Stewardship of the Evolving Scholarly Record:

From the Invisible Hand to Conscious Coordination

Brian Lavoie and Constance Malpas

OCLC Research

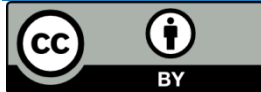# Stewardship of the Evolving Scholarly Record: From the Invisible Hand to Conscious Coordination

Brian Lavoie and Constance Malpas

OCLC Research

June 2015

Please direct correspondence to:
Brian Lavoie
Research Scientist
lavoie@oclc.org

Contents

Acknowledgments

The Weightless Scholarly Record

Former US Federal Reserve Chairman Alan Greenspan once observed that while the value of the US economy has expanded considerably over the years, the sheer weight of its production has not. "The physical weight of our gross domestic product," Greenspan noted, "is evidently only modestly higher today than it was fifty or one hundred years ago".[1]

This curious remark acknowledges a deep change in the nature of US economic activity, involving a shift away from manufacturing and other forms of physical production, and toward the production of intangible assets and services. Digital and network technologies have played a leading role in this transition: ". . . [D]oubtless it has been the advent in recent decades of the synergies of the microprocessor, lasers, and fiber optics that has fostered a distinct quickening in the displacement of physical weight of output with concepts," Greenspan remarked.[2]

The trend toward a weightless American GDP is a useful frame for thinking about the evolution of the scholarly record and higher education's role in its long-term stewardship. Just as digital technologies are lightening economic production, so too are they reducing the physical weight of intellectual production. The scholarly record—the aggregation of books, journals, and other information resources that document and perpetuate the results of scholarly inquiry—increasingly exists as weightless bits on digital networks, rather than collections of print materials occupying physical space in academic libraries.

Like US economic production, growth in the physical weight of the scholarly record may be slowing but its value continues to grow apace, both from the accretion of new scholarly outputs, as well as the ongoing availability of previous work to researchers and learners. Consequently, the long-term stewardship of the scholarly record in its fullest expression is a matter of special interest to higher education institutions, whose faculty and students are both producers and consumers of scholarly materials. Academic libraries have traditionally played the leading role in gathering, organizing, and preserving the scholarly record, but have done so in a largely uncoordinated way. Much as Adam Smith described an invisible hand leading private economic interests toward a socially beneficial outcome, the efforts of individual academic libraries to develop and maintain local collections for local use have led to the formation, maintenance, and long-term preservation of a scholarly record available for use both by today's scholars and future generations.

While the invisible hand has worked quite well as a means of distributing and coordinating stewardship responsibilities attached to a largely *print* scholarly record, its effectiveness is diminishing in an era where the scholarly record is evolving into a digital, networked form. As a result, *conscious coordination* is likely to replace the invisible hand as the key principle underpinning stewardship models for the scholarly record, with local decisions taken in the context of broader system-wide conditions; more explicit collecting and curation responsibilities within collaborative arrangements; a greater degree of specialization in collecting activities; and deeper, more robust resource-sharing mechanisms. This in turn will lead to more interdependence across higher education institutions and other organizations in regard to gathering, making available, and preserving the scholarly record in its fullest expression. An evolving scholarly record implies evolving stewardship models for the scholarly record. Strategies designed to support the stewardship of print materials will no longer suit the "weightless" scholarly record now coalescing in digital, networked spaces.

The Evolving Scholarly Record

The scholarly record evolves in concert with changes in scholarly practice and communication. Today, the pace of this evolutionary process is remarkably swift, with the nature and scope of the scholarly record shifting dramatically in the last several decades. The transition from print to digital is a central feature of the scholarly record's transformation, but the full extent of the change runs much deeper. The boundaries of the scholarly record are in flux, as they stretch to extend over an ever-expanding range of materials.

The term *scholarly record* evokes familiar images of text-based print materials like journal articles and books, and indeed, these are still important components of the scholarly record today. Yet contemporary documentation of scholarly inquiry is evolving to encompass far more. Rather than attempt to enumerate the many specific types of materials around which interest and effort is coalescing to make them part of the permanent scholarly record, we can instead retreat to a "ten thousand foot view" by moving up a few layers of abstraction and thinking of the broad *categories* of materials that are or potentially could be gathered and curated as part of the scholarly record (See figure 1).[3]

Figure 1. The Evolving Scholarly Record

Published outcomes from scholarly inquiry, such as journal articles or monographs, are still the coin of the realm for academic contribution and discourse, and are therefore placed at the center of figure 1. But in addition to these traditional outputs, the scholarly record potentially includes other categories of material as well. Three of these categories belong to the *process phase* of scholarly inquiry—the activities leading up to the final published outcome. The *Method* category includes materials relating to the methodologies and tools used to produce the results of a particular research activity (e.g., computer programs, experimental protocols, survey instruments). The *Evidence* category includes materials that represent the "raw inputs" from which the findings reported in the published outcome are derived (e.g., data sets, survey responses, literature reviews). The *Discussion* category includes materials generated from scholars' interactions with others that serve to sharpen and refine the ideas and findings reported in the published outcome (e.g., blog commentary, discussion lists, preprints).

When a published outcome is made available, activities around this piece of work continue in the *aftermath phase* of scholarly work. These activities in turn generate several categories of material that could become part of the scholarly record. As with the process phase, the aftermath phase includes a *Discussion* category that includes materials produced from discourse taking place around the published outcome—often through the same channels noted in the process phase, as well as formal post-publication reviews and commentary. The *Revision* category includes materials that enhance, correct, or clarify

the published outcome (e.g., additional findings, supplementary data, *errata*). Finally, the *Re-use* category includes materials representing "re-packaged" or edited versions of the published outcome intended for new venues or audiences (e.g., conference presentations, summaries, versions for non-specialist audiences).

Efforts to collect and curate print scholarly materials were mainly focused on the published outcomes depicted at the center of figure 1. In contrast, today's digital, networked scholarly record is expanding to include materials residing in the outlying parts of the figure—that is, materials generated during the process and aftermath phases of scholarly inquiry. This suggests that the scholarly record is evolving to incorporate a deep contextual layer around traditional published outcomes and their equivalents. The result is a scholarly record that is a much more complete documentation of scholarly inquiry than what we have historically retained.

Key Characteristics of the Evolving Scholarly Record

Transmission of the fruits of scholarly inquiry from one generation to the next requires careful stewardship of the scholarly record. For the purposes of this paper, *stewardship* is taken to mean a collection of processes that systematically collect, organize, make available, and preserve information resources. Three characteristics of the evolving scholarly record represented in figure 1 are particularly important in thinking about feasible approaches to stewardship:

Increasing Volume of Content

The volume of materials eligible for inclusion in the scholarly record has surged, driven in no small part by the relative ease with which digital materials can be created and distributed. A wide variety of tools, platforms, and services are available to support rapid publication, and in some cases, self-publication, of scholarly outputs in digital form. Often these materials are published or otherwise made available through channels that bypass formal publication venues with their attendant (and relatively slow) peer review and editorial processes, further reducing the barriers to making scholarly outputs available for use and therefore potentially part of the scholarly record.

Another factor accelerating growth in the size of the scholarly record is its simultaneous expansion both vertically and horizontally. Vertical growth in the scholarly record occurs through the accretion of new research results—in other words, the published outcomes represented in the center of figure 1. While vertical growth has traditionally been the chief driver in the scholarly record's expansion, it is increasingly supplemented by horizontal growth: an expansion in the quantity of materials a given research activity contributes to the scholarly record. Research projects yield not only published outcomes like journal articles or monographs, but also a host of ancillary materials represented by the outlying components of figure 1. More and more effort is now directed toward incorporating these materials into the permanent scholarly record. So while previously a journal article might be a research activity's sole output that is collected and curated, today the article might be accompanied into the scholarly record by a data set and software.

The output of digital scholarly works is rapidly expanding, but the traditional print scholarly record continues to grow as well. Print books and journals are still being published, and libraries still add them to their collections. In this sense, academic libraries inhabit two worlds—traditional print and emerging digital—as they continue in their mission to gather and provide access to an ever-growing scholarly record.

Increasing Diversity and Complexity of Content

In addition to quickening growth in sheer size, the scholarly record is also experiencing an expansion in the range of content types and formats it encompasses, moving well beyond the familiar forms associated with printed documentation of scholarly activity. This increased diversity is found both in published outcomes, where the text and static images forming conventional modes of scholarly communication are increasingly joined by video, interactive programs, and complex visualizations, and in the ancillary materials generated in the process and aftermath phases of scholarly activity, such as data sets, software, blogs, and conference presentations.

Greater diversity in the materials comprising the scholarly record also introduces greater complexity—in two senses. First, technical complexity is greater. Scholarly outputs are transitioning to digital form, but "digital" is not monolithic: it encompasses a wide range of formats, some well-known and others more obscure. Moreover, digital materials reside in specialized systems and storage infrastructure, and often require special applications for access and use—all of which can vary from content type to content type, from format to format. Second, structural complexity is greater. The components of a particular scholarly work—i.e., a published outcome and its ancillary materials—can be scattered across the various categories depicted in figure 1. Each of these components may reside at a different location on the network. While this creates a rich, multi-faceted scholarly work, identifying and establishing relationships across all of these objects can be challenging.

Increasing Distribution of Custodial Responsibility

As the scholarly record grows in volume, diversity, and complexity, it is also becoming increasingly scattered over the network. Important segments of the scholarly record still reside within the familiar confines of *in situ* academic library collections—chiefly print materials—but many other pieces of the scholarly record reside elsewhere: on publishers' servers, on proprietary social media platforms, in subject-based data repositories, and so on. An important reason for this dispersal of custody is the expansion of publication and communication channels through which scholarly materials can be created and made available; many materials remain in and are accessed through the environment in which they are created. This dramatically expands the number of organizations currently holding custodial responsibilities over portions of the scholarly record. Some of these organizations may count long-term stewardship as part of their mission; many do not. The scholarly outputs produced today are in many hands, forming a broad network of custodial responsibility that extends far beyond libraries, archives, and the rest of the cultural heritage community.

Dispersal of custody may be amplified by the growing technical complexity of scholarly materials mentioned above. This complexity widens the distribution of stewardship

through increased specialization. The shift from print to digital has made the scholarly record much more heterogeneous in its content, with the result that the infrastructure and expertise needed to steward these materials has become correspondingly more heterogeneous as well. Specialized curation skills are needed for different kinds of content, coupled with potentially distinct storage, maintenance, and access technologies. The ability of any single institution to consolidate and deploy the range of capacities and expertise necessary to steward the scholarly record in its full diversity of expression is questionable. As a practical matter, rather than trying to concentrate a diverse slice of the scholarly record at one location, it may be more feasible to concentrate a particular expertise and infrastructure at one location and leverage it over scale—i.e., over high volumes of a particular type of material. This could increase the number of organizations engaged in stewardship activities, through a proliferation of "stewardship specialties", differentiated on the basis of technical capacities and perhaps further divided along subject or disciplinary lines. Again, this expansion of custodial responsibilities would extend beyond traditional collecting institutions.

Dispersal of custody may also be intensified by libraries' selection decisions. Selection of materials for stewardship from the range of emerging scholarly products represented in the outlying components of figure 1 will be influenced by a variety of factors, including the existence of appropriate stewardship capacity/expertise, perceived potential for re-use, and the availability of metadata of sufficient quality to support discovery and other services. Given these and other considerations, many scholarly products will not, at least in the near-term, be collected by libraries. In these circumstances, various materials represented in figure 1, if they are retained at all, will reside in a plethora of information management tools, services, and infrastructure spread out across the network. Many of these custodians have only recently emerged, and their long-term future, as well as that of the information objects they manage, are far from assured. Often, these services deal directly with individual scholars, without institutional mediation; therefore, even in the event that a library should wish to collect these materials, it may be difficult to locate and gather them across the wide range of services in which they might reside.

A rapidly expanding, more diverse and complex scholarly record widely distributed over numerous custodians across the network suggests that local versions of the scholarly record residing in academic library collections are becoming less and less complete, in the sense of approximating the full universe of scholarly materials. The portion of the scholarly record that a single institution can hope to collect, store, and offer locally is getting smaller and smaller. Of course, no academic library would claim that its collections ever covered the full extent of the scholarly record, which is and always has been a practical impossibility. But the rapid pace at which the scholarly record is evolving today has severely diminished the ability of even the most well-resourced institutions to gather and make available a reasonable approximation of the scholarly record in its fullest expression—or even to fully represent the research output of their own faculty and students.

In short, the features of the evolving scholarly record suggest that autonomous, institution-scale stewardship of the scholarly record is becoming less and less feasible: the volume of materials is too high, the cost of building local stewardship infrastructure and expertise is prohibitive, and much of what potentially constitutes the scholarly record (as represented in figure 1) is widely scattered across many custodial hands, and cannot in any realistic sense be gathered and physically located or duplicated at a single institution. This observation is a useful jumping-off point for thinking about how stewardship models will evolve in concert with the scholarly record itself.

Evolving Stewardship Models

Stewardship of the scholarly record has historically been the byproduct of an uncoordinated, highly distributed, and to some degree, duplicative process of managing local print collections. At a time when the scholarly record consisted largely of printed texts such as books and journals, faculty and students' primary access point to the scholarly record was the assembly of physical materials housed in their local academic library—supplemented, to some extent, by inter-institutional resource sharing networks. In light of this, libraries needed to ensure that their collections offered a reasonable approximation of the full scholarly record, with the degree of approximation varying according to institutional need and available resources.

In these circumstances, academic libraries for the most part managed their collections as autonomous units, without much attention to broader system-wide conditions. For example, the collecting activities of a particular library were generally not altered appreciably by the knowledge that other (possibly nearby) libraries were collecting the same materials; each library needed to make these materials physically available on campus. This practice mirrored a broader pattern in higher education, in which universities operated as relatively autonomous units providing a range of services to their affiliated faculty and students. The library was one of these services, and part of the overall educational offering. Given this, it made little difference if similar library services were offered at other universities. Scholars expected to access the largely print scholarly record locally, and so print collections were assembled and managed locally.

In this traditional model of stewardship, local collections of print materials were preserved for ongoing local use. Each library took steps to ensure the continued availability of its own collections. Some of these materials were relatively rare—or perhaps even unique—within the library system as a whole; others were duplicated quite widely in other libraries' collections. But the key point is that the relative scarcity or redundancy of locally-held materials *vis-à-vis* the holdings of other academic libraries had little impact on local collection management.

Despite the lack of deliberate coordination, individual libraries nonetheless contributed to a broader, collective effort to secure the permanent scholarly record. The totality of individual efforts to steward local collections for local use meant that the aggregate library resource—the collective collection of libraries everywhere—represented a relatively complete version of the scholarly record. If one academic library lacked a particular publication in its collection, another library (or several libraries) was bound to have it,

and duplicative investment in common materials produced a beneficial layer of redundancy within the system as a whole. In this way, the scholarly record, while not available *in toto* at any single academic library, nevertheless was stewarded in its entirety through the uncoordinated, collective efforts of all libraries. To borrow from Adam Smith, self-interested (i.e., locally-focused) collecting and retention decision-making was directed as if by an invisible hand to produce a social benefit shared by all: stewardship of a scholarly record that approximated the sum total of published scholarly work, and that transcended the collection of any single institution.

Stewardship of the extant, print-centric scholarly record has therefore been achieved through an uncoordinated process of local acquisition and retention. But as we have seen, the scholarly record can no longer be considered print-centric. The growing volume, diversity, and complexity of digital scholarly outputs means that assembling a reasonable approximation of the scholarly record at the local level is no longer a feasible proposition. But the implications go further: the nature of the evolving scholarly record suggests that even the collective efforts of the library system as a whole will not be sufficient to gather and curate it. In short, the scholarly record in its fullest expression will not be adequately approximated even in the aggregate library resource.

The reason is simply that libraries are not collecting—and nor is it feasible for them to do so—the full range of materials represented in figure 1. Now that scholars are taking a much more expansive view of what the scholarly record should contain, the traditional, uncoordinated "invisible hand" stewardship model that worked effectively for print materials begins to break down. Consequently, academic libraries can no longer assemble a representative slice of the scholarly record in their local collections, and then rely on the collective efforts of other libraries to fill the gaps in the rest of the scholarly record. We noted earlier that the portion of the scholarly record that a single institution can reasonably hope to collect, manage, and make available locally is shrinking. This assertion can be extended further: given the directions in which the scholarly record is evolving—in particular, its transition to a digital, networked form—the portion of the scholarly record that libraries can *collectively* capture and make available is also diminishing.

In light of this, academic libraries must develop new stewardship models that incorporate deeper cross-organizational dependencies within ever-widening networks of collaboration. Stewardship of the scholarly record will become an enterprise guided not by the invisible hand, but by conscious coordination. We define *conscious coordination* as a strategy of deliberate engagement with—and growing dependence on—cooperative agreements, characterized by increased reliance on network intelligence (e.g., domain models, identifiers, ontologies, metadata) and global data networks. Stewardship strategies based on conscious coordination involve an acceleration of an already perceptible transition away from relatively autonomous local collections to ones built on networks of cooperation across many organizations, within and outside the traditional cultural heritage community. In such an environment, providing local access to the scholarly record becomes less about accumulating large, representative local collections, and more about enabling access to scholarly resources distributed across the network.[4]

Four salient features distinguish stewardship arrangements designed around the principle of conscious coordination:

- Local decisions about stewardship are taken with a ***broader awareness*** of the system-wide stewardship context—who is collecting what, what commitments have been made elsewhere in terms of stewarding various portions of the scholarly record, and how the local collection fits into the broader system-wide stewardship effort. This consciousness of a broader stewardship context can simply inform local stewardship decisions, independent of any formal collaborations with other institutions: in this case, "conscious" implies taking the initiative to preserve something, knowing that no one else has done so, or conversely, deciding *not* to preserve something, knowing that someone else *has* done so. However, in many cases, this will lead to . . .

- . . . declarations of ***explicit commitments*** around portions of the local collection. Collecting institutions acknowledge, accept, and undertake to fulfill explicit responsibilities in regard to collecting, curating, and making available certain types of materials. Fulfillment of these responsibilities is seen as a commitment not only to local faculty and students, but also to a broader external stakeholder community, leading to the emergence of a . . .

- . . . ***formal division of labor*** within cooperative arrangements. Rather than attempting to collect some of everything for local access, greater emphasis will be placed on specialization in collection building. In short, collecting institutions will seek to *collect more of less*: investing more intensively in a narrower range of materials. This will occur in the context of a broader, cross-institutional cooperative arrangement in which different institutions specialize in collecting, curating, and making available different portions of the scholarly record. The resulting division of labor of the stewardship burden would be underpinned by the explicit commitments mentioned above, which would in turn form the backbone of . . .

- . . . trusted, reliable ***networks for reciprocal access***. Stewardship strategies characterized by a greater degree of specialization in collecting activity must be accompanied by robust resource sharing arrangements that ensure relatively frictionless access to all parts of the collective collection. These trust networks provide mutual assurance that materials collected by one institution will be made available to other partners, and vice versa. Such assurances lead to a fundamental shift in the motivations for stewardship: traditionally, institutions primarily collected locally for local access; in a stewardship model characterized by conscious coordination, they will collect locally for a stakeholder community scaled "above the institution"—and possibly for the global scholarly community at large.

Conscious coordination as a stewardship strategy represents an important departure from previous practice, and aligns with key trends in the evolution of the scholarly record itself. As we have seen, powerful centrifugal forces are at work within the scholarly record, with growing fragmentation of scholarly materials over a widening distribution of locations across the network. Even as the scholarly record becomes larger, more diverse, and more distributed, faculty, students, and other users will continue to expect access to it in its entirety. Conscious coordination involves a shift from the traditional approach of assembling a locally held approximation of the scholarly record, to one that creates a *virtual* approximation, drawn together and made available through inter-institutional networks of stewardship and access. Of course, academic libraries already do this to some degree, as evidenced by traditional inter-library loan networks. But conscious coordination is distinguished by, among other things, a greater intensity of coordination across institutions, as well as a greater diversification of participants in stewardship networks, including publishers, repositories, social networking services, and infrastructure providers.

Conscious Coordination: Emerging Examples

The reconfiguration of library stewardship roles for both the extant and emerging scholarly record are shaped by broader changes in the higher education landscape. Brad Wheeler and Shelton Waggener have explored the trend toward "above campus" sourcing of IT services in higher education, noting a general shift toward adoption of group-scale solutions.[5] Collaborative and commercial sourcing models are increasingly the norm across a broad range of university business functions, from enterprise content management systems to courseware and learning analytics platforms. A recent survey of university Chief Information Officers (CIOs) confirms this trend, with 54 percent of respondents reporting that collaborative solutions/shared services are key to stretching limited IT budgets, and 70 percent reporting increased reliance on cloud computing.[6] The move toward a more consciously coordinated approach to stewardship is aided by this broader adoption of above-the-institution solutions.

Stewardship models for the evolving scholarly record are already in transition. We now turn to some examples of how the four salient features of consciously-coordinated stewardship models discussed in the previous section are shaping this transition.

Broader Awareness of System-wide Context

In the network environment, "right-scaling" stewardship requires increased attention to the context in which local preservation investments are situated. There is a greater need for evidence and data-driven decision support. Consider, for example, the attention that HathiTrust gives to measuring and monitoring the overlap between member libraries' print collections and the digital surrogates managed in the HathiTrust shared repository.[7] These overlap measures are a key component of HathiTrust's cost model, which posits that institutional capacity to benefit from partnership correlates with collection overlap.[8] Accordingly, HathiTrust partners place great value on understanding how their collections compare to the growing digital aggregation: it has become part of the context against which local decisions about print preservation are made.[9] The importance of an informed view of the larger landscape is also reflected in institutional planning documents. In its Strategic Initiatives Plan for FY12-FY14, the University of Illinois at Urbana-Champaign Library makes explicit reference to its role as an "informed steward" of scholarly resources and its increased reliance on evidence and data to shape institutional investment, including an initiative to grow the university's collection of "materials scarcely-held among research libraries."[10]

The growing need for context-aware decision support is also reflected in the evolution of collection management tools to support group-scale stewardship. In the United Kingdom, COPAC is developing a suite of tools to assist university libraries in identifying rare and unique resources so that local and collective preservation investments (and library withdrawal decisions) can be better informed.[11] The Western Regional Storage Trust (WEST) initiative in the US provides members with collection analysis services to support distributed archiving efforts.[12] In 2015, OCLC acquired Sustainable Collection Services, to increase its capacity to support data-driven collection management, acknowledging a gradual shift away from institution-scale stewardship toward group-scale arrangements.[13]

As these examples suggest, broader awareness of system-wide context may be especially important for traditional forms of scholarly works such as print books and journals (and their digitized surrogates)—materials that would be classified in the Outcomes component of figure 1. A long record of local collecting activity for these materials exists for most institutions, and therefore it is in this area that the greatest near-term potential might be found for reducing unneeded redundancy through cooperation at scales above the institution—as evidenced by the growing interest in shared print programs.

Explicit Commitments

Conscious coordination of stewardship relies on explicit declarations of responsibility (or intent) to preserve different classes of material or component parts of the distributed scholarly record. During the 1980s, when many university libraries were engaged in cooperative preservation micro-filming projects, standards were developed to support the registration of local preservation actions in group catalogs using designated fields in the MARC bibliographic record.[14] This practice enabled the coordination of large-scale cooperative preservation projects, including a long-running NEH-funded project to microfilm brittle books in US libraries.[15] Twenty years later, these standards were adapted and extended to support digital reformatting projects, so that libraries could record and share information about "preservation master copies" in their collections.[16] This practice is now used by libraries to report print archiving commitments; indeed, the Western Regional Storage Trust guidelines require that participating libraries disclose their preservation commitments for print journal back-files in local and shared catalogs.[17] The Print Archives Preservation Registry (PAPR), jointly developed by the Center for Research Libraries and the California Digital Library, provides a knowledge base of more than ten thousand journal titles from about 30 print archiving programs.[18] In 2014, the Maine Shared Collections program became the first group to register print archiving commitments for books in OCLC's global bibliographic database WorldCat, and has recorded more than a million and half commitments to date.[19] Explicit preservation commitments are also essential in the UK Research Reserve, a cooperative print archiving program that relies on a centralized register of retained holdings.[20]

As these examples suggest, cooperative stewardship of the traditional core of the scholarly record—books and articles—has been aided by the development of standards and

infrastructure to support the systematic disclosure of explicit preservation commitments. Standard practices for claiming a stewardship interest in materials associated with emerging portions of the scholarly record (the outlying components of figure 1) are less well developed. Recent policy mandates by funders that require documentation of research data management plans have begun to stimulate interest in best practices for disclosing data retention and access rules. Compliance with funder rules is a powerful motivator for institutions to standardize documentation. The University of California system has spearheaded an effort to develop standard templates for data management plans in an effort to help faculty and researchers meet funder requirements; more than a hundred institutions have signed on as partners to support further development of the Data Management Planning Tool (DMPT).[21] A parallel effort in the UK is managed by the Digital Curation Center.[22]

While a long-term preservation strategy is generally acknowledged to be a vital component of research data management plans, institutional compliance concerns have thus far centered on access rather than archiving. This is partly due to growing acceptance that faculty and researchers are more inclined to rely on disciplinary infrastructure (including data repositories) than institution-scale solutions. Thus, many universities provide routine guidance on identifying external disciplinary repositories for long-term preservation of research data sets. The degree to which these repositories disclose retention commitments varies significantly, however.[23] It is noteworthy that the metadata schema for the international Registry of Research Data Repositories supports the explicit disclosure of institutional responsibility, including the term and nature of that claim, but in practice it is rare to find detailed information regarding preservation commitments offered by individual repositories.[24]

Formal Division of Labor

A byproduct of the emergence of more formalized claims of responsibility to different parts of the scholarly record is an increasing specialization of institution- and group-scale stewardship. This trend is apparent in shared print management programs that specialize in preservation of books and journals from particular publishers or platforms (JSTOR print back-files or IEEE e-journals, for example), or organize archiving efforts around specific disciplinary interests (e.g., LegalPAPR, MedPrint or Cornell University's long-running Core Historical Literature of Agriculture project).[25] It is equally evident in thematic web-archiving programs, such as the Contemporary Composers Web Archive (CCWA) or the Latin America Web Archiving Project (LAWAP), in which multiple organizations collaborate to preserve web-based publications related to specialized disciplinary interests.[26]

The growth of disciplinary data repositories provide further evidence of specialization in stewardship of the scholarly record. There are reportedly more than a thousand disciplinary data repositories in operation today.[27] Beyond specialization by discipline, publisher, or material format, one can also point to examples of innovative "market

segmentation" that result in increasingly specialized business models for stewardship. The data repository Dryad focuses not just on research data in the life sciences, but exclusively on datasets associated with formally published journal articles. It thus represents an extension of the traditional scholarly communications environment. By contrast, Zenodo, a multi-disciplinary and multi-format repository, has positioned itself as a discovery and preservation platform for "multidisciplinary research results (data and publications) that are not part of the existing institutional or subject-based repositories."[28] It functions in part as a rescue repository for content that does not fit elsewhere, and in part as a publication vehicle for new scholarly work products—what Zenodo refers to as the "'long tail' of research results." Figshare, a repository service for a wide range of digital research outputs, has likewise carved out a specialized niche supporting both commercial publishers and individual researchers in the dissemination of data sets, data visualizations, and other research results that cannot be easily accommodated in traditional publishing platforms. In addition to authors and publishers, Figshare also supports universities (usually through their libraries) by enabling the deposit of content into local institutional repositories, supporting vital research management functions.[29]

Other examples can be found of stewardship efforts aimed at specific portions of the evolving scholarly record. The arXiv e-print repository specializes in the stewardship of more than a million e-prints of scholarly articles in physics, mathematics, and other sciences.[30] F1000 Posters is a permanent repository for conference posters and presentations.[31] Each of these services specializes in stewardship of a circumscribed portion of the scholarly record, defined on the basis of material type (e-prints, posters/presentations). The specialization evident across these services also suggests the kinds of cooperative networks that will be needed if the scholarly record in its fullest expression is to be collected, preserved, and accessed. One can imagine an article in quantitative biology published in a Wiley journal, the data for which resides in Dryad; the e-print in arXiv; and the conference poster in F1000. All of these materials may be considered part of the scholarly record, but no single institution will collect them all. Instead, access is achieved through a coordination of stewardship roles in which the scholarly record is decomposed into discrete, interrelated units that organizations specialize in collecting, preserving, and making available. Stewardship of a growing range of materials is made feasible as specialization creates opportunities to leverage economies of scale.

We also see examples of what might be termed "micro-specialization"—institutions undertaking stewardship of small portions of the scholarly record—even individual resources—in order to ensure they remain persistently available. For example, The University of Texas Libraries recently agreed to collect and archive the Savage Minds blog, an online anthropology resource—implicitly certifying its importance as part of the scholarly record.[32]

The trend toward specialization presents attractive opportunities for research institutions interested in elevating their reputation as a "center of excellence" in specific domains.[33] A recent study underwritten by the Andrew W. Mellon Foundation examined whether the

center of excellence model that has found favor in academic and industrial settings might be applied to the organization of library collections and services (including digital preservation). The researchers concluded that collaborative structures are needed to support interdependent "networks of excellence" focused on shared areas of expertise and institutional capacity. In other words, a formal division of labor that aligns with institutional research priorities is vital to the success—and sustainability—of a distributed enterprise, whether its focus is on supporting the information needs of researchers in a given domain, or ensuring long-term preservation of the scholarly record.[34]

Networks for Reciprocal Access

With increased specialization and diffusion of stewardship responsibility comes a need for more robust distributed access arrangements. Beyond the relatively loose arrangements that prevail in traditional interlibrary loan operations, new partnerships and increasingly formal Service Level Agreements will be needed to support the flow of information resources that are less widely duplicated in the network as a consequence of growing specialization. The last few years have seen a proliferation of direct consortial borrowing arrangements that support unmediated patron access to the collections of geographically distant institutions, often with guaranteed delivery windows. Borrow Direct, for example, is one frequently cited example of a "high performing" arrangement linking the collections of 11 major US research universities.[35] The longstanding OhioLINK resource sharing network, which comprises more than 90 academic institutions in Ohio, is another.[36] The increasing professionalization of resource sharing partnerships (including the creation of new "collection strategist" positions) is a clear sign that institutional expectations about the efficiency and total yield on partnership arrangements are a subject of growing focus.[37]

Beyond optimizing the flow of print materials – increasingly necessary as physical inventory is reduced in favor of licensed content with greater restrictions—there is growing attention to reciprocal access networks for research results associated with the process and aftermath of scholarly communication. The recent SHared Access to Research Ecosystem (SHARE) initiative, led by a coalition of leading higher education organizations, is evidence that universities recognize the need for an above-the-institution strategy for managing research outputs. Importantly, SHARE acknowledges that other stakeholders—commercial and non-profit publishers, scholarly societies, providers of research information management systems and services—have a vital role to play in developing the federated infrastructure that is needed to support the production, dissemination and preservation of the scholarly record.[38] Like HathiTrust, SHARE aims to provide the coordination capacity needed to support a distributed stewardship enterprise.

Designing Consciously-coordinated Stewardship Strategies: Some Considerations

Managing the trends shaping stewardship strategies for the scholarly record will involve context-specific choices leading to context-specific solutions. In this section, we consider some of the key issues and decision points that arise in developing concrete strategies for stewardship of the scholarly record, with a focus on three areas: right-scaling, transaction costs, and institutional identity in a consciously coordinated stewardship environment. Our discussion is aimed primarily at senior decision-makers in information technology and library administration.

Right-scaling

Right-scaling involves organizing activities at a scale that maximizes impact and benefit and/or reduces overall cost, within the context of stated objectives. As stewardship of the scholarly record evolves toward a consciously-coordinated model, stewardship responsibilities will become increasingly shared and integrated, with individual institutions (or groups of institutions) making specialized contributions to the collective effort, but relying on external partners or providers for access to the full range of scholarly outputs. The common theme across all consciously-coordinated stewardship models is the elevation of stewardship activities above the institution; however, the details of implementation will differ from context to context. Right-scaling is an important and multi-faceted element in the design of any stewardship model built on the principle of conscious coordination. In this section, we discuss three aspects of right-scaling stewardship activities: right-scaling the scale of consolidation, right-scaling the scale of cooperation, and right-scaling the diversity of partners.

Conscious coordination can take a variety of forms: a pooling of highly distributed local stewardship efforts, a shared collection residing in centralized infrastructure, or a hybrid model incorporating both distributed and centralized components. A key decision point in designing a consciously-coordinated stewardship strategy is locating the appropriate balance between investing in local collections, infrastructure, and services (which are then integrated into a broader network of distributed yet coordinated stewardship efforts) and consolidating collections, infrastructure, and services into a centralized, shared activity. In cases where stewardship strategies favor a consolidated approach, further choices must be considered: should the centralized stewardship activity be organized as a collaborative effort among a group of organizations, or should it be entrusted to an independent third-party provider that supplies stewardship-as-a-service on a contractual basis? In short, a key aspect of right-scaling stewardship activities involves optimizing the

scale of consolidation—i.e., determining whether stewardship should be organized as a coordinated network of distributed, local-scale stewardship efforts, or consolidated into a centralized activity at scales above the capacity of a single institution.

Current initiatives aimed at stewarding various portions of the scholarly record reflect different approaches to right-scaling consolidation. The United Kingdom Research Reserve (UKRR)[39] is a "collaborative and coordinated" distributed arrangement within UK higher education aimed at achieving more efficient management of low-use print journals. Participating universities manage materials locally, but reduce duplication (and release valuable shelf space) by coordinating local retention decisions across the network. In contrast, HathiTrust is a partnership among academic and research institutions that consolidates digital curation infrastructure and services within a single organization, resulting in a shared collection of curated digitized book and journal content that is "available to all to the extent permitted by law and contracts."[40] Figshare also consolidates stewardship infrastructure and services, in the form of an on-demand curation and access platform; however, in contrast to HathiTrust, Figshare is a commercial entity independent of the individuals and institutions it serves. All of these examples involve stewardship activities elevated above the institution—but they do so through different approaches to right-scaling consolidation.

As we have seen, the nature of the evolving scholarly record creates opportunities for institutions to act collectively in order to meet shared goals. Cooperative print management efforts, such as the Research Collections and Preservation Consortium (ReCAP), are an example of a portion of the scholarly record (print journals and books) that was traditionally managed relatively autonomously at the local level, but is now increasingly moving above the institution for coordinated stewardship. Another example is HathiTrust, which offers digital curation capacity at scale. In both cases, universities have come together to solve specific problems (sustaining the legacy print investment, sustainable curation of digital materials) by working out consciously-coordinated solutions above the institution, rather than relying on individual institutions acting locally and autonomously.

These examples illustrate that cooperation can be implemented at a variety of scales. ReCAP[41] is a collaboration among three institutions (Columbia University, Princeton University, and the New York Public Library); in contrast, HathiTrust was initially developed to serve the needs of the CIC academic consortium and the University of California system (about twenty-five institutions in all). The difference in scales across these stewardship initiatives serves to emphasize an important point: right-scaling is not just about sourcing activities either locally or above the institution; it is also about right-scaling the scale of cooperation—in other words, calibrating the extent of cooperative partnerships to the needs and circumstances of a particular stewardship context. The scale of cooperation—whether a small group of institutions, a consortium, a region, a nation, or the world—must be adapted to the circumstances of the activity and its overall objectives.

In many instances, stewardship collaborations are initiated within existing cooperative arrangements, where trust networks are already strong—for example, many shared print initiatives are organized within existing academic consortia. However, there is evidence that benefits could potentially be obtained from expanding both the scope (geographical extent) and the depth (types of libraries) included in the arrangement.[42] While there are natural advantages to working within long-standing, familiar partnerships, institutions must also be alert to opportunities to work "above the consortium" and other legacy associations. Put another way, conscious coordination requires planners to think about right-scaling the diversity of partners, where diversification can occur across a variety of dimensions, including geography and institution type.

Cooperative efforts that aim to move beyond existing consortia and other partnerships may need to be supported by new forms of cooperative infrastructure. For example, a regional effort to cooperatively manage print monographs that includes both academic and public libraries may be optimal in theory, but if there is no existing cooperative platform that brings such institutions together to address mutual interests, it will have to be built. The cost and effort of doing so must be weighed against the perceived benefits of working outside established partnerships. In the short run, long-standing cooperative arrangements like academic consortia may be well placed to coordinate cooperative stewardship efforts around the scholarly record. Whether new cooperative infrastructures will emerge to support coordinated stewardship on a broader scale will depend, in large measure, on whether the efficiency gains of increased scale outweigh the coordination costs of managing larger partnerships.

This leads to another point about right-scaling: often, it can be a dynamic process. A stewardship arrangement may be initiated at a relatively limited scale, but then increase in scale over time, either by design or opportunistically. For example, while HathiTrust was originally launched as a consortial-scale initiative, it now includes nearly 100 partners, including universities in the United States, Australia, Canada, Lebanon, and Spain. WEST, which began with 22 founding partners, now is supported by a membership of over 100 institutions in 18 states. The lesson here may be that working up to optimal scale is a good strategy in many collaborative contexts: initiatives that are incubated within existing partnerships like consortia can eventually expand to encompass a broader range of participants.

Transaction Costs

Conscious coordination does not come without cost. *Transaction costs* are the costs involved in interacting with others in the course of carrying out multi-party activities. Time and resources must be expended finding appropriate partners; agreement must be reached on the responsibilities or commitments of each party to the activity; monitoring may be necessary to ensure that the terms of the agreement are observed. In short, interacting with other parties entails costs—time, effort, and resources—incurred to make the interaction work.

Consciously coordinated stewardship of the evolving scholarly record necessarily involves a variety of transaction costs. Institutions must coordinate the provision and maintenance of shared infrastructure; negotiate and enforce policies regarding collecting, curating, and providing access to a range of scholarly materials; and in some case, implement mechanisms to ensure that the terms of a cooperative arrangement are being met by all participating institutions. Moreover, institutions must find the right set of partners for the particular circumstances of a stewardship activity. As we saw above, stewardship models based on conscious coordination may involve cooperative arrangements that extend beyond long-standing partnerships like academic consortia, and require reliance on organizations outside natural peer groups. Coordination across organizations that lack any prior history of trusted interaction will likely increase the transaction costs involved in sustaining stewardship activities.

The greatest transaction costs are likely those associated with establishing and maintaining trust. If the benefits of specialization as described above are to be realized, an academic library needs to be able to trust that other organizations will collect, properly curate, and make available the various portions of the scholarly record that it has chosen not to collect itself. These organizations may include peer institutions that have committed to collecting certain classes of material; they could also be commercial services that have committed to archiving (or making suitable archiving arrangements for) the material in their custody. If conscious coordination is to work as a viable means of organizing stewardship activities, robust trust networks supported by reliable monitoring and enforcement mechanisms will be needed.

Trust of this kind might be fostered by the emergence of more formalized, business-like relationships between participants in coordinated stewardship activities, to ensure mutual expectations and commitments are met. Well-defined service level agreements, audit frameworks, and hand-off mechanisms may be required to formalize the conditions of coordination, and secure the levels of trust needed to cultivate mutual reliance and achieve gains from specialization and interdependence. While libraries would be important consumers of such verification mechanisms and data, other stakeholders would benefit as well: for example, an academic library may need to supply demonstrable proof to faculty and administrators that the decision to cease local collecting of certain kinds of materials is justified by the formal commitments made (and subsequent actions taken) by other institutions. Indeed, the yardstick of success for the relationships binding together participants in a coordinated stewardship arrangement may be whether they generate sufficient trust for an institution to cease collecting a particular class of materials, and perhaps even dispose of any materials of that kind already in its collection, because it is confident that another institution is committed to collecting and making them available to the rest of the partnership. Of course, libraries already engage in coordinated arrangements involving transaction costs; the point is that as stewardship models evolve, coordination will become more structured and formalized as it becomes more central to institutional stewardship strategies. As this occurs, transaction costs will increase, as more effort and resources will be expended in negotiating, monitoring, and enforcing such arrangements.

Good data-driven intelligence can reduce these transaction costs. Robust implementation of consciously-coordinated stewardship networks will likely be underpinned by evidence-based processes that guide decision-making, facilitate cooperation, and support verification. For example, taking full advantage of the cost reductions and other benefits associated with specialization and scale requires a shared understanding of the collective resource held by academic libraries: what materials does it contain? How is it distributed? How is it used? Reliable knowledge of this kind helps in locating the right partners for a particular stewardship initiative, identifying gaps in current collecting activity, and supporting ongoing monitoring mechanisms to verify that agreed collecting obligations are being met. Of course, collecting and disseminating this kind of information is itself a transaction cost, but one that is likely to be well justified by the advantages it confers in encouraging and sustaining productive coordination of stewardship activities.

Institutional Identity in a Consciously-coordinated Stewardship Environment

Academic libraries are often a source of pride—and in some cases, a perceived competitive advantage—for the institutions in which they are embedded. Indeed, in a print-centric environment, a university's ability to assemble on campus an extensive approximation of the scholarly record, in the form of collections of physical materials, could be an attractive recruiting feature for both faculty and students. In a digital, networked environment, the incentive to invest in large, just-in-case local collections is diminishing. Driven by the very nature of the evolving scholarly record—its increasing volume, complexity, and distribution—the vast majority of scholarly materials used by faculty and students will not be located on campus, but instead will be accessed through other channels. As Lorcan Dempsey puts it, library attention will shift from managing a *bought* collection to curating *facilitated* collection.[43]

In the academic sector, the chief role of the library is not to make materials and services available to the scholarly community at large, but to do so in support of the needs of the *local* scholarly community. University administrators, understandably, are concerned with the value the academic library confers on the institution's *affiliated faculty and students*. But the academic library's traditional role as a service provider in support of its local university community conflicts, in some ways, with the consciously coordinated stewardship models we have described here. In particular, the shift to stewardship marked by conscious coordination raises an important question: how can an academic library maintain a clear institutional identity in a stewardship environment where individual libraries function less as autonomous local service hubs, and more like nodes in complex networks of specialization, mutual dependence, and collective responsibility?

A stewardship model based on conscious coordination, with its defining characteristics of system-wide awareness, explicit commitments, specialization, and robust networks of resource sharing, raises important implications for the incentives and benefits associated with collecting and curating the scholarly record. While an element of public service has

always been present in stewardship of the scholarly record, academic libraries have traditionally been tasked with assembling and sustaining materials for local use: in other words, the benefits from stewardship were understood to be chiefly private (i.e., local). In a consciously coordinated stewardship model, the primary benefits from an institution's stewardship activities will likely be conferred on a scholarly community scaled above the local institution; private benefits may be incidental in comparison. In an age of budget tightening for higher education institutions, an externally-focused stewardship mission might be a difficult proposition for university administrators to endorse. The problem may be exacerbated by the potential for a "free-rider" mind-set to arise, with some institutions reaping the benefits of a deeper, more extensive network of resource sharing, without making any explicit commitments around their own local collections. In this event, the stewardship burden may not be spread equitably over the group of institutions benefiting from it.

The shift in benefits from a private to public complexion means that a university's allocation of resources to stewardship of the scholarly record will increasingly be for the "common good", rather than primarily for local benefit. This will require an alignment of collective stewardship goals with local institutional priorities. Conscious coordination often requires institutions in higher education and elsewhere to collect locally, and share globally. There are several ways for university administrators and library decision-makers to better align local incentives with global commitments.

First, global stewardship commitments may fit quite well with broader institutional interests. More and more universities are beginning to think globally in terms of their activities, recruiting faculty and students from all over the world; engaging in international research partnerships; and in some cases, opening up satellite campuses in other countries. Mohrman, Ma, and Baker (2008) describe what they call the Emerging Global Model of the 21st century research university, in which a segment of research-intensive universities are "engaged in a worldwide competition for students, faculty, staff, and funding; they operate in an environment in which traditional political, linguistic, and access boundaries are increasingly porous. These top universities look beyond the boundaries of the countries in which they are located to define their scope as trans-national in nature."[44] In this context, collecting and curating materials for the scholarly community at large might positively reinforce an institutional strategy that seeks to elevate its international profile and enhance its global reputation.

Second, a deliberate redirection of institutional investment toward curation of distinctive special collections and scholarly outputs can create or enhance distinctive "brand" attributes within a consortial, regional, or even international context. Here, as elsewhere, scale matters. To exercise "gravitational pull" on scholarly attention, student/faculty recruitment, and research funding, institutions will need to assemble a critical mass of materials, services, and curatorial expertise. The expanding scope of the scholarly record, coupled with the increased capacity for easy access in a digital, networked environment,

creates new opportunities for universities to leverage their profile by specializing in the collection and curation of a particular niche within the scholarly record. As increasing specialization in local stewardship activities leads to collecting and curating "more of less", greater differentiation could be achieved as universities evolve into centers of excellence in their chosen portion of the scholarly record. Even now we see some academic libraries shifting focus to their special collections as the mainstay of their collecting activities, rather than materials that are widely duplicated elsewhere. Dempsey, et al (2014) describe this as a shift from an "outside-in" model of collections (where materials produced outside the institutions are brought in to form the library collection), to an "inside-out" approach, in which the library is chiefly engaged in curating and making available the university's *distinctive* intellectual assets.[45]

Third, consciously coordinated stewardship also creates opportunities for universities to earn a global reputation not just for the distinctive class of materials it specializes in curating, but also the distinctive curation skills and systems it can marshal in conducting its stewardship activities. In particular, an institution can enhance its global profile and impact—and in doing so, create robust private incentives to curate in the public interest—by adopting a stewardship role that makes it a center of excellence in a specialized form of curation expertise. An entrepreneurial university may be able to make the rewards from stewardship even more direct: specialization and scale in a particular curation service could create business opportunities to provide this service to other organizations both within and outside the higher education sector.

Conclusion

The scholarly record is undergoing important changes in its scope and composition, necessitating a parallel evolution in the stewardship models that secure its long-term persistence. A fundamental task for the 21st century academic library is to adapt its traditional stewardship role to the changing ways in which the scholarly record is created, communicated, and used. Conscious coordination of stewardship efforts across an extended network of stakeholders, in which collecting activities and curatorial responsibilities become at once more specialized and more globalized, is likely to emerge as the defining feature of stewardship models for the evolving scholarly record. To make conscious coordination a robust and dependable stewardship strategy, academic libraries and other caretakers of the scholarly record will need to *right-scale* their curatorial efforts, by optimizing the scale of consolidation, cooperation, and diversity of partners within multi-party stewardship arrangements. They will need to identify and mitigate the *transaction costs* associated with a coordinated stewardship effort, build robust trust networks across partners, and leverage data-driven intelligence to inform decision-making and reduce transaction costs. Finally, stewards of the scholarly record will need to find new opportunities to enhance *institutional identity* as an incentive for collecting and curating the scholarly record in the public interest, by aligning local stewardship efforts with broader institutional interests, leveraging scale, and building distinctive collections and services. Addressing and solving these problems is a necessary condition for ensuring that the scholarly record in its fullest expression continues to be available for use by scholars now and in the future.

Notes

1. The Federal Reserve Board. 1999. "Remarks by Chairman Alan Greenspan before the Dallas Ambassadors Forum, Dallas, Texas." 16 April 1999. http://www.federalreserve.gov/boarddocs/speeches/1999/19990416.htm.
2. Ibid.
3. This section is based on Lavoie, Brian, Eric Childress, Ricky Erway, Ixchel Faniel, Constance Malpas, Jennifer Schaffner, and Titia van der Werf. 2014. *The Evolving Scholarly Record*. Dublin, Ohio: OCLC Research. https://doi.org/10.25333/C3763V. The examples given in this section (and others provided throughout the paper) tend to focus on the natural and social sciences, rather than the humanities. This is due in part to the limited services that exist to support publication, citation and assessment of scholarship in the digital humanities. The fact that "digital humanities" are regarded as distinct from traditional humanities speaks to the discontinuity in communication practices, if not research methods.
4. Our colleague Lorcan Dempsey describes this transition as a shift from the "bought collection" to the "facilitated collection."
5. Wheeler, Brad, and Shelton Waggener. 2009. Above-Campus Services: Shaping the Promise of Cloud Computing for Higher Education. *Educause* Review 44(6): 10. http://eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ864636.
6. Leadership Board for CIOs. 2014. *Information Technology in Higher Education*: *2014 Survey of Chief Information Officers Executive Summary*. 11. Broomfield, Colorado: The Leadership Board for CIOs. http://lbcio.org/wp-content/uploads/2011/01/LBCIO_2014_Survey_Final.pdf.
7. A set of sample institutional profiles from 2013 is available on the HathiTrust Digital Library website: "H-plots of In-Copyright items: PHDB Cost Calculation: Feb 2013." https://docs.google.com/presentation/d/1UlNTBThHXQyA7E_I4IKkt-mKAPqbgZSie5kS0J7RAWE/edit#slide=id.gacbc3e27_00.
8. HathiTrust's cost model is documented here: http://www.hathitrust.org/cost.
9. In a 2014 presentation to the Research Libraries UK group, Sarah Michalak identified "coordinated record keeping" for print preservation as a key above-campus benefit of participation in HathiTrust. See "HathiTrust: An Above Campus Solution." Presented at the Research Libraries UK 2014 Conference, Birmingham, England. 14 November 2014. http://www.hathitrust.org/documents/HathiTrust-RLUK-20141114.pptx.
10. University of Illinois at Urbana-Champaign Library. 2011. *University Library Strategic Initiatives FY12-FY14*. December. [Final version] Urbana-Champaign: The University Library Strategic Planning Task Force. http://www.library.illinois.edu/committee/exec/documents/2011-2012/Library_Strategic_Initiatives_Final.pdf.
11. See http://copac.ac.uk/innovations/collections-management/aboutcollectionmanagement/
12. See California Digital Library. 2010. "WEST: Collections Model." *Western Regional Storage Trust (WEST) planning meeting 7-8 June 2010*. Final draft published as a Microsoft Word file. http://www.cdlib.org/services/west/docs/WESTCollectionsModel_documentfinal.docx
13. See "OCLC Acquires Sustainable Collections Services." *OCLC News Release*. 13 January 2015. http://www.oclc.org/news/releases/2015/201502dublin.en.html.
14. The introduction of the MARC 583 Action Note is described in charming period detail here: McCrady, Ellen, ed. 1987. "Preservation Elements in MARC Format." *The Abbey Newsletter* 11(7). http://cool.conservation-us.org/byorg/abbey/an/an11/an11-7/an11-712.html.
15. The development of best practices for recording microfilming commitments and other "preservation actions" in shared union catalogs was an important factor in the success of these efforts. See, for example, Elkington, Nancy E., ed. 1992. *RLG Preservation Microfilming Handbook*. Mountain View, CA: The Research Libraries Group, Inc.
16. For a brief account of the DLF/OCLC Registry of Digital Masters, see: http://www.diglib.org/community/groups/rdm/.

17. See "Western Regional Storage Trust: Archive Holder/Builder Responsibilities." 2012. Last modified 14 December. Microsoft Word file. http://www.cdlib.org/services/west/collections/archiveHolder_builderresponsibilities.doc.

18. See PAPR Database: http://www.crl.edu/archiving-preservation/print-preservation/papr-database.

19. See Maine Shared Collections: About the Project: http://www.maineinfonet.org/mscs/about/.

20. The Linked Automated Register of Collaborative Holdings (LARCH) system enables the UK Research Reserve (UKRR) "to co-ordinate the de-duplication process more effectively . . . provides a single point for accessing data relating to UKRR offered holdings, and facilitates better reporting." See "LARCH goes live." *UKRR News*. December 2010. http://www.ukrr.ac.uk/news/default.aspx; The LARCH User Guide provides an overview of the system. See LARCH. 2013. *User Guide for UKRR Member Libraries*. London, UK: The UK Research Reserve http://www.ukrr.ac.uk/resources/LARCH%20User%20Guide-v.4.2.pdf.

21. See https://dmptool.org/about.

22. See https://dmponline.dcc.ac.uk/about_us.

23. A recent analysis of research data repositories found little formal documentation of preservation policies. See Mannheimer, Sara, Ayoung Yoon, Jane Greenberg, Elena Feinstein, and Ryan Scherle. 2014. "A Balancing Act: The Ideal and the Realistic in Developing Dryad's Preservation Policy". *First Monday*. 19(8). http://journals.uic.edu/ojs/index.php/fm/article/view/5415/4105.

24. Elements 18.4, 18.8 and 18.9 in the current version of the schema are used to report the role, start and end dates of responsibility. See Vierkant, Paul, Shaked Spier, Jessika Ruecknagel,, Heinz Pampel, Florian Fritze, Jens Gundlach, David Fichtmüller, Maxi Kindling, Agnes Kirchhoff, Hans-Jürgen Göbelbecker, Jens Klump, Gabriele Kloska, Evelyn Reuter, Angelika Semrau, Edeltraud Schnepf, Michael Skarupianski, Roland Bertelmann, Peter Schirmbacher, Frank Scholze, Claudia Kramer, Michael Witt, Claudio Fuchs, and Robert Ulrich. 2014. *Schema for the Description of Research Data Repositories*. v. 2.2. December. Distributed by Helmholtz Centre Potsdam: GFZ German Research Centre for Geosciences. doi:http://doi.org/10.2312/re3.006.

25. The California Digital Library provides a nice summary of their various shared print efforts, which exhibit this trend toward specialization with respect to format, publisher and disciplinary domain. See "Active Shared Print Agreements and MOUs: Combined List" http://www.cdlib.org/services/collections/sharedprint/agreements_combined.html.

26. The CCWA is a project of the Borrow Direct Music Libraries Group. See Columbia University Libraries, Behind the Scenes, "Web Resources Collection Program (Web Archiving)": https://library.columbia.edu/bts/web_resources_collection/contemporary_composers_web_archive.html; LAWAP is a project of the Latin American Information Network Center at the University of Texas, Austin. See Latin American Web Archiving Project: http://lanic.utexas.edu/project/archives/.

27. A 2014 comparative analysis of DataBib and re3data.org reported a total of 1,037 disciplinary data repositories. DataBib and re3data.org merged in January 2015; the consolidated registry now includes more than 1,100 repositories. See Nicholls, Natsuko and John Kratz. 2014. "Finding Disciplinary Data Repositories with DataBib and Re3data. *Data Pub* (blog). 3 March. http://datapub.cdlib.org/2014/03/03/finding-disciplinary-data-repositories-with-databib-and-re3data/.

28. See https://zenodo.org/about.

29. Figshare describes its researcher-facing service as a means to ensure that authors get "credit for all the research you do" by enabling the dissemination of work products that aren't easily accommodated in the "current scholarly publishing model." See http://figshare.com/about. For a description of Figshare's publisher-oriented service, see http://figshare.com/services/publishers. For a description of the institutional service offer, see http://figshare.com/services/institutions.

30. See http://arxiv.org/.

31. See http://f1000.com/posters.

32. Alex Golub. 2014. "Academic Life is a Trapeze, and Librarians are the Safety Net: SM is Now Archived" *Savage Minds: Notes and Queries in Anthropology* (blog). Posted 24 October.

http://savageminds.org/2014/10/24/academic-life-is-a-trapeze-and-librarians-are-the-safety-net-sm-is-now-archived/.

33. In a recent press release announcing a collaborative journal archiving program between the Association of Southeastern Research Libraries (ASERL) and the National Agricultural Library, ASERL Board President Thomas McNally (Dean of Libraries at the University of South Carolina) praised the "highly-focused" nature of the collaborative program and anticipated it would be the first of many such mutual-benefit arrangements. See Burger, John and Christopher Cole. 2015. "New Partnership between National Agricultural Library and ASERL to Archive 875 Research Journals." *ASERL News Announcement*. 12 February 2015. http://www.aserl.org/wp-content/uploads/2015/02/2015_02_ASERL_NEWS__Natl_Ag_Library_1st_Program_Affiliate.pdf.

34. Kirchner, Joy, José Diaz, Geneva Henry, Susan Fliss, John Culshaw, Heather Gendron, and Jon E. Cawthorne. 2015. *The Center of Excellence Model for Information Services*. Washington, DC: Council on Library and Information Resources (CLIR). http://www.clir.org/pubs/reports/pub163/pub163.pdf.

35. The Borrow Direct group was first formed in 1999 and has grown from a group of 4 libraries to a network of 11 "Ivies Plus" institutions. See http://www.borrowdirect.org/.

36. See https://ohiolink.edu/content/history.

37. Recent examples include the recruitment of a Manager of Shared Resources and Print Policy at OhioLINK: https://ohiolink.edu/content/manager_shared_resources_print_policy, and the appointment of a Visiting Program Manager for Shared Print at the CIC: https://www.cic.net/about-cic/staff-directory. The California Digital Library employs a full-time Shared Print Manager as well as a dedicated Collections Analyst for shared print efforts: http://www.cdlib.org/services/collections/sharedprint. The UK Research Reserve has a professional program manager as well as a service manager responsible for oversight of the UKRR resource sharing network: http://www.ukrr.ac.uk/contact/default.aspx.

38. Walters, Tyler and Judy Ruttenberg. 2014. "SHared Access Research Ecosystem." *EDUCAUSE Review*. 24 March. http://www.educause.edu/ero/article/shared-access-research-ecosystem.

39. See http://www.ukrr.ac.uk/what/default.aspx.

40. See http://www.hathitrust.org/partnership.

41. See http://recap.princeton.edu/.

42. We explore this point in Lavoie, Brian, Constance Malpas and JD Shipengrover. 2012. *Print Management at "Mega-scale": A Regional Perspective on Print Book Collections in North America*. Dublin, Ohio: OCLC Research. http://www.oclc.org/research/publications/library/2012/2012-05.pdf.

43. For more on this shift, see Dempsey, Lorcan, Constance Malpas, and Brian Lavoie. 2014. *Collection Directions: Some Reflections on the Future of Library Collections and Collecting*. 10. http://oclc.org/content/dam/research/publications/library/2014/oclcresearch-collection-directions-preprint-2014.pdf.

44. Mohrman, Kathryn, Wanhua Ma, and David Baker. 2008. "The Research University in Transition: The Emerging Global Model" *Higher Education Policy* 21:6. doi:10.1057/palgrave.hep.8300175.

45. Dempsey, Malpas and Lavoie. *Collection Directions*. 27-29.

For more information about our work related to
Understanding the System-wide Library, please visit:
http://www.oclc.org/research/themes/systemwide-library.html

OCLC Research