Title

Assessing the Future Landscape of Scholarly Communication: An Exploration of Faculty Values and Needs in Seven Disciplines - Executive Summary

Authors

Harley, Diane
Acord, Sophia Krzys
Earl-Novell, Sarah
et al.

Publication Date

2010

Assessing the Future Landscape of Scholarly Communication: An Exploration of Faculty Values and Needs in Seven Disciplines

EXECUTIVE SUMMARY

Authors: Diane Harley, Sophia Krzys Acord, Sarah Earl-Novell, Shannon Lawrence, C. Judson King

January 2010

The proper citation for this publication is:

Harley, Diane, Acord, Sophia Krzys, Earl-Novell, Sarah, Lawrence, Shannon, & King, C. Judson. (2010). *Assessing the Future Landscape of Scholarly Communication: An Exploration of Faculty Values and Needs in Seven Disciplines.* UC Berkeley: Center for Studies in Higher Education. Retrieved from: http://escholarship.org/uc/cshe_fsc

Center for Studies in Higher Education
771 Evans Hall #4650
University of California
Berkeley CA 94720-4650
(510) 642-5040

The Future of Scholarly Communication Project website:
http://cshe.berkeley.edu/research/scholarlycommunication

CSHE | Center for Studies in Higher Education

EXECUTIVE SUMMARY

INTRODUCTION

Since 2005, the Center for Studies in Higher Education (CSHE), with generous funding from the Andrew W. Mellon Foundation, has been conducting research to understand the needs and practices of faculty for in-progress scholarly communication (i.e., forms of communication employed as research is being executed) as well as archival publication. The complete results of our work are available at the Future of Scholarly Communication project's website.

We describe here the results of our research conducted between 2007 and 2010. In the interest of developing a deeper understanding of how and why scholars do what they do to advance their academic fields, as well as their careers, our approach focused on fine-grained analyses of faculty values and behaviors throughout the scholarly communication lifecycle, including career advancement, sharing, collaborating, informal and formal publishing, resource generation, and engaging with the public. The report is based on the responses of 160 interviewees across 45, mostly elite, research institutions in seven selected academic fields: archaeology, astrophysics, biology, economics, history, music, and political science. We concentrated on assessing scholars' attitudes and needs as both producers and users of research results. The report is divided into eight chapters, which include a document synthesizing our research results plus seven detailed disciplinary case studies. This executive summary also includes overviews for each of the disciplinary case studies.

SUMMARY OF FINDINGS

Our work has confirmed the important impact of each discipline's nature, culture, and traditions on many scholarly communication habits in research universities; the peer-reviewed journal article is the primary mode of scholarly dissemination in the sciences and the quantitative social sciences, while the more interpretive, historical, and qualitative disciplines rely heavily on the university press monograph with a varying mix of journal articles, critical editions, and other publications. These traditions, which rely heavily on various forms of peer review, may override the perceived "opportunities" afforded by new technologies, including those falling into the Web 2.0 category.

Criteria for Judging Scholarship

There are a variety of criteria used to judge a successful scholar in a tenure and promotion case: publication, service, and teaching. Excellence in the latter two holds little weight without a stellar publication record and evidence that a scholar's work is widely read, is judged to be of high quality by internal and external reviewers, and advances the field. Adjectives such as "groundbreaking," "creative," "original," "transformational," "high impact on the field," "indicative of sustainable scholarship," and "lauded by the larger community of scholars" are just some of the descriptive criteria that are used to judge the quality of a scholar's work in every discipline we have examined. We noted a fair amount of flexibility in terms of how a scholar coming up for tenure and promotion is judged; "quality over quantity" was a common refrain. Exceptions to the unwritten rules (e.g., N journal articles per year, N books, rigid adherence to citation indices, etc.) are regularly made if a scholar meets the more qualitative criteria given above.

We found no evidence to suggest that "tech-savvy" young graduate students, postdoctoral scholars, or assistant professors are bucking traditional publishing practices. In fact, as arguably the most vulnerable populations in the scholarly community, one would expect them to hew to the norms of their chosen discipline, and they do. Established scholars seem to exercise significantly more freedom in the choice of publication outlet than their untenured colleagues, although in the sciences, high-impact publications remain important for garnering research grants throughout a career. There is some indication that faculty in newer and less established departments in the humanities and social sciences may be more amenable to risk-taking in publication practices since their particular institutions support such efforts to carve out the identity of niche departments.

Advancement in research universities is often described as a "three-legged stool," with a "research" leg that is far more important than the "teaching" or "service" legs. Of course, the ratio of these three legs of scholarship can vary somewhat depending on the stage of a scholar's career and the type of institution. The advice given to pre-tenure scholars was consistent across all fields: focus on publishing in the right venues and avoid spending too much time on public engagement, committee work, writing op-ed pieces, developing websites, blogging, and other non-traditional forms of electronic dissemination (including online course activities).

Judging non-text scholarship

Mechanisms for judging non-text and non-traditional scholarship (e.g., databases, cell lines, curated collections, websites, etc.) exist in all of the academic institutions we surveyed. Additionally, the codification of discipline-specific practices, such as performances or architectural designs, is prevalent in the arts and some professional schools. In most fields, however, a stellar publication record in prestigious peer-reviewed outlets usually counts significantly more in advancement decisions. At some institutions, scholarly contributions such as data curation or multimedia websites are considered to be forms of "service" or "teaching" in a scholar's academic portfolio, or they may receive credit when presented in a peer-reviewed publication that "discusses" the resource or data set.

Concerns about the limitations of the current publication system have led to growing interest in the potential of electronic publication to extend the usefulness and depth of final publications (e.g., multimedia books, CDs, linked data, footnotes, embedded media, software, etc.). The lack of easy-to-use authoring tools, the perceived difficulty of evaluating such publications, and the prohibitive financial and opportunity costs to produce truly multimedia monographs all suggest that experiments with these genres will likely be rare in the near term. In fact, tenure and promotion committees generally have not seen alternative genres presented in dossiers to date.

Dissemination Practices

Scholars use a range of mechanisms for disseminating scholarship at various stages. That is, within any given discipline there may be a variety of publishing strategies available to authors. For example, in physics, astrophysics, and mathematics, discipline-specific repositories, such as the arXiv, are essential outlets that exist alongside formal commercial- and society-owned journals. Economists use working paper repositories, such as SSRN and personal websites, for disseminating research but continue to rely upon society and commercial journals for final, archival publication. In the book-based fields of the humanities, journals are still important as a means for disseminating short arguments, book reviews, and other communications. In computer science, peer-reviewed conference proceedings are the most prestigious outlet, but distribution of scholarship using more open methods, such as posting on personal websites, is common. In musicology, there are multiple outlets ranging from books and critical editions to

highly competitive and selective society journals to encyclopedias. In biology—and perhaps other sciences that are fast-moving, well-funded, highly competitive, and have commercial potential—there is a more limited range of outlets (although numerically many more journals in some subfields). The journal article reigns in these fields and the more prestigious the journal, the better from the perspective of faculty at competitive institutions.

Precision About Terms

Scholars must balance concerns about prestige and impact factor with considerations of audience and the technical affordances of particular media when choosing a publication outlet. The inherent diversity in publication practices makes precise terminology absolutely imperative. Such precision includes being clear about what is meant by "open access" publishing (i.e., using preprint or postprint servers for archival scholarship published in prestigious outlets versus publishing in new, untested, open-access journals, or the more casual individual posting of working papers, blogs, and other non-peer-reviewed work). Although there is a universal embrace of the rapidly expanding body of digital "primary" sources and data, there is an equally strong aversion to a "glut" of unvetted secondary publications and ephemera. The degree to which peer review, despite its perceived shortcomings, is considered to be an important filter of academic quality, cannot be overstated.

Sharing, Social Media, and Web 2.0

Sharing research results prior to archival publication is a complex issue. Sharing depends on what, when, and with whom, and—as we found with so much of scholarly behavior—is dependent on individual personality. Personal communication to colleagues in small, informal networks is the norm for sharing "half-baked" ideas in all disciplines. That is, a modicum of privacy is essential for many scholars in their initial dissemination practices. In some competitive and commercially lucrative fields, such as molecular biology, journals have developed an exceptionally fast turnaround time from manuscript submission to publication, and early sharing of research in, for example, the form of working papers or via Web 2.0-type vehicles (e.g., Facebook-type platforms) is simply non-existent. Even in fields such as astrophysics and economics, which have preprint/working paper cultures, early public sharing most often takes the form of penultimate drafts that are ready for submission to formal publication venues.

In all fields, many young scholars, and particularly graduate students, are especially leery of putting ideas and data out too soon for fear of theft and/or misinterpretation. Given these findings, we caution against assumptions that "millennials" will change the social landscape of scholarship by virtue of their facility with cell phones and social networking sites. There is ample evidence that, once initiated into the profession, newer scholars—be they graduate students, postdoctoral scholars, or assistant professors—adopt the behaviors, norms, and recommendations of their mentors in order to advance their careers. Of course, teenagers eventually develop into adults. Moreover, given the complex motivations involved in sharing scholarly work and the importance of peer review as a quality and noise filter, we think it premature to assume that Web 2.0 platforms geared toward early public exposure of research ideas or data are going to spread among scholars in the most competitive institutions. These platforms may, however, become populated with materials, such as protocols or primary data, that established scholars want to disseminate in some formal way but without undergoing unnecessary and lengthy peer review. It is also possible, based on our scan of a variety of "open peer-review" websites, that scholars in less competitive institutions (including internationally), who may experience more difficulty finding a high-stature publisher for their work, will embrace these publication outlets. Time will tell.

Collaboration and Multiple Authorship

Large-scale collaboration is standard and increasing in the sciences, especially with funding bodies demanding innovative approaches to "grand challenge" questions or, as is the case in the EU, making cross-national collaborations a requirement of funding. Collaborations around interdisciplinary grand challenge questions are especially complex, creating new demands for funding streams, administrative homes, sharing of resources, institutional recognition of individual scholars' contributions, and the need for participants to learn the "languages" of the multiple contributing disciplines. The picture is more mixed in the humanities and social sciences; while data collection and analysis for some research projects require collaboration with multiple specialists in other fields (including technical advisors), collaboration beyond the joint authorship of a paper or volume of essays is relatively rare (with the exception of some projects encompassed by the digital humanities). While multiple authorship is common in astrophysics and biology, and is increasing in economics and political science, it can present a challenge to tenure and promotion committees, which require clear statements of the exact contributions made by each author. Some faculty suggested that the current academic reward system may handicap large-scale scholarly collaborations because scholars must showcase their individual research contributions when preparing their dossiers.

Resource Use and Generation

Scholars produce an immense amount of heterogeneous data in the course of their research. The variety of tools at their disposal for generating, manipulating, and analyzing data is dazzling and growing in sophistication by the day. With a few exceptions, the management, preservation, and dissemination of data are not particularly encouraged or well-supported by local and national entities. Despite the widespread enthusiasm for the sheer amount of research material that is now online, some expressed concerns that the ability to process more information in a shorter amount of time does not always result in better scholarship. As with new publication genres, technological advances in the availability and manipulation of data are ultimately used within the framework of each discipline's traditional value systems and established research protocols.

Public Engagement

Engagement with the public is valued at the institutional level and occurs in every field investigated in this study. It is considered to be an important part of service and is judged by tenure and promotion committees as such. But it must be emphasized that public engagement is something that is only viewed as appropriate on any appreciable scale once a scholar has been promoted and has made a name in the field. Moreover, even well-established scholars who write regularly for the general public can be stigmatized for being "public intellectuals."

Public engagement can encompass a wide variety of activities, including press interviews, op-ed pieces, K-12 interactions, and "citizen science" initiatives. Opportunities for public engagement often follow the changing winds of public interest and world affairs. The mainstream press does not always appreciate the "nuances" of academic research, however, and several scholars valued the importance of academia as preserving a "pure space" for research, the implications of which may not be worked out for some time.

IDENTIFYING FACULTY NEEDS

In sum, our research suggests that enthusiasm for the development and adoption of technology should not be conflated with the hard reality of tenure and promotion

requirements (including the needs and goals of final archival publication) in highly competitive and complex professional environments. Experiments in new genres of scholarship and dissemination are occurring in every field, but they are taking place within the context of relatively conservative value and reward systems that have the practice of peer review at their core. Perhaps, as a consequence, we found that young scholars can be particularly conservative in their research dissemination behavior, and that established scholars can afford to be the most innovative with regard to dissemination practices.

We cannot suggest that our interviewees had singular or unanimous opinions about what, or even if, change was needed in the current scholarly communication system of their respective disciplines, but we identified five key topics, addressed in detail in the case studies themselves, which require real attention:

(1) The development of more nuanced tenure and promotion practices that do not rely exclusively on the imprimatur of the publication or easily gamed citation metrics,
(2) A reexamination of the locus, mechanisms, timing, and meaning of peer review,
(3) Competitive high quality and affordable journals and monograph publishing platforms (with strong editorial boards, peer review, and sustainable business models),
(4) New models of publication that can accommodate arguments of varied length, rich media, and embedded links to data; plus institutional assistance to manage permissions of copyrighted material, and
(5) Support for managing and preserving new research methods and products including components of natural language processing, visualization, complex distributed databases, and GIS, among many others.

Although robust infrastructures are needed locally and beyond, the sheer diversity of scholars' needs across the disciplines and the rapid evolution of the technologies themselves means that one-size-fits-all solutions will almost always fall short. As faculty continue to innovate and pursue new avenues in their research, both the technical and human infrastructure will have to evolve with the ever-shifting needs of scholars. This infrastructure will, by necessity, be built within the context of disciplinary conventions, reward systems, and the practice of peer review, all of which undergird the growth and evolution of superlative academic endeavors.

INTRODUCTION AND OVERVIEW OF THE DISCIPLINES

ARCHAEOLOGY

Archaeology is the study of the material remains and environmental effects of human behavior throughout prehistory to the modern era. Scholarship in archaeology is divided into a large number of subdisciplines, many defined geographically (e.g., North America, Egypt, Near East, Oceania) and/or by time period (e.g., Paleolithic, Neolithic, Classical). A moderately sized field, archaeology overlaps with a range of other scholarly disciplines, including biological anthropology, ethnobotany, paleozoology, geology, and classics (in particular, palaeography, philology, papyrology, epigraphy, numismatics, history of the ancient world, Hellenic literature, and art and architectural history). There is also a large private-sector component to the field, which includes contract archaeology and cultural resource management. The sub-specialization of research in archaeology and its institutional and regional contexts influence publishing behaviors, criteria for advancement, mechanisms for keeping up to date, and practices of sharing and

collaboration. Sampling across these varied subdisciplines, as performed intentionally here, presents a complex picture of scholarship in archaeology and of the diversity of approaches the field encompasses.

Publishing practices are somewhat fluid throughout this broad interdisciplinary domain. Final publication can take the form of one, or often two, books or monographs, while more scientific work (e.g., in ethnobotany) or technical work (e.g., in papyrology) tend toward the publication of articles in peer-reviewed journals. Some scholars also publish edited volumes or editions of primary sources. In publication, scholars place great weight on choosing a press or journal with prestige in their particular research area. Speed to publication can be a problem in archaeology, as excavation of a field site can take a decade or more to complete and the publication of work-in-progress can be constrained by funding bodies, local governments, and other stakeholders. Problems in monographic publication disproportionately affect highly specialized and heavily illustrated work, which has led to a desire to experiment with high-quality, lower-cost digital monograph series. Existing publishing models limit the amount and nature of data that can be presented, leading some scholars to embrace supplemental and alternative publication outlets such as DVDs and complex multimedia websites to disseminate extensive data sets, images, virtual models, and other data.

Although practices differ by subfield, most scholars (including those pre-tenure) keep data and work-in-progress close to their chest before archival publication. Informal networks are the most prevalent means of sharing early ideas and receiving feedback on drafts of work. Given the long lag time to final monographic publication, conferences and conference proceedings are an important vehicle for dissemination and publication, particularly for data just “out of the ground.” The public posting of well-polished working papers on personal websites or in repositories has been embraced by some, generally senior, scholars. Yet complaints were voiced about the lack of rigorous peer review and established prestige in conference proceedings, collected volumes, and various forms of in-progress publication. While listservs, blogs, and social networking tools can disseminate useful information in the field and may help communities of scholars to stay in touch, they were not used to share work-in-progress among our informants.

Archaeological research is somewhat exceptional among its humanistic neighbors in its reliance on time- and location-specific data, abundant use of images, and dependence on complex interdisciplinary teams of scholars and specialists, who work on both site excavation and complex lab-based data analysis. Teams produce a plethora of data types in archaeology, including three-dimensional artifacts, maps, sketches, moving and still images, flora and faunal assemblages, geological samples, virtual reconstructions, and field notes. Site directors use complex databases (which are sometimes networked) to organize excavation data and facilitate collaboration among team members. Scholars who work with archival materials may similarly cluster around common data sources and tools in technical fields such as papyrology and epigraphy. The mechanisms of collaboration across archaeology range from email and Skype to sophisticated Web-based platforms and Google Office tools for document/database exchange. Emerging geospatial technologies, 3D modeling, and other visualization tools are facilitating new ways to analyze data and create dynamic publication models. Subdiscipline-specific research centers and more general digital humanities centers can be important sources of support for innovators at some institutions.

Archaeology has an “ethic of preservation.” Like astrophysics, it is a data-intensive, observational, and time-dependent field. Recording and archiving an excavation accurately are imperative in archaeology; once a site is excavated, it is effectively destroyed and nothing can be repeated. Unlike astrophysics, however, data collection, management, sharing, and preservation practices are anything but standardized. Data management practices are defined by varied criteria such as the nature and scope of the

site itself, the training and interests of the lead researcher, the nature of data and the methods involved in their collection and preservation, and the influence of various stakeholders (e.g., funding bodies, universities, museums, governments, and/or local authorities).

Rather than viewing archaeological data as the property of the individual researcher, some scholars are seeking outlets for the dissemination, curation, and reuse of archaeological data by the research community through professionally managed "archaeoinformatics" initiatives. Though establishing standards for data curation remains problematic, experiments in "radical data sharing" have the potential to open up swathes of archaeological data for reuse. Questions of time, funding, preservation, and the conversion of analog data to digital formats, as well as intellectual property and excavation security concerns, all pose obstacles to realizing such an open system of data sharing in the near term.

Archaeology has an "Indiana Jones" and "Golden Idol" panache that results in a relatively widespread appeal and various outlets for engaging the public. Such activity can be driven by funding requirements but generally does not count for much in institutional review. Public engagement, however, is personally important for many scholars, who note that educating publics about the value of cultural heritage is essential to its preservation. Outreach can consist of varied practices such as museum curation, public lectures, and even virtual reconstructions of archaeological sites for public exploration.

In sum, archaeology is an exceptionally heterogeneous field, and its publishing models and needs are reflected in that heterogeneity. Although the monograph is the norm, journal articles and conference papers are also important dissemination outlets. There is a desire for publications that can affordably support diverse, multimedia data types, virtual reconstructions, and complex databases. Digital imprints could play an important role in ensuring peer-review and the quality of new publication models. Because archaeological excavations cannot be repeated, and artifacts are diverse, fragile, and distributed in collections around the world, archaeologists are eager to extract and document as much information as possible using a variety of digital and non-digital media. There is a resulting need to preserve and share large amounts of diverse data for posterity and reuse, but issues of common standards for data curation and preservation remain pressing. Repositories for certain primary sources, such as papyri, are already playing an important role in ensuring access to digital surrogates of artifacts. In the study of written evidence, these databases of annotated primary sources could also play an important role as digital critical editions. Collaborative research environments can also afford new types of mechanisms for amending previously published interpretations. Additional funding, clear statements on intellectual property and data reuse, centralized repositories, and funder-led guidelines for data curation are important for preserving more work generated in the field. Making more archaeological data accessible in a centralized manner may also raise questions about evaluating the contributions of multiple scholars to final publications based on "curated" data, rather than original fieldwork.

ASTROPHYSICS

Astrophysics, the study of the physics of the universe, provides a fascinating case because of its dependence on large data sets, the importance of complex visual data, the ubiquitous use of a preprint repository, the convergence of collaborating scholars around large and expensive telescopes, and its popular appeal stimulating significant amateur participation. Astrophysics has two primary branches: observational astrophysics (representing applied research, such as infrared, optical, radio, and gamma ray astronomy) and theoretical astrophysics (the study of physical cosmology, including

galactic structure and the dynamics of stellar systems). Department organization varies by institution, although most departments encompass both branches. Astrophysicists can also hold positions in academic units including observatories, laboratories (such as the Space Sciences Laboratory), or can perform civil service roles at NASA.

Astrophysics is a relatively small, high-paradigm, fast-moving field in which the refereed journal article is the primary means of final publication. Journals are typically society-owned, are few in number, have page charges, and display high acceptance rates. The field has a strong pre-publication tradition that functions in parallel with formal publication. Well-developed papers are generally disseminated through the open access preprint server, astro-ph (the astrophysics section of the arXiv), in conjunction with journal submission. In addition, early work is shared informally with a trusted network of colleagues to elicit feedback before being presented at professional conferences for further refinement and to stake a claim. Because early sharing of well-developed research is prevalent, there does not appear to be a need for online and open access journals.

Although astrophysics is a well-funded field in the US, astrophysicists who conduct research using data from NASA's flagship space missions were noted as being better funded than those engaged in theoretical astrophysics.[1] The application process for telescope time can be variable and highly dependent on a scholar's home institution. New technologies enable the possibility of remote observing, although a preference was expressed for doing such work on site, particularly since stable Internet connectivity can be a problem. Complex large collaborations at national facilities are commonplace, many of which are multi-institutional and intergenerational, and result in the publication of multi-authored papers, sometimes running into the dozens of authors. Although astrophysicists use several methods to collaborate, including video-conferencing and Internet calls, most work is facilitated through wiki use and email networks. Face-to-face interaction remains an essential part of the collaborative process.

There is an array of digital data types in astrophysics and reliance on bibliographic and observational repositories is widespread; the Astrophysics Data System (ADS), a NASA-funded bibliographic database, and the arXiv are used heavily to keep up-to-date with the field. Since data are unique to their observed point in time and data capturing techniques are becoming increasingly sophisticated, data growth has been exponential. Public-access data archives, such as those associated with whole-sky surveys and NASA's space-born observatories (including, among others, the Hubble Space Telescope, the Chandra X-Ray Observatory, and the Spitzer Space Telescope) are fast becoming the bedrock of observational astronomy.[2] The field may be witnessing a move toward virtual astronomy where individual scholars, and even the public, can mine data archives and access free software that is increasingly available online. While the "lone" researcher is well positioned to make a scientific discovery—by taking advantage of the mass of available resources—complete independence from a project team may impede a full understanding.

Data sharing among scholars is widespread, though demand for more comprehensive and mandatory guidelines is prevalent. The International Virtual Observatory Alliance is working toward providing access to global astrophysical data by developing consistent data standards. Refined or raw data can be posted on journal websites as supplementary or supporting online material, on personal or project websites, or made available upon request.

[1] Astrophysics receives significant support from NSF, NASA, private foundations (including the W.M. Keck Foundation, the Alfred P. Sloan Foundation and the Gordon and Betty Moore Foundation), and universities. Funding is awarded across institutions and national facilities.
[2] These data become publicly available after a twelve-month embargo period.

Astrophysicists have limited engagement with Web 2.0 technologies; Facebook, LinkedIn, YouTube, and other such platforms are not frequently utilized for scholarly purposes. As a rule, blogs are rarely consulted, though a few renowned academics write them; listservs, the arXiv, and "telegrams" are more widely used. Scholars utilize a variety of avenues to engage significant public interest—these include the popular press, observatory talks, and school outreach. Astrophysics as a field has high rates of amateur participation and boasts a growing role for the citizen scientist, particularly as online sites, such as SETI@home and Galaxy Zoo, encourage involvement by the general population in processing data. Google Sky and Microsoft's WorldWide Telescope enable exploration of the cosmos by turning the home computer into a virtual telescope.

In sum, astrophysics is a small field with little to no commercial potential, and the publication system is well-adapted to the discipline's needs. The astro-ph preprint repository and other scholarly communication vehicles serve a variety of functions to get ideas, announcements, and well-developed papers into the public domain quickly. There are only a few journals (which are society owned, but often outsourced to commercial publishers) and acceptance rates are relatively high. Correspondingly, there appears to be little discussion about the need for open access publication outlets among astrophysicists, despite the fact that scholars in physics—a close disciplinary neighbor—are participating in the Sponsoring Consortium for Open Access Publishing in High Energy Physics (SCOAP3), an open access publishing initiative. Demand for an improved computing infrastructure is widespread. A major challenge facing the field is managing, moving, and preserving the ever-increasing volume of data generated. As data collection becomes more complex, training astrophysicists in computer science and the use of new technologies and tools likely will be widespread.

BIOLOGY

As many say, we are in the "era of biology," which is reflected in the field's dynamism, commercial potential, and the rapid expansion of new sub-disciplinary branches. Biology, broadly defined, is the scientific study of life and living organisms. The biological or life sciences can be subdivided into a number of specialized subfields, often distinguished by the level of organization addressed, from ecosystems, to the whole organism, to the cellular and molecular. The field can be clustered into two primary academic divisions: the "bench" sciences, which encompass molecular and cell biology (MCB, e.g., genomics, neurobiology, microbiology, developmental biology, biochemistry, immunology, and biotechnology), and the "field" sciences, comprising organismal biology (OB, e.g., marine biology, ecology, zoology, and evolutionary biology).[3] In addition, the expanding field of computational biology/bioinformatics utilizes techniques borrowed from informatics, artificial intelligence, applied mathematics, computer science, statistics, chemistry, and biochemistry. Bioengineering is a relatively new field as biologists increasingly collaborate with engineers, chemists, and computer scientists to explore existing life forms and to create new ones. Departmental organization is idiosyncratic to individual universities, and those with medical schools offer a particularly large range of subspecialties. In addition to faculty members, non-tenure track scholars in the field work as research scientists, support staff, or directors of research facilities. MCB follows the laboratory model, with a single faculty principal investigator who oversees graduate students and postdoctoral scholars.

Peer-reviewed journal articles are the principal means of archival publication in biology. Molecular and cell biologists are particularly attracted to a small handful of prestigious

[3] See Quinn and Kim (2007: 3) for a useful map of the discipline.

journals for their high impact factors[4] and speed to publication—including *Science, Nature*, and *Cell*—despite, or because of, their low acceptance rates and consequent high selectivity. Experiments in many areas of MCB can be conducted rapidly, which, in combination with the highly competitive nature of the field, can preclude the widespread sharing of work-in-progress. Rapid review for publication is paramount in MCB, contributing to the continual incremental growth of knowledge and the need to get new discoveries into the public scholarly domain quickly. The trend toward the "smallest publishable unit" has been met with some resistance by some scholars and facilitates a virtual race to formal publication. (Speed to publication remains subfield dependent, however; in neurobiology and the field sciences, speed does not appear to be as crucial as in genomics, for example, where scientists depend heavily on hyperlinked literature and their associated data.) Papers, in the form of preprints, are often posted online by journals once articles have been accepted for publication. The electronic publication of supplementary and visual data enables scholars to reuse, re-manipulate, and verify research.

In biology, medicine, and other life sciences, the academic community faces a "serials crisis," in which a handful of commercial publishers are perceived as monopolizing scientific knowledge. University libraries, often with decreasing budgets, are struggling to cope with rising journal subscription rates. Many are forced to cancel journal subscriptions, resulting in diminished access to articles for faculty members. The "serials crisis" has prompted a number of responses from the field. Most notable is a move toward open access (OA) journal publication—exemplified by the array of journals published by BioMed Central and the Public Library of Science—and self-archiving to digital repositories like PubMed Central. Some funding agencies, such as the National Institutes of Health (NIH) and the Wellcome Trust, stipulate open access dissemination of research results (at variable periods following publication) as a condition of awards. Author-pays fees are common for OA journals and are generally covered by grants.

MCB is comparatively very well funded by national agencies and industry research grants, often in the multi-million dollar range. The top funding bodies in the US include the NIH, the National Science Foundation (NSF), and the Howard Hughes Medical Institute (HHMI). In the UK, the top funding body is the Wellcome Trust. Securing extramural funding, particularly single-investigator grants, is essential for a scholar's career. Such large-scale funding is less common in the field sciences.

There is an abundance of digital data types in biology; in molecular and cell biology, a reliance on centralized and hyperlinked electronic literature and large databases is prevalent, specifically PubMed. The National Library of Medicine (NLM) has worked with other organizations to bring together databases of protein structures, DNA sequences, human genetic diseases, pharmacological tools, and other resources—all interlinked to PubMed and journal abstracts (though not always full-text papers). In MCB, data and other materials are typically distributed in three ways: as supplementary material to a journal article, deposited in a subfield-specific or federal repository (often mandated by funding bodies), or shared *ad hoc* by the researcher (which may be dependent on the size or culture of the research area; cell lines are often distributed this way). GenBank and other data repositories play an important role in harvesting and storing genetic, protein, and other sequence data for reuse. Some have suggested a role for Wikipedia-like platforms for the correction of data.[5] Work in bioinformatics and genomics may increasingly rely on the computational branches of the discipline to create software facilitating the mining, collection, analysis, and publication of data. The use of imaging technologies for analyzing and visualizing data is becoming increasingly important and

[4] The impact factor is used widely for assessing the stature of journal outlets in biology. Some suggest it is overused heavily (Monastersky 2005a).
[5] Huss *et al.* (2008), Pennisi (2008).

many scholars publish visual material, including complex charts and figures, still and moving images, animations, and three-dimensional images.

While conferences are an important means to keep up to date in the field and to make contacts for collaboration, other sharing mechanisms (e.g., working papers, preprints, public blogs, and wikis) do not appear to be embraced by scholars at the most competitive institutions. Some publishers are experimenting with Web 2.0 and social computing models as mechanisms to publish early results and solicit online public review, though uptake appears to be predictably limited. Email, informal networks, and face-to-face interaction remain invaluable for sharing ideas in-progress and managing collaborations. Although biology is already a social, team-based enterprise, there is a push by some scholars and funding agencies to encourage a move toward very large and complex multidisciplinary collaborations targeted at "grand challenge questions." These projects enlist multiple experts across diverse disciplines and thus can present significant challenges to the advancement system, which tends to reward individual scholarly contributions within more or less familiar disciplinary boundaries.

Scholars engage with the public through formal talks and seminars, community outreach, visiting schools, and public forums that include op-ed pieces and media interviews. Such activities are considered natural by many given that the bulk of biological research funding comes from taxpayer supported agencies. Some funding bodies, such as the NSF and the Wellcome Trust, require a public outreach component as a condition of their grants. Publishers are experimenting with new ways to engage lay audiences, including the heavy use of multimedia and "light" genres such as video and podcasts. The "public," according to our interviewees, includes the usual suspects—school children and the community—as well as biotechnology and pharmaceutical companies, and government agencies.

In sum, the publication system in biology is almost exclusively journal based and dominated by a few highly selective journals, although there is a proliferation of journals of varying quality to accommodate new and existing subfields. Competition is fierce and speed to publication is critical. Working papers and other forms of early public sharing in MCB are eschewed, although non-prestige outlets that publish long-form articles (with room to expound on methods and to present data) and more prosaic material, such as protocols, may find a niche. Until the academic reward structure is sufficiently nuanced to judge multiple authorship, "grand challenge" questions will continue to collide with tenure and promotion requirements and have the potential to impede collaboration across institutions. In response to exorbitant subscription charges by commercial publishers, open access experiments have emerged. Some institutions have set up funds to pay for publication charges, and new journals have been established both by scholarly societies and commercial publishers with well-known and prestigious imprimaturs. Large repositories play a crucial role in ensuring the preservation of and access to data, though the field still lacks a sufficiently robust technical and institutional framework to support widespread data sharing practices. Issues of data preparation, accurate curation, storage, preservation, and the migration of changing data forms, remain outstanding challenges facing the field.

ECONOMICS

Economics is the study of the production, distribution, and consumption of goods and services. Though generally a homogeneous discipline, the field's major division is between empirical and theoretical practice. There are a variety of subfields in both areas, many of which overlap with other disciplines, such as business (e.g., finance, marketing), political science (e.g., political or international economics) and psychology (e.g., neuroeconomics or behavioral economics), to name a few. Despite numerous

subfields, economics is a high-paradigm field in which scholars generally share a core base of knowledge and epistemological practices.

In economics, peer-reviewed articles are predominantly final, archival publications evaluated as part of institutional review. There is a relatively small number of high-impact, prestigious journals with extremely low acceptance rates that are generally society run.[6] Submission fees, which are common, have risen in the past two decades. Time to publication is unusually lengthy in most subfields (two to four years on average, and sometimes longer). As in the sciences, economics is experiencing a brand proliferation in journals, driven in part by commercial publishers.[7] While there have been experiments with varying forms and degrees of open access journal publication (e.g., *Theoretical Economics*, bepress), new genres of publication have not made major inroads to date.

Most journal content is available in digital form, and a variety of citation indices track the prestige and impact of journal outlets and articles. For example, Journal Citation Reports (JCR), published annually by Thompson ISI, lists journal impact factors. (These types of metrics, however, are taken with a grain of salt by many tenure and promotion committees.) Many online resources providing access to papers in economics, including Google Scholar, Research Papers in Economics (RePEc), and Social Science Research Network (SSRN), have tools for tracking download and citation counts. Listservs and similar email subscription services notify readers about papers of interest.

Due to long lag times between article submission and publication, speed to print is a major concern for economists. The sharing of work-in-progress is widespread (with the exception of a few subfields with "low-hanging fruit," such as neuroeconomics), and is an important way for scholars to stake a claim on research topics, disseminate drafts, and solicit feedback prior to formal journal submission. Conferences and informal networks (sustained by email) play a dynamic and important role in sharing early research drafts and ideas. Well-polished working papers are frequently posted online in paper repositories, such as SSRN and the National Bureau of Economic Research (NBER), or on personal websites. The sharing of preprints is less common. Formal journal submission and peer review can overlap with the circulation of working papers, and the resulting published journal article (the version-of-record) may be significantly revised. Consequently, individual scholars have various strategies for managing the different public versions of a given paper.

Economists use data derived from a variety of sources, including government, non-profit, and corporate entities. Some scholars also generate their own data sets. Publishing or disseminating some form of back-end data has become more common in the past decade, and a number of journals and funding bodies are beginning to mandate such release (though data sharing practices are governed by individual personality, data sensitivity, and proprietary concerns). The growing subfields of behavioral and experimental economics are opening new directions for data collection and research; for example, X-Lab (Experimental Social Science Laboratory), part of the Institute of Business and Economic Research (IBER), offers real and virtual laboratory facilities to support research into methods based on experimental design. There is little use of visual data beyond graphs and charts, although some scholars are working with geospatial tools and fMRI scans. Collaboration among small numbers of scholars (i.e., two to three individuals) is common and growing, and can occur both within and across fields. Graduate students and pre-tenure scholars often serve as data collectors or analysts in partnership with more established scholars. The mechanisms of collaboration remain

[6] Dawson and Rascoff (2006).
[7] The American Economics Association also introduced four new online-only journals in early 2009, but their success has yet to be measured.

largely traditional—email networks and face-to-face communication—and pre-existing personal relationships underwrite many collaborative endeavors.

Public engagement depends on a scholar's area of specialization and career stage. Interdisciplinary economists who work in public policy or business may be more likely to publish popular press books or have a media presence through newspaper editorials or radio and television interviews. During the recent financial crises, for instance, academic economists were daily fixtures on national and international news. (Journalists may also mine working-paper series to inform news articles.) Generally, however, these activities are considered to be outside the realm of standard scholarship and discouraged for pre-tenure scholars. Although there are some well-known economics blogs, there is little evidence of widespread blogging as a scholarly pursuit among economists.

In sum, economics is a high-paradigm field that almost exclusively depends on journals for final publication. There is a robust working paper culture, which functions as a form of early research dissemination and informal peer review. The primary concern in the discipline centers around the long lag time of the publication system, and scholars expressed hope that activities like paying referees and reusing peer reviews (for rejected papers submitted to other journals) could mitigate the problem. There is some concern about the high costs of commercial publications and the need for more journal outlets (either electronic or open access), but the main society journals are generally seen as serving the needs of the field, and commercial journals are perceived as disproportionately overpriced.[8] There is no significant need for new publication genres to accommodate complex media, although more comprehensive guidelines on publishing software code or experimental data types may become pressing in the future. Economists are eager to exploit the growth of digital and Internet data for research purposes. The subsequent need to generate additional training or technical support in harvesting and integrating diverse data forms could become more pressing.

HISTORY

History is the study of the past. Scholarship in history is divided into a large number of subfields defined by geography (e.g., American, African, Asian, world), time period (e.g., classical, medieval, early modern), and other thematic criteria (e.g., public, religion, technology, economic). Some areas of specialization overlap with general area studies, such as African or European studies. History also interacts with the neighboring fields of geography, economics, anthropology, literature, political science, and linguistics, which can all play important roles in historical research. Generally considered to be a conservative field, historical work emphasizes the lengthy incubation of arguments, a rigorous and established chain of transmission of ideas, and the importance of peer review. In comparison to other large academic fields exhibiting a good deal of fragmentation, history is a relatively "commodious" discipline, with a shared culture and an overall understanding of common methodology.

As a book-based field, the standard form of final publication in history is the scholarly monograph, ideally published by a prestigious scholarly press. Historians also produce peer-reviewed journal articles, chapters in books, documentary editions, and book reviews, which supplement, but do not replace, the monograph. In general, historians, especially those pre-tenure, appear to be quite conservative in terms of publication. Multimedia websites, archival databases, and other digital activities are seen not as full-fledged scholarly products, but rather as methodologies that support or extended the monograph or formal articles.

[8] Bergstrom and Bergstrom (2001).

Pressures in the publication environment have grown alongside the expansion of subfields within the discipline. While some see the rising bar of tenure and promotion requirements as producing a "glut" of low-quality books in American or modern history, monographic publication has become increasingly difficult in smaller, specialized subfields. While the publication crisis might, in some cases, be in the "eye of the beholder," there are concerns that publication challenges in specialized subfields may be driving scholars toward more readily marketable areas of scholarship. Experiments with electronic monograph production, such as Gutenberg-e and ACLS Humanities E-Book, have made inroads in combating the negative perceptions associated with electronic publication, but they remain outliers in the publishing landscape and are hard-pressed to compete with the prestige of well-regarded university presses. They also present great challenges to reviewers and review committees, especially among genres that present information in nonlinear and difficult-to-print formats. Similarly, despite an overall proliferation of specialized journals, publishing in nascent online-only journals carries much less prestige than the flagship print journals.

Historians engage in extended dialogues or "ongoing conversations" within their areas of specialization, which may occur over long periods of time.[9] Speed to publication, with the exception of the pre-tenure scholar's first book, is not a pressing issue, and older publications remain vital resources. In particular, book reviews, accessed through subscriptions to the flagship journals or H-Net listservs, play an important role in scholars' filtering practices. The visibility of some historical blogs and online resources, notably the History News Network (George Mason University), is increasing, but scholars are generally skeptical of non-peer-reviewed material. History is on the "slow side of sharing," and historians cautiously share well-polished work with trusted colleagues. Conferences are the main venue of public sharing of work-in-progress, though published proceedings are uncommon.

Traditionally, the root of historical scholarship is the archive. Multiple authorship is very rare and takes the form of edited volumes or coauthored research articles. Historical research relies on multiple lines of evidence, and thorough, internal footnotes play an important role in publication to ensure rigor and validity. Some say history is becoming more evidence-driven, as high-quality, freely accessible online databases and other archival resources change the way historians do their work. Furthermore, like archaeology, historical research can be exceptionally visual and concerned with issues of time and space. Experimentation with GIS and other visualization technologies is supporting innovative work in spatial history and digital history. In a field that traditionally emphasizes sole authorship, projects that employ heavily quantitative and visual elements, or the collaborative building of digital data sets and archives, present new challenges to assessing scholarship. Bringing such resources to bear on relatively traditional questions of historical significance and analytical readings of archival documents, however, is still the primary use of innovative technology in the discipline.

The field of history has a strong public component and can be relevant to public policy and cultural heritage. Public engagement through news outlets, museum talks, documentaries, and work with local historical societies is common for scholars working in topical areas. While publishing or producing work explicitly for popular audiences is embraced by some, too much public exposure can work against a scholar during institutional review.

Despite a thriving journal culture, the monograph published by a prestigious university press is here to stay in history. There is a real monograph crisis for some young scholars, scholars in less competitive institutions, and scholars in smaller subfields that university presses determine to be less commercially viable. While electronic editions have sought

[9] Griffiths, Dawson, and Rascoff (2006).

to solve the cost problem, the preparation and peer review of digital monographs still requires much in the way of financial support. Just as important, few scholars or reviewers are accustomed to reading book-length work in digital form and are uncomfortable with non-linear narratives. More successful moves to address the publication crisis could come with print-on-demand services and subsidies to university presses to ensure that good scholarship can be published, regardless of subfield. Additionally, scholars seeking to publish copyrighted images in their work—and scholars using GIS, extensive data sets, databases of archival materials, and other media not readily supported in traditional publication—will need new publication forms and support to present and discuss such resources. While experiments in hybrid publishing abound, more nuanced reward mechanisms are needed to evaluate such non-traditional work, and scholars face a higher burden of proof to demonstrate directly the value multimedia publication can add to the development of the closely-reasoned argument that defines traditional historical scholarship.

MUSIC

Music is a multifaceted discipline that spans academic and applied work in the arts and the humanities. Broadly speaking, the "academic" study of music concerns the history, cultural contexts, and interpretation of music. The academic subfields of music include musicology (the history of Western music traditions), music theory (the elements and mechanics of music), and ethnomusicology (music in its sociocultural context), as well as more interdisciplinary studies such as music psychology and cognition, philosophy of music, popular music studies, cultural studies, and music education. "Applied" scholarship in music concerns the attainment of distinctive proficiency in a specialized field of performance, composition, or conducting. The lines between academic and applied scholarship are blurred by many scholars in academic institutions, such as scholar-performers, composers who engage in extensive music theoretical work, or computer musicians. The institutional arrangement of scholars in various subfields varies greatly; some campuses have departments that embrace both musical practice and academic musicology while others have separate conservatories. Ethnomusicology, a relatively new field, may reside in its own department, or in departments of anthropology or folklore.

In addition, the past 30 years have witnessed the burgeoning interdisciplinary area of computer-assisted research in music, built on work by French composer Pierre Boulez "to engage with the sciences to create new music-like experiences." Scholars in this area investigate the possibilities of digital music creation (e.g., computer-assisted composition, new models of performer interactivity or diffusion, and new instruments), as well as the "music sciences" (e.g., acoustics, perception, cognition, and sound analysis/synthesis). A triumvirate of new music centers leads work in this area: the French Institute for the Promotion of New Music (IRCAM), the Center for Computer Research in Music and Acoustics (CCRMA, Stanford), and the Center for New Music and Audio Technologies (CNMAT, UC Berkeley). All are marked by interdisciplinary collaborations among composers, performers, computer scientists, engineers, and psychologists.

Taken as a whole, publication in music includes monographs, journal articles, book chapters, encyclopedia articles, conference proceedings, critical editions of musical manuscripts for study or performance, reviews, liner and program notes, discographies, CDs, multimedia websites, scores, live performances, DVDs/videos of performances, recordings (albums or single tracks), and software (which can represent new computer-based instruments or protocols for musical performance or composition). Monographs are the common form of archival publication in historical musicology and ethnomusicology, while peer-reviewed articles are important for more technical or theoretical work. Publication practices center around prestigious and highly selective university presses and

flagship journals, the latter of which have a considerable publication backlog. The integration of musical examples in text (whether they be manuscripts, scores, audio, or video) is important, but restricted both by the high financial costs of securing permissions and the technical constraints of print publication. Scholars in particular subfields have responded to these limitations by creating supplementary or alternative publication models, such as multimedia websites to host audio and video in ethnomusicology (e.g., the peer-reviewed EVIA Digital Archive Project), and specialized technical websites to publish software and other technical contributions (including some open source products) in electronic/computer music.

Conference presentations are important across music for sharing work-in-progress among specialized audiences, but most scholars in the academic subfields keep their work and data close to the chest prior to publication. Overall, much sharing takes place informally by circulating polished papers via email within a close network of trusted colleagues. Listservs function in specialized fields to disseminate information and to track the location of archival sources, and may be used to share work-in-progress to a limited extent by some scholars. Visibility is a key ingredient to building reputation in the applied music subfields, and scholars make extensive use of personal websites to promote and disseminate recordings of their work.

Taken together, music scholars work with a variety of musical texts. In addition to monographs and journal repositories, scholars across all music subfields regularly consult *The Grove Dictionary of Music and Musicians*, a thorough encyclopedia run by a professional editor in partnership with academic editors at Oxford University Press. Research in the musicological or ethnomusicological tradition involves lengthy periods of archival manuscript study or ethnographic fieldwork (with a large audiovisual component), while more theoretical work uses readily available instruments, scores, or recordings to explore musical sound structures. Some work in musical cognition or computational musicology is lab-based and generates data sets. Collaboration, specifically coauthorship, is not typical for any musical subfield, with the exception of research in new music and electronic composition. Here, composers, researchers, and technologists work together to develop applications that support musical composition and performance. Networked performance (utilizing high-speed internet connections and sophisticated software to unite performers distributed geographically) is opening new avenues for improvisation and performance. Like the traditional humanities, music receives little funding for research and publication. The exceptions are computer/electronic music research, which may create patentable technologies and foster partnerships with industry.

Music is inherently public and the general public plays a large consumer role. Public engagement can take a variety of forms: educational outreach, media interaction, pre-performance lectures, and writing program notes for a concert or liner notes for a recording. Academic music scholars may also engage in more “applied” work, such as the performance of traditional vocal and instrumental music by ethnomusicologists and artistic consultation with opera companies by musicologists. In computer/electronic music, software tools for musical composition and performance are often made publicly available for use by amateur and professional musicians.

In sum, publication in music encompasses a variety of genres, and the relative importance of both books and journals depends on subfield. The limited number of journal outlets with perceived prestige (and which are operated by scholarly societies) has led to a call for more quality outlets (often electronic and/or open access) that can maintain high standards of editorial quality and peer review. The cost of securing permissions to use and publish copyrighted musical materials is a large problem in the field, and can heavily limit the scope and substance of published work. While some institutions and scholarly societies offer publication subventions, the latter may be called

upon to play a greater role in negotiating lower costs for permissions. The growing availability of music in digital formats (including audio and video) is creating new possibilities for publishing multimedia material in hypertext form, particularly in ethnomusicology, and additional support and funding could bring more scholars to use these publication models. There is currently little available funding for scholars interested in this approach to publication, however. In new music technology, where software and other technical components are integral to contemporary composition, scholars have developed Web-based platforms for hosting such work since traditional journal publishers cannot yet provide these necessary services. Music scholars collectively need more databases of primary research materials, which can include archival manuscripts, scores, recordings, fieldnotes, and software. Online resources could function as digital critical editions or searchable banks of notated scores. In the case of ethnomusicology and new music technology, the preservation and migration of changing data forms are problematic. Several scholars called for a "PubMed for music," in which secondary resources, such as *Grove* articles and instrumentation guides, are hyperlinked with these primary data forms.

POLITICAL SCIENCE

Political science is a multidisciplinary field characterized by scholarship that "leaks" into both humanistic and scientific perspectives and skills. There is a diverse array of subfields in political science, including American government and politics, area studies, comparative politics, formal theory and methodology, game theory, international relations, political behavior, political theory/philosophy, public law and jurisprudence, public organization, administration, and public policy, among others. One emerging interdisciplinary subfield is neuropolitics, where brain imaging technologies are used to examine individual political choice. The diversity of research in political science makes it a decentralized, low-paradigm field. Scholarship in political science is often divided by methodological orientation between theoretical and applied approaches; the latter can be further separated into qualitative and quantitative work (although these methodological divides are challenged by scholars who combine socio-historical qualitative analysis, ethnography, quantitative analysis, and/or formal modeling, such as that which occurs in international relations). Consequently, there can be tension among methodological approaches or subfields. It is not uncommon for faculty in large research universities to be affiliated with interdisciplinary research institutes or have joint appointments in schools of public policy, economics, and history.

As in economics, political science has seen a trend toward publishing journal articles and away from publishing books. The degree to which final publication is both book- and article-based depends largely on the work's qualitative or quantitative orientation and the argument length. Most flagship journals in the field are sponsored and run by scholarly societies or university presses. There appears to be no call within the field for open access journals, and although there are a few online-only journals, they lack the gravitas of their traditional print counterparts. Citation indices are used by many tenure and promotion committees as an indicator of an article's impact in the field, though it is not a sole mark of good scholarship, particularly since such metrics do not comprehensively capture import and visibility. While prestige and imprimatur are the most important considerations for publication, scholars also increase the visibility of their work by publishing in journals targeted at specialized audiences. Frustration with the slow speed of the peer review process has led to an emerging climate of sharing in-progress work, particularly through working papers, though this may be more prevalent among established scholars who already have reputations built through traditional publication mechanisms.

As a field, political science appears to generally welcome the sharing of information due to its focus on the often unpredictable unfolding of world events. The extent to which scholars share depends, in part, on personality and on the pace and nature of their particular subfield; scholars in policy or current affairs may value timeliness of information more than those with a historical or theoretical focus. Additionally, qualitative scholars may have a higher threshold for engaging informal networks for feedback on drafts compared to their quantitative counterparts, who are more likely to publicly share working papers. Society conferences and smaller research symposia are important venues, particularly for increasing the visibility of pre-tenure scholars' work, though fear of poaching can hinder participation in publishing conference papers.

Political scientists use a variety of sources to keep up to date in their research area. These include email and listservs (or similar subscription services), as well as resources such as JSTOR and Google Scholar. Most print journals in political science can also be accessed online. Scholars rely heavily on large databases, especially those concerning election results, public opinion data, survey data, and census data. Political scientists amass their own data sets as well, some of which are made publicly available via institutional repositories or personal and journal websites. Materials required for the replication of results, such as data sets or back-end data and code, often accompany the text of the publication. Digitally innovative social scientists, including political methodologists, draw increasingly on various forms of computational analysis, including text and data mining, visualization, and GIS to analyze new and more diverse kinds of digital data that are derived from all manner of electronic media. Demand for more sophisticated tools and techniques to make sense of this growing mass of information will consequently increase throughout the social sciences (Berman and Brady 2005).[10]

Growth in the implementation of quantitative and mixed methodologies has led to a general increase in collaborative authorship across the field.[11] Scholars seem to use traditional mechanisms for collaboration, preferring to circulate documents via email, wikis, and other social media platforms. Overall, the field is relatively well funded compared to many other social sciences, and research is typically inexpensive to conduct, especially as expanded access to online information reduces the need for research travel. There is some evidence, however, that the increasing use of technology may increase research costs. Securing large amounts of external funding, however, is not considered necessary for advancing a scholar's career.

Like history, some topical areas in political science are relevant to government activities, policy, and public interest, and consultation work with government agencies, NGOs, and corporations is commonplace. There is a large component of public engagement in the field as a whole, particularly through the news media where academics can serve as political analysts or commentators, though this may be more common among scholars whose specialties have popular resonance. Excessive public engagement is discouraged for pre-tenure scholars since it falls outside the realm of traditional scholarship.

In sum, complaints concerning the slow publication process are widespread and particularly problematic in time-sensitive subfields. While there is demand for more specialized journals (following a proliferation of subfields), there is limited experimentation with open access or online-only journals. There is little evidence of a crisis in scholarly monograph publication at the most competitive institutions. Instead, scholars call for university presses to continue publishing scholarship across the spectrum of the field. Post-publication data sharing is common practice among quantitatively

[10] See Goodchild (2007) on sensors and King (2009) on new software and methods to enable reading a million blogs.
[11] The American Political Science Association established a working group to address this topic (Chandra *et al.* 2006).

oriented political scientists, primarily to facilitate the replication of published results. Information and communication technologies have enabled the ability to harvest new kinds of data and increased access to diverse resources in the field. Although data repositories, including the Interuniversity Consortium for Political and Social Research (ICPSR) and the Harvard-MIT Data Center, play an important role in data preservation, there is demand for more specialized institutional repositories, such as polling archives. For those scholars who depend on archives outside of the US and the EU, there is tangible concern about the selectivity of what gets archived and the continued need to travel to physical sites to get an accurate assessment of a given cultural and political situation.