefits not only information harvesting and preservation, but it is also hoped that a successful IR will reduce reliance on expensive publishers.

The development of a university-wide repository moves the tasks of knowledge collection, dissemination, and preservation beyond the traditional library's terrain. The IR represents an organizational commitment to the stewardship of the knowledge generated within the university (Lynch, 2003). Participants will include the teaching and research faculty, students, and administrators, as well as librarians, archivists, and information technologists. It may be desirable for the university's legal council to participate as well in the decision-making process.

The initial planning process requires strong leadership, great amounts of energy, and time from *someone*. The impetus for MIT's D-Space (http://dspace.org/index.html) grew from discussions between the director of the libraries and faculty members.[14] The director then became the driving force of the initiative. Kansas University Provost encourages librarians to make sure their university presidents and chief academic officers

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[12] From DSpace website at http://www.dspace.org/index.html
[13] Some of the established repositories that have already been developed are at University of California, Caltech, Hofstra University, Virginia Polytechnic Institute and State University, and MIT. See the SPARC webpage: http://www.arl.org/sparc/core/index.asp?page=m1#usa
[14] See "MIT's DSpace Experience: A Case Study." http://www.dspace.org/implement/case-study.pdf

understand that the scholarly communication, as it stands, is not sustainable. Most importantly, faculty need to "get the message."[15]

Regardless of the origin of the IR initiative, the transaction costs are high. A massive education campaign must be undertaken to inform faculty and administrators of the critical state of scholarly communication. The SCC community must be informed that:

- many of the current trends in the scholarly communication process are not sustainable;
- licensed information is costly and can be impermanent;
- there are numerous threats to fair use, Interlibrary Loan, and access to scientific information;
- open access increases visibility;
- faculty play an active role in the new SC climate; and
- copyright can still remain with the author.

There are more costs. Experience is already showing that it is universally difficult to get compliance from faculty. Steven Harnad (2003b) writes that "It is becoming apparent that our main challenge is not creating institutional repositories, but creating policies and incentives for filling them." Many faculty worry that by depositing their research and teaching products into their university's IR, they will forfeit ownership of their own work. Greater social capital needs to be built and greater levels of trust.

Benefits may be greater than the costs when one considers the joint benefits that can be achieved when individuals share the values of building an available knowledge base that can be used by faculty, researchers, students, librarians, and citizens in all places that are interconnected with modern digital facilities. But participants have to value these benefits for them to take the time and energy required to make this new kind of infrastructure work effectively. New York University President John Sexton points to the "defining premise of the research university: the affirmative integration of knowledge creation and knowledge transmission al all levels in a rich and synthetic engagement, a

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[15] "Key to any success was defining the problem confronting us. It is not 'the library problem' or 'the Provost's problem,' but 'the scholarly communication problem.'" (Shulenburger, 1999).

multilayered immersion in the world of ideas and the growth of knowledge" (Sexton, 2003: 5). Sexton also points to a "disconnect" between the values and the reality of today's research university (ibid.: 6). The changing nature of the faculty community, from tenured faculty to part-time lecturers and independent contractors, can cause deep transformations in the missions, decisions, and outcomes of the university.

Patterns of Interaction

Given a situation with identifiable participants and actions, it is also useful to examine how participants actually behave. Are there free riders, or do most participants responsibly contribute? Are the participants able to gain sufficient information about the structure of the situation, the opportunities they and other participants face, and the costs of diverse action, that they develop increasing trust that the situation helps to generate productive outcomes and in the expected behavior of others? Patterns of interaction can be strongly conflictual, however, especially when there is hyperchange in the community of users, and their values and goals. In addition to conflict, interactions may be simply unfocused and unthinking—a part of a growing "culture of carelessness" (Baron, 2000) where quick-fix solutions take the place of collaborative analytical processes. In the scholarly community, patterns of interaction may be influenced by hierarchies, lack of respect, and distrust that often accompanies the "tribalism" of disciplines (Becher and Trowler, 2001; Thorin, 2003: 13, who discusses the "complexity embedded in the disciplines").

Outcomes

Often, it is easier to apply the framework by starting with the outcome. As with environmental research, the analytical process often begins with the outcomes, especially negative outcomes such as "why is there continual drought in the African Sahel?" or "why are the cod fisheries close to depletion?" Or analysis is motivated by confusing and conflicting outcomes, such as "why is one forest depleted while another ten miles away is thriving?"

With the scholarly communication commons there are a myriad number of competing outcomes—some of which are considered "public bads," while others are seen as public goods (see Figure 3). The conflicting outcomes reflect a highly complex

resource where new technologies have increased capabilities to "harvest" information as a commodity. There are now multiple uses by expanded communities for the same resource—not just scholarship, but entrepreneurship, competition, and financial gain. Because the outcomes are often the result of numerable actions, it is helpful to keep an interdisciplinary frame of mind. The *desired* outcome may be the dissemination and preservation of the scholarly record, but contributing factors in the outcome formula are new computer technologies, financial constraints, university corporatization, declining numbers of tenured faculty, lack of information, and new intellectual property rights legislation.

Figure 3

Selection of OUTCOMES of the Scholarly Communication Commons

PUBLIC BADS	PUBLIC GOODS
Password-protected research libraries (enclosure)	Open access research libraries (access)
Restrictions on ILL through licensing	InterLibrary Loan
Imbalance in collection coverage & services (degradation)	Diverse collections & services ("bibliodiversity")
Licensed journals and databases (high cost, instability)	Owned journals and databases (sustainability)
Libraries' traditional collection budgets cut—Fewer published journals & books available (degradation, less diversity)	Free access online to scholarly journals and articles; PLoS, IRs (expansion of resources)
Costly or privatized information (enclosure)	More free, quality information online (access)
Less-informed citizens (degradation of democracy)	More informed citizens (democracy in action)
Withdrawal of government information (instability, degradation, depletion)	Internet to public schools (access)
Overpatenting (enclosure)	Open Science initiatives (enhanced access/ communication)
DMCA & Digital Rights Management (enclosure)	Fair Use / First Sale (educational access)
Copyright Extension (enclosure, withdrawal)	Self-Archiving Initiative (open access, sustainability)
Spam (pollution)	Scholarly blogs (enhanced communication)
Internet porn (pollution)	Internet2 (enhanced access)
Computer waste (pollution)	More computers (enhanced access)

Evaluating Outcomes

In addition to predicting outcomes, the institutional analyst may also evaluate the outcomes that are being achieved as well as the likely set of outcomes that could be achieved under alternative institutional arrangements. Evaluative criteria are applied to both the outcomes and the interaction among participants that leads to outcomes. While there are many potential evaluative criteria, some of the most frequently used criteria are (1) increasing scientific knowledge; (2) sustainability; (3) conformance to community values; (4) accountability; (5) economic efficiency; (6) equity through fiscal equivalence, and (7) re-distributional equity.

Increasing Scientific Knowledge

One of the core evaluations made of scholarly communications is whether they lead to an increase in the scientific knowledge that has been recorded and made available to other scholars, students, and the public at large. One of the challenges is sorting out claims to knowledge from knowledge. Over time, participants in the SC commons have come to recognize that claims can be naively false or strategically false. Thus, all claims need to be challenged in an open, competitive process that is also fair to new ideas that may be radical but may also contain the germs of entirely new insights that are important for the further development of understanding in a core area of knowledge. Thus, one needs to evaluate the process of reviewing knowledge as well as storing knowledge when one is examining the interactions and outcomes of a repeated set of arenas.

Sustainability

Sustainable systems are those that meet current needs of many individuals involved in producing, deciding and using a SC Commons (e.g., students, faculty, researchers, librarians, administrators, citizens, public officials) without compromising the ability of future generations also to meet their needs. Thus, when evaluating the sustainability of a system, one needs to examine the processes involving interactions among participants and whether they increase the physical, social, and human capital involved or slowly erode that capital. In regard to ecological systems, sustainability has usually meant the maintenance of the capacity of an ecological system to support social and economic systems over time (Berkes, Coding and Folke, 2003: 2). When applied to

SC Commons, one is asking whether these systems can survive themselves over time as well as supporting ecological, social, and economic systems through increased access to relevant information.

Conformance to Community Values

In addition to accountability, one may wish to evaluate the level of social capital fostered by a particular set of institutional arrangements. Are those who are able to cheat and go undetected able to obtain very high payoffs? Are those who keep promises more likely to be rewarded and advanced in their careers? How do those who repeatedly interact within a set of institutional arrangements learn to relate to one another over the long-term?

Accountability

In a democratic polity, officials should be accountable to citizens concerning the development and use of public facilities and natural resources. Without accountability, actors can engage successfully in various strategic behaviors that bring them benefits but put costs on others. Concern for accountability need not conflict with efficiency and equity goals unless efforts to achieve accountability require excessive bureaucratic costs.

Economic Efficiency

Economic efficiency is determined by the magnitude of the change in the flow of net benefits or costs associated with an allocation or reallocation of resources. The concept of efficiency plays a central role in studies estimating the benefits and costs or rates of return to investments, which are often used to determine the economic feasibility or desirability of public policies. When considering alternative institutional arrangements, therefore, it is crucial to consider how revisions in the rules affecting participants will alter behavior and, hence, the allocation of resources.

Equity through Fiscal Equivalence

There are two principal means to assess equity: (1) on the basis of the equality between individuals' contributions to an effort and the benefits they derive and (2) on the basis of differential abilities to pay. The concept of equity that underlies an exchange economy holds that those who benefit from a service should bear the burden of financing

that service. Perceptions of fiscal equivalence or a lack thereof can affect the willingness of individuals to contribute toward the development and maintenance of resource systems.

Re-distributional Equity

Policies that redistribute resources to poorer individuals are of considerable importance. Thus, although efficiency would dictate that scarce resources be used where they produce the greatest net benefit, equity goals may temper this objective, resulting in the provision of facilities that benefit particularly needy groups. This is an example of a type of the digital divide that is becoming more frequent. International scientific collaboration is steadily increasing, but the information divide between the haves and have-nots is also increasing. Should universities from developed countries take a more active role in providing access services with partners in developing countries?[16] On the other hand, re-distributional objectives may conflict with the goal of achieving fiscal equivalence.

Requirements of Adaptive Governance in a Complex System

Researchers who have focused on the governance of natural resources have struggled with the question of why some self-governing systems have survived for many years (some as long as 1,000 years), while others collapse within a few years, or even after a long and successful era. There is no simple answer. One of the core problems that has been documented is that rapid change in the environment and in the community is always a major challenge for any governance system. Over time, scholars have come to a general level of agreement that there are several requirements that somehow need to be met for a governance system to be adaptive and robust over time. These are: providing information, dealing with conflict, inducing rule compliance, providing infrastructure, and being prepared for change (see Dietz, Ostrom, and Stern, 2003). A wide diversity of specific ways of meeting these requirements have been observed. Let us briefly discuss each of these requirements.

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[16] This is the notion of "common but differentiated responsibilities" frequently applied in international law and promoted in the in the World Summit on Sustainable Development, Johannesburg, August, 2002. See: http://www.cisdl.org/pdf/brief_common.pdf.

Providing information. All effective governance systems at multiple levels depend on good, trustworthy information about stocks, flows, and processes within the entities being governed, as well as about the relevant external environment. This information must be matched with the level of aggregation that individuals are using to make decisions. All too often, large flows of data are aggregated. Decisions are, however, frequently made by much smaller units where there is substantial variance from the average reported in the aggregated data. Information must also be fit with decision makers' needs in terms of timing, content, and form of presentation. Informational systems that simultaneously meet high scientific standards and serve ongoing needs of decision makers and users are particularly useful. Information must not overload the capacity of users to assimilate it. Finding ways to measure and monitor the outcomes generated for an Institutional Repository that has substantial impact outside the university is an informational challenge for any governance system.

Dealing with conflict. Sharp differences in power and in values across interested parties make conflict inherent in all choices of any importance. Conflict resolution can be as important a motivation for designing institutions as is the concern with building and maintaining a resource itself. People bring varying perspectives, interests, and fundamental philosophies to problems of the scholarly commons. Conflicts among perspectives and views, if they do not escalate to the point of dysfunction, can spark new understandings and better ways of accomplishing outcomes. The core problem is designing conflict resolution mechanisms that enable participants to air differences and to achieve resolutions that they consider legitimate, fair, and scientifically sound.

Inducing rule compliance. As we have learned, effective governance also requires that whatever rules are adopted that they are generally followed, with reasonable standards for tolerating small variations that always occur due to errors, forgetfulness, and urgent problems. It is generally most effective to impose modest sanctions on first offenders, and gradually increase the severity of sanctions for those who do not learn from their first or second encounter (Ostrom, 1990). The challenge in designing a new governance system is how to use informal strategies for achieving compliance at the beginning that rely on participants' commitment to a new enterprise and the rules they have designed and subtle social sanctions. When a more formal system is developed,

those who are the monitors and those who impose sanctions must be seen as effective and legitimate by participants or rule evasion will overwhelm the governance system.

Providing infrastructure. Infrastructure includes physical and institutional structures and technology. Thus, the infrastructure affects how a commons can be utilized, the extent to which waste can be reduced in resource use, and the degree to which the physical conditions of a resource and the behavior of users can be effectively monitored. Indeed, the ability to choose institutional arrangements depends in part on infrastructure—largely in regard to ways of storing and communicating information. Infrastructure also affects the links between local commons and regional and global systems.

Be prepared for change. Institutions must be designed to allow for adaptation because some current understanding is likely to be wrong, the required scale of organization can shift, and biophysical and social systems change. Fixed rules are likely to fail because they place too much confidence in the current state of knowledge, while systems that guard against the low probability, high consequence possibilities and allow for change may be suboptimal in the short run but prove wiser in the long run. This is a principal lesson of adaptive management research.

Building a New Research Agenda

In order to better understand the deepening complexity and rapid hyperchange of scholarly communication, there need to be new ways of analyzing the resource and its dilemmas. Research focused on scholarly communication and knowledge as a *commons* could be fruitful in many ways.

- It could draw on the rich research literature on natural resources commons over the past 20 years.
- It could bring together international, interdisciplinary scholars, which would help to break through the geographical and "tribal" barriers.
- It could lead the way to new partnerships and build social capital among the disparate community of users.

- It could elucidate the symbiotic connection between technological changes and the creation of the preservation and adaptation of new patterns of choice and interaction among participants (Oakerson, 1978: 80).

- It could shed new insights on long-term directions in scholarly communication.

- It could weave together intricate threads of the entire knowledge ecosystem, such as the national and international digital divide and its effects on democratic processes, open science, and the creation of new knowledge.

- It could bring new focus to the urgency of the dilemmas facing higher education and scholarly communication.

The IAD framework that we have discussed in this paper provides a useful, tested method for analyzing commons dilemmas. We expect that over time, the framework will evolve to better fit with the unique attributes of the knowledge process and a commons.

A close analysis of the SCC in its institutional and historical context points to a number of fundamental and extremely important questions.

- How can the concept of the *commons* and the previous research on natural resource commons assist in understanding the *knowledge commons*?

- Understanding the scholarly communication commons requires in-depth knowledge of the rules-in-use, the commons community, and the physical nature(s) of the resources. Analysis needs to examine how these factors influence subsequent actions and behaviors that lead to sustainable or less-than satisfactory outcomes. The outcomes need to be carefully evaluated on multiple levels.

- How can researchers best follow change in the scholarly communication process over time?

- Do universities still have the responsibility to educate and provide information to the public at large? Democracies require knowledge, communication, and skills.[17] What responsibility does the university have to less-educated citizens?

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[17] Vincent Ostrom (1997: 8-9) writes: "Can we expect democracies to be created and maintained by muddling through devoid of knowledge, skill, and intelligibility? Everything we do requires knowledge, skill, and intelligibility in the use of present means to achieve some future apparent good—what Thomas

- Are universities deviating from their traditional primary mission to create, disseminate, and preserve knowledge?[18] Are the different groups within the university community aware, adequately informed of the questions, and committed to making educated decisions?

- From Duderstadt, Atkins, and Van Houweling (2002: 182): Which values and principles of the university should be reconsidered? "Academic freedom? Openness? A rational spirit of inquiry? Sustaining a community of scholars? A commitment to excellence? Almost certainly. But what about shared governance? Tenure? Are these values to be preserved?"

- What are the most efficient and fruitful ways of making wise decisions in a large, rapidly-changing, diverse university?

- Are the appropriate participants involved in negotiating licensing contracts with publishers? In negotiating sales with large computer companies? Can universities better use their leverage to negotiate partial solutions for computer waste, perhaps with recycling programs?

- Are university administrators and faculty playing an active enough role in the political process of information? There may need to be new institutional arrangements within the university to provide monitoring of SC trends, and representation at local, state, national, and multinational legislative meetings where new laws and rules for information, information technology, and intellectual property rights are being decided.

- A new research agenda would need to bring students and scholars together from multiple disciplines—political science, economics, informatics, law, computer science, anthropology, education, library science, and so forth. There would be no discipline that could not make an important contribution to

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Hobbes meant by the term power. Those conditions always apply in context. There is no universal contextless realm of human activities."

[18] NYU President John Sexton addresses this question: "To aspire to and achieve its own version of change, each university must shape its future through an explicit articulation of mission—an articulation which is, in our time and for each institution, the modern equivalent of what historically has been known as the *ratio studiorum*, a self-reflective statement of purpose and priorities. On this view, universities are in a race not with each other, but with their own distinct vision and ideals, and are called to rethink the scope and reach of how they discover, test, convey and preserve knowledge—applying to their study of institutional self the same principles of continuous, rigorous examination and inquiry that guide academic research and dialogue" (Sexton, 2003: 4).

this area of study. A broad multidisciplinary approach would facilitate analyses of how socioeconomic, demographic, political, and legal factors affect the sustainability of ecological systems.

This type of research requires a broad dissemination of results. Further, each researcher needs to serve as a *translator* to other disciplines, cultures, and professions. They need to communicate their findings clearly to policymakers, the business community, and the less-educated. The university needs to take on the responsibility to support the dissemination process and the enhancement of interdisciplinary studies.

Conclusion

In this paper, we have presented a framework for analysis of the scholarly communication commons. As with the "environment," this knowledge commons holds within it an entire ecosystem that reflects complex interactions between humans and the resources. The focus on the commons brings attention to the self-governing aspects of information resources or *decisions about* those resources. As with all shared resources, management issues can be complex, conflicts can develop, and outcomes are uncertain.

The research agenda we propose brings to the fore the most basic and fundamental questions in society: Is the scholarly communication system, as it is developing, sustainable? Are we making wise and informed decisions as we rapidly change our universities? Do universities have increased or decreased responsibilities to society? Is the relationship between knowledge and democracy still reflected in the academic mission? Are democratic systems, as they are evolving, sustainable over the long run?

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