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Beyond Open Access: A Framework for Openness in Scholarly Communication

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6 BEYOND OPEN ACCESS: A FRAMEWORK FOR OPENNESS IN SCHOLARLY COMMUNICATION

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There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear. Yet specialization becomes increasingly necessary for progress, and the effort to bridge between disciplines is correspondingly superficial.

—Vannevar Bush (1945/1995)

Formal and informal communication practices have evolved in different ways in response to digital media. Journal publications and books have changed very little beyond creating digital versions nearly identical in structure to their print counterparts. The growing body of research on open access to scholarly publications sheds some light on scholarly communication and digital media, but with a primary focus on formally published work. This is not to suggest a misplaced focus; it does, however, point to gaps in our understanding of evolving modes of informal communication, particularly regarding the use of digital media and the new possibilities of openness that reach beyond open access.

The juxtaposition of widespread adherence to traditional publishing models (access to which typically is not open) and increased openness among informal modes of scholarly communication raises some interesting questions about emerging configurations of open science. On the one hand, academic publishing, also known as formal scholarly communication, is slow to change in response to the vast potential for using digital media to increase openness. Publication of research output is a fundamental component of scientific progress. New knowledge builds on existing knowledge, and

publication of new knowledge creates possibilities for future knowledge. Publishing is important in the careers of individual researchers. Open access has been shown to increase the dissemination of new knowledge, but full adoption of it seems to have stalled. On the other hand, there are now a wide variety of openness initiatives within the realm of informal scholarly communication, including enhanced publications, repositories of draft manuscripts, repositories of linked data, open lab notebooks, academic blogs, and structured content ontologies. These projects are demonstrating new possibilities of openness related to increased transparency and improved interoperability of content. This is possible in part because the realm of informal scholarly communication is typically not included in the formal metrics of scientific impact and individual career advancement, and thus the stakes are lower. Informality can facilitate innovation and experimentation; however, it also complicates systematic analysis of whether, and in what ways, these new configurations of openness contribute to open science.

In this chapter we discuss scholarly communication in the context of e-research; thus, we foreground communication practices facilitated by digital media and the Web rather than overtly focusing on the technology itself. The particular attention to openness elevates its importance among other possible ways to examine dissemination of “virtual knowledge.” To make this more explicit, the selection of openness as an object of study means that other perspectives not chosen are necessarily excluded. In our view, emerging forms of openness among informal modes of scholarly communication have enormous creative potential. Analyzing the dynamics of these emerging forms holds promise for furthering understanding of “virtual knowledge” in general and scholarly communication in particular.

Against this backdrop, we offer illustrations of both formal and informal communicative forms, focusing on emerging practices in the informal realm and recent digital publishing initiatives by academic publishers. These illustrations serve as a basis for examining the tension and flux in scholarly communication associated with dimensions of openness.

The chapter begins by situating openness and scholarly communication. This is followed by elaboration of the conceptual framework of openness afforded by digital media and the proliferation of user-generated content associated with Web 2.0 (O'Reilly 2005; Vossen and Hagemann 2007). We identify inclusivity and transparency, in addition to access, as dimensions of the *interface of openness* in a communication medium. Correspondingly,

the selection of a specific communication technology or platform, and decisions made during its installation, influence the potential for openness. We identify standards, content interoperability, and levels of customization as dimensions of the *infrastructure of openness*. We present examples of innovation in formal scholarly communication for books and journal articles; we also discuss trends in informal scholarly communication. Finally, we reflect on the theoretical and practical import of these developments and suggest areas for additional empirical inquiry related to openness in scholarly communication.

SITUATING OPENNESS AND SCHOLARLY COMMUNICATION

Open-access publishing on the Internet “is demonstrating dramatic and striking gains in the circulation of knowledge” (Willinsky 2005, 29). After a long period of anemic adoption, institutions, funding agencies, and even many publishers are increasingly engaging the possibilities of open access. However, to focus on the free *availability* of academic literature on the Internet—that is, on open access (e.g., BOAI 2002)—is to miss a larger range of open practices emerging in informal venues. The proliferation of Web 2.0 participatory practices associated with the use of blogs, social networks, and wikis has helped to stimulate an appetite for increased open scholarship. In addition, many funding agencies are increasingly expressing high expectations for the development of “new forms of scientific discovery and scholarly research” associated with the affordances of digital media and networked resources (Arms and Larsen 2007, 3). However, this interest is at odds with quality control, academic rewards, and other important activities facilitated by academic publishing (Roberts 1999; Fitzpatrick 2011). In spite of increased transparency and new collaborative possibilities related to openness, formal scholarly communication remains in the decades-old state of crisis. Even as open access seems on the verge of accelerating, with rapid adoption plausible, interesting new practices and innovations in informal scholarly communication remain in relative obscurity.

While informality facilitates opportunities for open exchange, for presentation of new ideas, and for the testing of new claims, the lack of boundaries results in an expansion of what can be considered scholarly discourse, both in terms of content and in terms of contributors. Common to these informal modes of communication is the ethic and practice of openness, which on

the surface is consistent with the principles of open science. Openness in science is most visible in the ethos of “communism” that prescribes “open communication of findings,” a practice that benefited tremendously from early advances in print technologies (Merton 1979, 474). Such advances facilitated improvements in the accuracy of the knowledge communicated, a more secure system for protecting intellectual property rights, and vastly increased dissemination.

Paradoxically, it appears that use of digital communication media in scholarship has increased openness in such a way as to challenge these long-held principles of open science. For example, the term *radical transparency* refers to the practice of providing access not only to the content produced by contributors but also to information about the organization of the collaboration, and, crucially, to the stakes, or interests, in the collaboration. Moreover, radical transparency makes these resources visible to collaborators and stakeholders alike, as well as to competitors and often the public at large, in contrast with the traditional practice of only providing open access to the final publication. The fact that cooperative publication coexists with competition for intellectual priority points to an inherent tension within the normative structure of science. This tension is attenuated, to some degree, by “disinterestedness,” another institutional norm of science, which is the distancing of personal interests or ideologies from scientific inquiry. Disinterestedness, communism of intellectual property, organized skepticism, and universalism “comprise the ethos of modern science” (Merton 1979, 270). This discussion of radical transparency is meant to illustrate an increase in the intensity of tensions created by the possibilities of both openness and closeness. Further, the notion of communal sharing of intellectual resources is often contingent upon academic rewards’ having already been extracted from resources to be shared. In other words, only after new knowledge has been formally published (and rewarded), and its novelty diminished, will open access to such work be broadened.

The context within which scholarly communication functions is changing, and this is occurring in parallel to the proliferation of digital versions of materials and Web-based dissemination. Scholarship, in such an environment, goes by different labels (see chapter 1 above), but it is increasingly prevalent in the context of e-research, which is defined as “a form of scholarship conducted in a network environment utilizing Internet-based tools and involving collaboration among scholars separated by distance, often on a

global scale” (Jankowski 2009, 7). Delineating the components of e-research in the form of a model is useful here in that it illustrates the relationships of informal and formal modes of communication, which are made visible in a technologically enabled research collaboration environment. Jankowski (2009) has proposed such a model, suggesting three clusters of research activities within a networked environment. (See figure 6.1.)

As with constructions of the notion “science communication” (Garvey et al. 1972), two overlapping activities are identified in figure 6.1, both

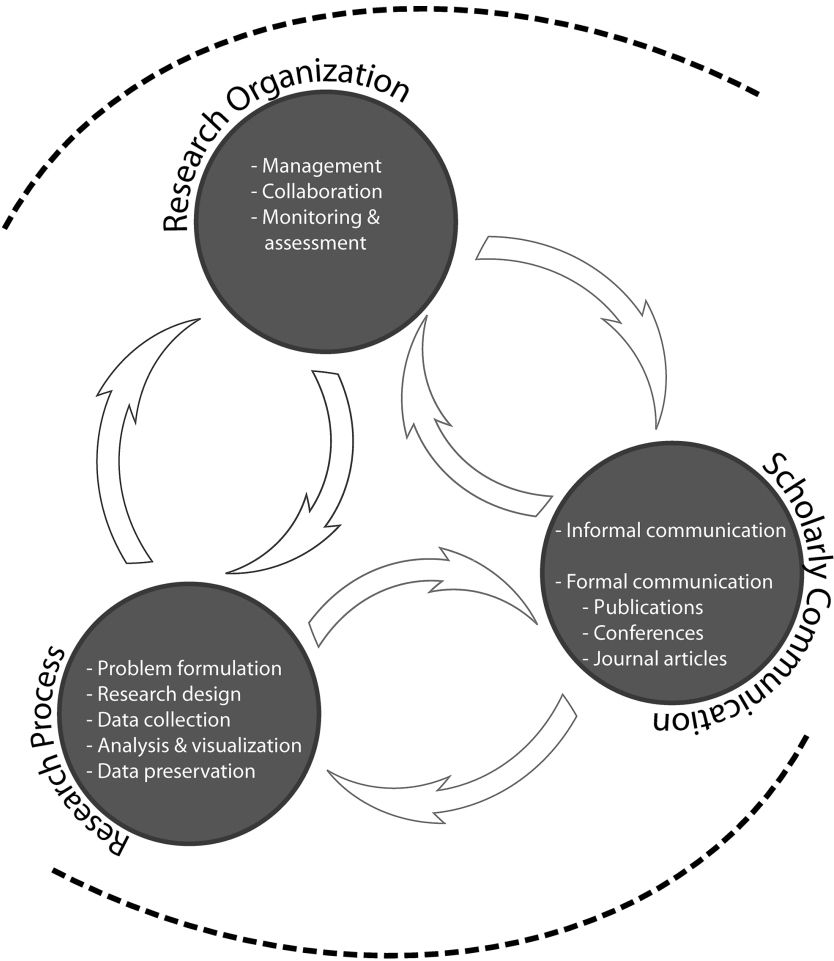


FIGURE 6.1
Components of e-Research (adapted from Jankowski 2009).

oriented toward audiences external to the research project: informal and formal communication. Traditionally, emphasis rested with, and importance was attributed to, formal communication as reflected in ISI-ranked journal articles and monographs released by established scholarly publishers. (The ISI is the Institute for Scientific Information.) These forms of publication are still prominent across the social sciences and the humanities, particularly in North America and Western Europe, and they affect institutional criteria for hiring, tenure, and promotion. This arrangement, however, has come under pressure as institutions struggle to evaluate the proliferation of academic contributions produced in an e-research context (ACLS 2006).

Changes in communication practices vary across disciplinary settings. In his historical account of science and the formation of disciplinary work, Whitley (2000) identifies mutual dependence and task uncertainty as significant for understanding variations in how knowledge is produced. Mutual dependence and task uncertainty are also useful for understanding variations in scholarly use of information and communication technologies (Fry 2006; Fry and Talja 2007). By tracing social and intellectual influences of scientific practice over the past two centuries, Whitley develops an analytical framework that locates scientific work (broadly construed to include the humanities and the social sciences) as primarily a craft that evolved in different ways associated with the particularities of cognitive objects and contextual factors. Practices clustered in relation to mutual dependence (e.g., standardized methods) and in relation to task uncertainty (e.g., the particularity of research objects) have implications for how scientific fields are organized and for how they make use of formal communication venues.

For example, Whitley (2000) claims that scientific fields with high task uncertainty often rely on social networks to interpret research findings once they are published. In a field in which ethnographic methods are used, findings are often descriptive, and data are of little use when not situated in social context. In such fields, empirically based knowledge claims are necessarily localized in a particular social context. Integral to the argument are the research approach and interpretive framework as adapted to particular circumstances. In fields with high task uncertainty, the meaning and the significance of published research results are often ambiguous without an argument to support a particular interpretation. By contrast, in fields with a high degree of standardized research methods—for example, fields with routine laboratory practices and standard raw materials—published research

results are understood on the basis of the specific standards used. The validity of new knowledge is contingent upon compliance with a known set of standards.

In other words, a high degree of variability in the way research is conducted limits the potential to standardize research practices, a characteristic that influences the role of scholarly communication. According to Whitley's (2000) account, although the format of journal publication remains very similar across disciplines, the role of publication serves different strategic ends. In a field in which mutual dependence is dominant, published research is often used to establish the priority of common goals and problems, and thus to facilitate coordination of a research agenda within a field or among related fields (*ibid.*, 269). Use of formal communication venues to address issues of strategic importance relies in part on a stable meaning for the results of research.

This is less the case where task uncertainty is dominant, as publication of research would not be readily understood on the basis of standardized practices. Where the object of research is situated in a social context, for example, formulation of problems and goals would be unlikely to find common ground on the basis of published research. Researchers in fields with uncertain and usually unstable research agendas, correspondingly, have more individual autonomy in facilitating a localized research strategy. Addressing issues of strategic importance would involve frequent negotiation and conflict (Whitley 2000, 122–7). Under these circumstances, coordination of goals, problems, and research priorities is typically facilitated through informal social networks rather than through formal publication (*ibid.*, 122–127). These differences in the role of formal communication suggest differences in informal communication. In their explorative case study, Fry and Talja (2007) use Whitley's theory to examine disciplinary uses of digital communication media. In fields with high task uncertainty and low mutual dependence, they find that scholars use informal modes of communication, such as email lists, to coordinate research goals, problems, and priorities (*ibid.*, 123–124).

The fact that the role of scholarly communication varies across different fields has implications for how we understand new communication practices emerging through the possibilities of openness afforded by digital media. It is important here to clarify the distinction between informal and formal modes of scholarly communication. Harley et al. (2010) find very little movement among scholars toward publication of scholarly work in online

venues. In spite of the increasing utilization of e-research practices, scholars interviewed across a variety of disciplines overwhelmingly give priority to traditional publication venues when considering career advancement. From the study by Harley et al., it is apparent that the academic reward system, particularly in the United States, shows few signs of deviation from the traditional structure. Although interesting articulations of openness are occurring in the area of informal scholarly communication, most visibly within emerging e-research practices and environments associated with virtual knowledge, there is little research that identifies it as the primary object of inquiry. To address these issues, we propose an analytical framework for openness in scholarly communication. The proposal is followed by examples of openness in both informal and formal venues.

CHANGES IN THE ROLE OF SCHOLARLY COMMUNICATION

Informal scholarly communication manifests itself in a variety of structures, from organized conferences to *ad hoc* discussions. In the traditional sense, few informal modes of scholarly communication are assessed as new knowledge and thus do not substantially contribute to the allocation of academic rewards. At the same time, it is difficult to imagine science and research functioning without informal communication practices. Formal scholarly communication has four distinct functions with respect to academic reward: registering intellectual priority, certifying quality and/or validity of research, disseminating new research, and preserving the scholarly record for future use (Roosendaal and Geurts 1997; Johnson 2004). As will be discussed below, aspects of digital media are being incorporated into formal communication, but these changes are incremental and seldom exploit the social aspects commonly associated with Web 2.0 applications. With notable exceptions (some of which are presented later in this chapter), the formats of academic journals and scholarly books have remained largely unchanged, whereas in modes of informal communication practices are more readily influenced by innovations in popular use. With a limited role in the academic reward system, advances in informal scholarly communication are more closely aligned with advances in popular uses of digital media, and thus provide a site for examination of changes in scholarly communication practices.

Discussions of informal scholarly communication have appeared within studies addressing other aspects of the academic system. This is evident in

science communication research (Garvey 1979) and in historical accounts of science and the emergence of academic disciplines (Whitley 2000), both of which have utility in examining the rapid growth and adoption of Web-based informal communication practices. Garvey characterizes formal communication as highly structured, its prime concern being the dissemination of knowledge, which is often “old” by the time it is available in scholarly journals. In contrast, Garvey characterizes informal communication as fluid, adaptive, and often ephemeral, where preliminary research results and new ideas are presented for feedback.

Informal communication operates much in the same way at the beginning of the twenty-first century, although adoption of Web-based communication media renders these practices more visible and, in so doing, provides a basis from which to identify both existing and new practices. For example, Garvey’s (1979) original account of expected audiences points to a tension in the utilization of digital media for formal and informal scholarly communication. In academic tradition, new knowledge is first made public when it appears in academic journals. In Garvey’s account, scientific communication finds its large potential audience in journal distribution, and informal communication is characterized by a small audience, intentionally limited to public presentations, face-to-face interaction, and distribution of printed-on-paper drafts (154). In comparison, a text published on an academic blog or a video uploaded to YouTube is instantly accessible, with the potential to reach a much larger audience. Whereas academic journals, even when published online, are often restricted through pay-for-access systems, content published openly on the Web is immediately accessible. One widely consulted example of academic use of social media is the YouTube video by Michael Wesch on the meaning of Web 2.0. The video “Web 2.0 . . . The Machine is Us/ing Us” (Wesch 2007) has been viewed more than 11 million times and received more than 23,000 ratings and 8,000 comments as of September 2011. Another example of informal publications by academics having achieved very large audiences is the online version of Fitzpatrick’s (2011) scholarly monograph. Made available before the book’s publication by the New York University Press, it was consulted more than 20,000 times by nearly 8,000 site visitors, who posted nearly 300 comments.¹

These examples are not meant to suggest that blogs or videos create a competitive threat to journal publishers, but they do suggest radical change in potential audiences. With the aid of digital media, modes of informal

scholarly communication are encountering much larger audiences, even when compared against open access to journal articles and books.

Changes in relative audience size have implications for the respective roles of scholarly communication. As Garvey (1979) notes, new findings and ideas are first presented in informal scholarly communication. Sharing insights and information on an academic blog makes them instantly accessible to the online public, and in so doing provides some degree of intellectual priority, albeit without formal assessment by peer review. However, because informal communication is both central to scholarship and still not very well defined in the literature, it is difficult to isolate. In addition to the overlapping contributions in establishing intellectual priority and to the extent that informal scholarly communication is distributed and maintained on the Web, it can also provide an archival role, thus overlapping another primary function of formal scholarly communication. Content repositories in particular serve an archive function.

Uploading draft articles to the Social Science Research Network² and uploading presentation slides to SlideShare³ are two ways in which scholars are using digital media to distribute informal scholarship. Procter et al. report that a majority of scholars in the United Kingdom occasionally (45 percent) or frequently (13 percent) “use Web 2.0 in novel forms of scholarly communication” (2010a, 4043). These results are based on an expanded definition of scholarly communication that combines the informal and formal modes. Elsewhere, the same authors conclude that a significant minority of scholars “express considerable enthusiasm for change” and an understanding that “benefits may come from relatively unconstrained early dissemination and discussion of their ideas and their findings” (Procter et al. 2010b, 49). However, their enthusiasm is muted by concerns about disrupting the academic reward system and by jeopardizing formal publication opportunities.

This conflict can be understood as a tension between the benefits of establishing intellectual priority through the use of digital media and the risk of losing intellectual priority by waiting for the process of formal publication. At stake in the move to increased openness are the rewards upon which academic careers are based. Academic journals have traditionally provided the “date stamp” that establishes when new knowledge was produced. This establishes when and by whom research results, ideas, theoretical claims, and discoveries are considered new and original. Amid the transformation of scholarly communication and the rush to build new ICT infrastructures,⁴ also within the academic publishing sector, the role of formal modes of

scholarly communication is being complicated by increasing openness in informal modes. One example is the academic reward system, which is traditionally based on research impact (e.g., publications and citations). Though these ICT infrastructures facilitate new possibilities for open science, there is a tension between the emergence of new forms of open scholarly communication, typically within informal venues, and the academic publishing system, which continues to facilitate the allocation of academic rewards. In other words, scholarly contributions that contribute to increased openness are difficult to measure in terms of research impact in one's field. This points to the need for an increased understanding of openness in scholarly communication, particularly among the many new forms emerging from informal venues.

ANALYTICAL FRAMEWORK OF OPENNESS

Taking this evolution into account, the proposed analytical framework of openness focuses on interfaces and infrastructures of communication media. (See figure 6.2.) Specifically, the interface of openness is defined here as the point of interaction between a user and a communication medium. The interface dimensions include accessibility, inclusivity, and transparency, which collectively provide a basis for examining the practice of openness. Analysis of the interface (and its corresponding dimensions) provides a view of openness in the ways in which digital media are used with respect to their intended functions. In this framework, the infrastructure of openness is embedded in the construction and the operation of the communication venues, each of which utilizes an enabling platform. The infrastructure of openness is defined here as the possibilities enabled or constrained by the interaction among technical standards, modes of interoperability, and levels of adaptability. Although it is not universally the case, we identify scholars as the primary actors at the interface of openness, and technical experts and administrators, as well as scholars, as the primary actors involved in the infrastructure of openness.

To elaborate, the interface of openness is conceived as the place where users act upon digital media to communicate with others. Correspondingly, the possibility for openness is conceived as socio-technological infrastructure, which includes activities such as selecting, configuring, and implementing associated communication resources. By shifting the purview of openness beyond access to published articles (typically the end result of

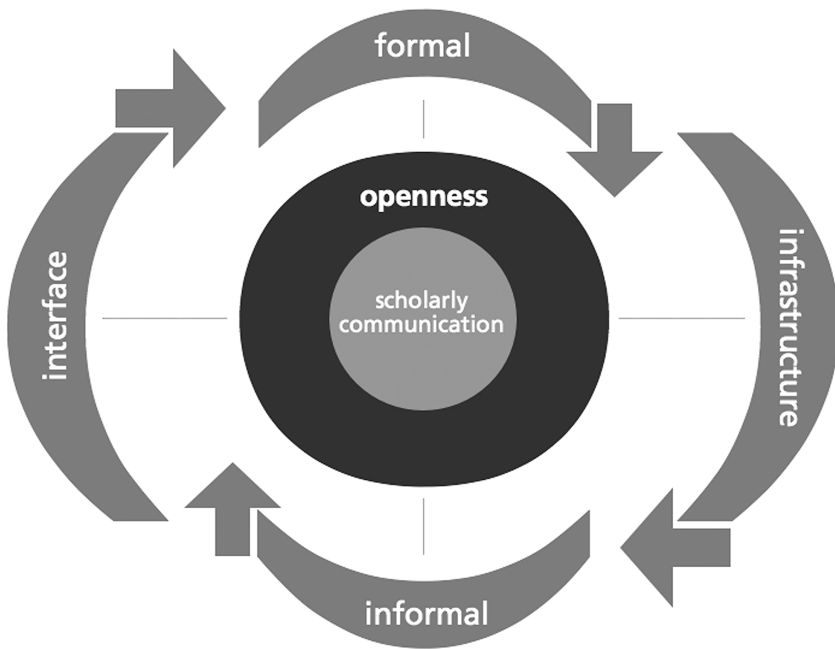


FIGURE 6.2

Diagram of Openness Framework (source: Tatum 2011).

research activity), a larger and more socially complex analytical domain is revealed. With respect to “virtual knowledge,” inclusion of the many and diverse actors who contribute to new constructions of openness increases the possibilities for open science embedded in the broader realm of scholarly communication—both formal and informal. As such, analytical focus is aimed at interaction among human agency, social structure in the form of situated practices, and material structure in the form of digital media. Following Orlikowski, we view technology as “both an enabler of, and a constraint on, human action” (Orlikowski 1992, 25). The conceptual framing of openness as contingent upon interface and infrastructure recognizes the dual role of technology in facilitating both agency and structure (Virtual Knowledge Studio 2008).

INFRASTRUCTURES OF OPENNESS

The infrastructure of openness as used here comprises standardization, interoperability, and adaptability. At a system level, the standards employed

have a significant role in shaping the possibilities of openness. We are not so much concerned with which standards are used. Rather, of interest are the ways in which selection and utilization of standards facilitate and/or constrain particular articulations of openness. The next two infrastructure dimensions, interoperability and adaptability, are understood first by establishing relevant technical standards; it is their respective orientations that have a bearing on openness. Issues of interoperability are typically concerned with inter-compatibility of technological components. Here we use the same logic, but applied to content rather than technology *per se*. Apart from whether a communication platform is in compliance with open Web standards, and thus accessible by anyone with Internet access and an active account, we measure content interoperability in terms of intertextuality among internal as well as external resources—specifically the ways in which digital content is compatible with tagging, hyperlinking, and syndication. Concepts of content intertextuality go back to Vannevar Bush's (1945/1995) "mesh of associative trails" and Ted Nelson's (1965) pioneering formulation of hypertext. (See figure 6.3; also see the discussion of Paul Otlet in chapter 3 above.) The capacity for intertextuality is fundamental to the structure of content across the Web, but these capabilities are not always similarly employed.

Technological infrastructure at universities, often vertically constructed, provides an illustrative view of the dynamics of content interoperability. A university installation may utilize proprietary or open-source software, or a combination of both, but the concerns for interoperability are typically prioritized with respect to a complete set of resources (perhaps including access to the Internet, office automation, and the latest installation of e-research infrastructures). The need to keep these resources safe and secure often requires significant and ongoing engagement. Such an effort would necessitate security standards across the campus-wide collection of resources while maintaining interoperability among them, but often at the expense of compatibility with resources outside of the collection. In a university setting, infrastructure is often the dominant consideration in enabling and constraining content interoperability.

In practice, however, the relationship between standards and interoperability can be a bit more convoluted. Standards create a shared technical language that governs how individual software and hardware components communicate with one another (Simcoe 2006, 161). Two international standards bodies, the World Wide Web Consortium and the Internet Engineering

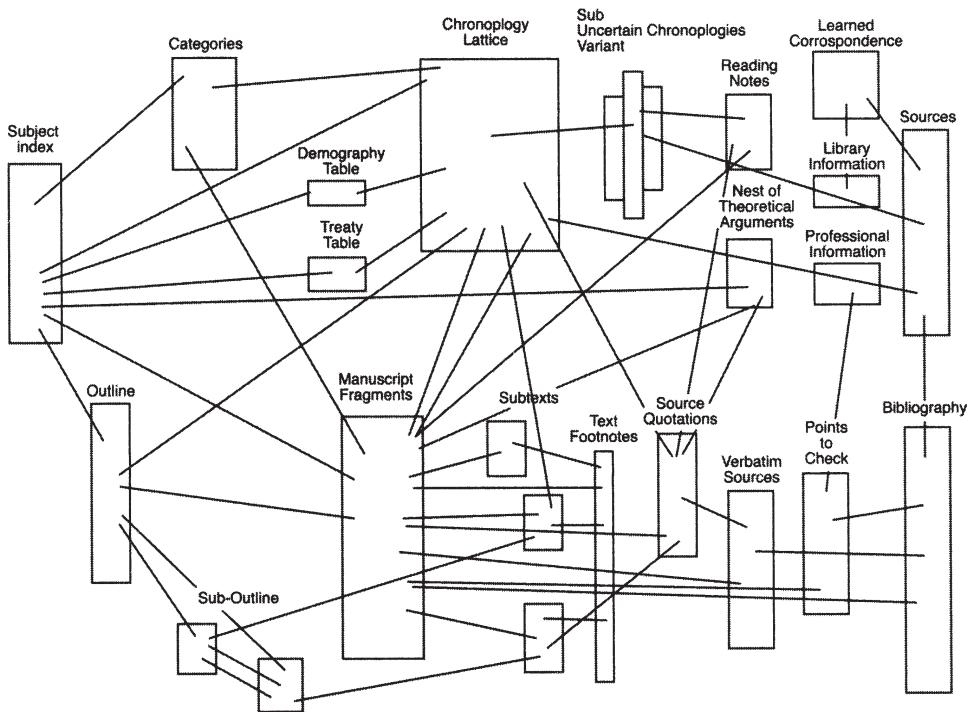


FIGURE 6.3

Nelson's notion of Evolutionary List File (ELF) applied to historiography (source: Nelson 1965, 12).

Task Force (IETF 2010), work closely together, and with others, to create and perpetuate open standards that establish “a formal set of obligations that promote fairness, responsiveness and progress” on the Internet (W3C 2010). Although the Portable Document Format is recognized as an open standard for publishing documents on the Web, its use limits interoperability. First introduced by Adobe in the early 1990s and released as an open standard in 2008,⁵ the Portable Document Format provides platform independent sharing of formatted text, graphics, and images within a single document. Developed in an era when sharing documents across different operating systems was problematic, the Portable Document Format employs a rigid internal structure to prevent inadvertent changes to the document content. As a consequence, it also prevents content from being linked to at the content level of word, sentence, or image within the document.

The ways an infrastructure can be adapted for a particular context are shaped by the technical standards employed in a platform and the associated degree of content interoperability. But the potential for user interventions also contributes to how a communication medium can be adapted for particular uses. We define the adaptability dimension as the level at which customization can occur. Adaptability is conceived here as the possibility of change at three levels: that of user customization, that of community-driven process improvements and refinements, and that of institutional customization.

THE INTERFACE OF OPENNESS

Operationally, the interface of openness is defined to include the dimensions of access, inclusion, and transparency. For our analysis, accessibility is a measure of when and to what degree content is made available for distribution and consumption. Inclusivity, on the other hand, depends on the extent to which a communication venue allows others to participate. Indications of inclusivity include when users are able to add comments to published content, to edit published content, to upload new content, and to delete existing content. The transparency dimension involves the visibility of stakeholders associated with the medium, relevant processes, and organizational issues associated with operation of the platform. Most digital resources include information about the site and about its owners, its organizers, and sometimes its participants, often found at the “About” page. Information regarding processes, codes of conduct, limitations, and liabilities is found at a “Terms of Service” or “Rules” page. Indicators of interests are more complicated, and may be impossible to find from information provided in a communication medium. However, examination of the structure and organization of the technology reveals information that, when combined with published information, allows inference regarding the degree of transparency of such platforms (and their administrators). Indicators of this sort include identification of the holder of the domain name and the location of the servers. Specifically, this is the identification of who “owns” the domain name and whether the site is hosted independently, by a related or parent institution, or by a commercial service provider. Things as seemingly innocuous as the registration of the domain name or the site’s host point to additional stakeholders in a particular configuration of openness.

The interface for uploading the previously discussed YouTube video (Wesch 2007) offers a range of user-selected parameters that both enable and

constrain how the video can be viewed, rated, commented upon, and distributed by both its producer and its viewers. Similarly, the viewing interface enables and constrains how the video can be consumed in conjunction with the content producer's settings. Over time, common usage patterns begin to form the expected use of the medium, at the same time informing developers about future enhancements. In this way, human interaction with the YouTube interface can influence decisions made about future iterations of the infrastructure. In this case, we are interested in changes in the YouTube platform that result in changes to its interface. Orlikowski describes this cycle as an "ongoing interaction of technology with organizations [that] must be understood dialectically, as involving reciprocal causation, where the specific institutional context and the actions of knowledgeable, reflexive humans always mediate the relationship [of the interaction]" (1992, 34). Because the possibility of openness exists among many other features of a particular interface and among many other attributes of a particular technology, it is necessary to operationalize the concepts of interface and infrastructure of openness.

We illustrated the components of our openness framework in figure 6.2. We used this framework to examine openness associated with technological innovations in both formal and informal scholarly communication. We then evaluated the implications of openness with respect to the functions of scholarly communication noted above. Of particular interest are the areas where informal communication practices overlap with the traditional role of formal communication, and the intertextual structures that are co-created through the collaborative use of digital media in informal communication. The results of this analysis enabled us to make explicit the emergence of new academic practices facilitated by digital media, and to provide a framework for examining new features introduced into formal modes of scholarly communication. Identification of the interfacial and infrastructural dimensions of openness provided a comparative basis for what a particular socio-technical installation enables and how it is used.

In the next two sections we review technological advances in both formal and informal modes of scholarly communication. Journal and book publishers continue to experiment with new ways of leveraging the capabilities of digital media, but with careful consideration for their role in facilitating the academic reward system described above. In spite of some rather innovative features, the structure of journal articles and books remains very much unchanged. While access has improved and readership has increased, the

benefits provided are limited to specific texts (those deemed publishable). On the other hand, there is significant change taking place among informal modes of communication where there is some overlap in establishing intellectual priority and the archival role of formal publication. More important, the increase of potential audience, the diversity of interconnected communication channels, and the creation of networked content through informal communication practices seem to expand the utility and function of scholarly communication in interesting ways. In the illustrations that follow, we show advanced features added to digital versions of academic journals and books. For informal communication examples, we select typical uses of stable technologies to illustrate the ways in which increased openness facilitates the interconnecting of communication content between and among communication venues.

FORMAL SCHOLARLY COMMUNICATION

As was mentioned earlier, the two main forms of formal scholarly communication are books and journal articles. Here we illustrate how these forms are adapting to the Internet environment. Three book examples are presented: an initiative of the University of Michigan Press, an overview of websites complementing scholarly titles, and a new variant to peer review of book manuscripts.⁶ Similarly, three journal examples are presented: illustrations from open-access journals, initiatives by commercial publishers in the social sciences and the humanities, and a new journal format by a major publisher in the natural sciences.

BOOK PUBLISHING

Book publishers have experimented with a range of marketing strategies involving digital media and Web-based distribution, and sometimes in hybrid fashion. The MIT Press, for example, released Mitchell's (1996) *City of Bits* online and in print, with some degree of financial success, according to Thompson (2005, 330–331). Other MIT Press books have since been released in a similar fashion: the revised version of Rheingold's (2000) *Virtual Community*, Willinsky's (2005) *The Access Principle*, and a series of reports on digital media and learning prepared in collaboration with the MacArthur Foundation.⁷ In 2007 the University of Michigan Press established "digitalculturebooks," an experimental publishing strategy that makes titles

available both as files that can be read online (but not easily printed) and as conventionally bound and printed versions for purchase (Turow and Tsui 2008). Another strategy involves the construction of websites that complement print-based books. Thompson (2005) suggests several reasons publishers consider this approach and constructs a list of “added values” similar to that compiled for other media, such as electronic newspapers (Jankowski and Van Selm 2000).

Thompson (2005) argues that the most substantial change in publishing is occurring in the production and marketing divisions of the enterprise. Readers are generally unable to see such changes, but the changes cover the range of activities in publishing, from receipt of a manuscript through to publication in print or electronic form, including the establishment of a point of sale on the publisher’s website. The scope and the intensity of the transformation of the publishing industry suggest that much is in flux. At the same time, the essence of scholarship —its contribution to understanding, to new knowledge, and ultimately to scientific breakthroughs—remains a craft entailing much time and intellectual investment, that is not fundamentally altered by digital innovations.

ACADEMIC JOURNALS

By and large, the role of scholarly journals is based on the publishing traditions developed within specific academic disciplines, and in the social sciences and the humanities these traditions generally place emphasis on text-based argumentation, with attention usually devoted to both theoretical issues and empirical evidence. Journal articles rely on, and are prepared according to, an accepted template, with limited attention to visualization and dynamic presentation of data, little opportunity for reader–author exchange, few internal or external hyperlinks, and almost no accessibility to research instruments and datasets. This sketch, though sweeping, outlines the dominant profile of social science and humanities journal article publishing. It is also prominent among online-only open-access periodicals in many disciplines in the humanities and the social sciences. One example of the application of this template is the *International Journal of Internet Science (IJIS)*, which is essentially a mirror image of the style and content found in the high-status print-based periodicals in the same area of scholarship. (See figure 6.4.).

The *Journal of Computer Mediated Communication (JCMC)*, also an online, open-access journal, exemplifies a move in the direction of increased

openness though providing full texts in HTML webpages. (See figure 6.5.) Full texts are typically provided only in pdf format, which preserves the format and layout and provides some limited protection from content changes. Originally designed as a solution of cross-platform compatibility, these benefits also limit content interoperability on the Web, insofar as publishing in pdf format is meant for downloading, storing, and reading on a local computer. Content within the pdf wrapper is to some extent isolated from the Web (as was discussed earlier), which diminishes the possibility for search-engine indexing of content elements and which also limits the sort of intertextual constructions possible with HTML. Thus, publishing

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Volume 4, Issue 1 (2009)

Continuous Measurement of Musically-Induced Emotion: A Web Experiment
Hauke Egermann, Frederik Nagel, Eckart Altenmüller, Reinhard Kopiez
Hanover University of Music and Drama

Abstract: The aim of this study was to determine the validity of the Internet-based ESeNet software for the measurement of emotional music experiences by comparing the data of this study with those previously collected in a lab experiment. Participants ($N = 83$) listened to different music pieces online. At the same time they gave a continuous self-report about their emotional state by moving their computer-mouse in a two-dimensional emotion space and indicating chills (strong emotions accompanied by shivers down the spine or goose pimples) by clicking the mouse button. The emotional dimensions assessed were arousal and valence. Participants reported that the music pieces caused different emotional reactions that were not significantly different from the lab study using the same stimuli. Thus, the validity of this Internet-based method could be confirmed. In general, nearly all participants evaluated positively most aspects of the study — with the exception of the participation time. None of the technical parameters investigated at the participants' computers significantly affected the emotional self-report, but an influence of the self-rated concentration on arousal and chill ratings was observed. The results also show that experiments in the Web offer a promising way for emotion research and provide insights on emotions experienced when listening to music in every day life.

Keywords: Emotion, music, Web experiment, continuous rating, Internet

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FIGURE 6.4

Screen shot of article in online-only journal (source: <http://www.ijis.net>).

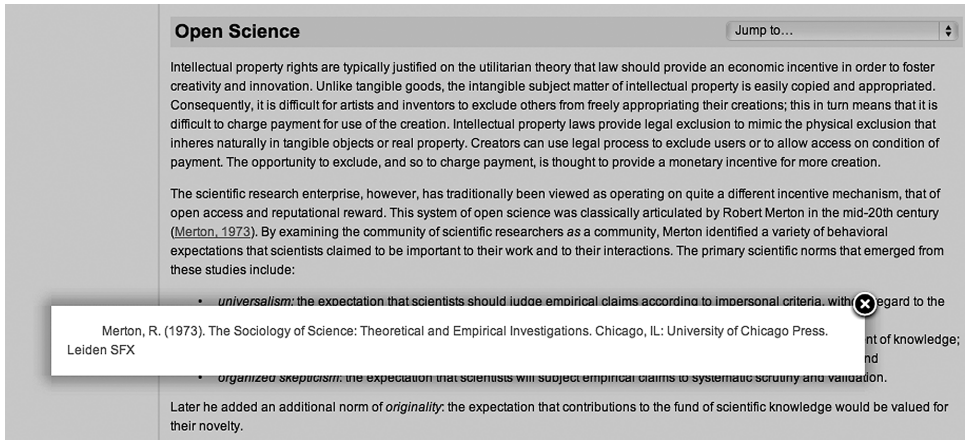


FIGURE 6.5

Screen shot of HTML formatted journal article (source: <http://onlinelibrary.wiley.com>).

content in HTML format increases content interoperability within and among journal articles published on the Web. A fundamental open Web standard, HTML facilitates hyperlinking and meta-data attributes within the full text.

In both the *IJIS* and *JCMC* examples, there is open access to articles and open Web standards are employed. However, although *JCMC* articles are available in HTML format, hyperlinking is used primarily for navigation within the text. Instead of linking directly to cited resources, hyperlinks are used to first display the full reference (see figure 6.5) and then to jump to its location in the reference list. This example shows how publishers selectively employ technological affordances in ways that limit the degree of openness. Another example of innovative use of Web features in a closed fashion is the journal *Cell*. Announced in 2009, *Cell*'s initiative was billed at its launch as "tak[ing] full advantage of online capabilities, allowing readers individualized entry points and routes through the content, while using the latest advances in visualization techniques" (Elsevier press release, July 20, 2009).⁸ In practice, readers are able to begin with any section and traverse sections through embedded hyperlinks. Literature references are also hyperlinked, often making a direct path to external text locations, but access to external sources is prevented when additional subscriptions are required. (The

continued presence of subscription firewalls between journal articles limits the broadening of network potential, particularly with regard to extending intertextuality beyond the individual article. Implications of intertextual hyperlinking are discussed further below.)

Cell published its first issue in the new format in January 2010. (See figures 6.6 and 6.7.) The new format directs reader attention to specific components of an article rather than an all-encompassing presentation or argument. It emphasizes visualizations and multimedia components. Internal and external hyperlinks are included, as are audio interviews with article authors. References with citation rankings are dynamically updated, and an analysis of references indicating frequency of citation is provided. Overall, the “Article of the Future” initiative suggests movement away from the traditional linear structure of the scholarly journal article to an almost postmodern conception of the article emphasizing visual, multiple modes of presentation and online dynamic updating.

There is nothing comparable to Elsevier’s “Article of the Future” initiative in the social sciences or in the humanities, although there are some titles exploring incorporation of multimedia. The *International Journal of Learning and Media (IJLM)*, launched in 2009 by the MIT Press and supported by the MacArthur Foundation, includes a contribution based on YouTube videos (Juhász 2009), and in January of 2010 *IJLM* organized a Web-based forum discussion involving the journal’s editor, two authors, and a respondent. (It is available at <http://ijlm.net>.) Several periodicals (among them *Journalism Studies*, *Television & New Media*, and *Information, Communication & Society*) have been experimenting since 2009 with podcasts and videos as supplements to journal issues, but such initiatives are present in only a few of the thousands of periodicals published in the humanities and the social sciences.

Although some observers (Hendler 2007; Whitworth and Friedman 2009) speak of an ongoing “revolution” in academic journal publishing, change of that magnitude is limited to a few scholarly periodicals. Elsewhere, change seems small, incremental, and cautious, at least in the humanities and the social sciences. Change also seems most prominent in those areas that facilitate organizational efficiency (e.g., “back office” manuscript processing) and in marketing and promotion. Though some scholars may incorporate social media into their informal communication practices, this is seldom evident in the journal articles prepared and published by these same academics.

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Monoacylglycerol Lipase Regulates a Fatty Acid Network that Promotes Cancer Pathogenesis

Reflect ☐ Proteins ☐ Chemicals

Find term in article Find Clear

Summary Introduction Results Discussion Exp. Proc. Data References Supp. Info. Related Info. Comments (2)

Cell, Volume 140, Issue 1, 49-61, 8 January 2010
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10.1016/j.cell.2009.11.027

Referred to by: Chewing the Fat on Tumor Cell Metabolism...

Referred to by: A New Age for MAGL

Authors
Daniel K. Nomura, Jonathan Z. Long, Sherry Niessen, Heather S. Hoover, Shu-Wing Ng, Benjamin F. Cravatt 
See Affiliations

Highlights

- Monoacylglycerol lipase (MAGL) is elevated in aggressive human cancer cells
- Loss of MAGL lowers fatty acid levels in cancer cells and impairs pathogenicity
- MAGL controls a signaling network enriched in protumorigenic lipids
- A high-fat diet can restore the growth of tumors lacking MAGL in vivo

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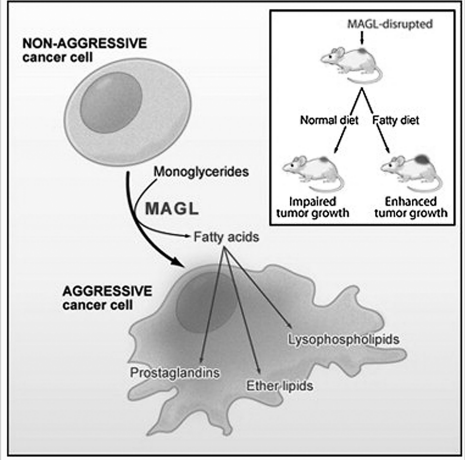


FIGURE 6.6

Screen shot of “Article of the Future,” *Cell*, January 2010 (source: <http://www.cell.com>).

INFORMAL SCHOLARLY COMMUNICATION

Informal modes of scholarly communication are increasingly made visible through the use of digital media. This section presents examples of how informal communication practices are evolving with the use of freely available products and services on the Web. In selecting commonly used applications for illustration purposes, emergent practices that are compatible with open Web standards are foregrounded. Excluded from this selection are the kinds of commercially oriented platforms that limit interoperability either intentionally (e.g., for economic purposes) or unintentionally (e.g., as a result of specific functional needs). As will be discussed below, compliance with open Web standards facilitates the use of explicit intertextual references through hyperlinking (Mitra 1999) from one text to another across different communication platforms.

Illustrative examples include an email list used by the Association of Internet Researchers (AoIR), the incorporation of individual blogs in the

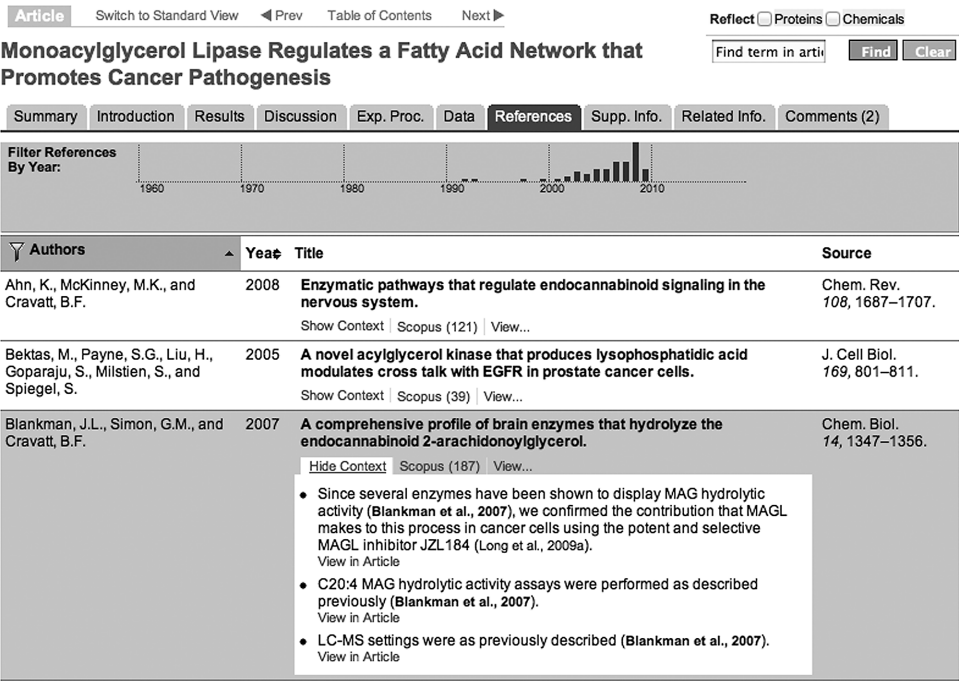


FIGURE 6.7
Screen shot of dynamic references included in “Article of the Future,” *Cell*, January 2010 (source: <http://www.cell.com>).

websites of the Oxford Internet Institute and the Humanities, Arts, Science, and Technology Advanced Collaboratory; syndication of article updates; and the use of a keyword tag cloud by the Science Studies Network. Although contemporary communication platforms can and do include all these functions bundled into a single website, individual examination of these practices sheds light on the role of digital tools and resources in the co-construction of scholarly discourse. A hybrid example, an Enhanced Publications project, illustrates a blending of formal and informal practices.

EMAIL

Scholarly communication using email lists may be the least dynamic contribution to the structuring of scholarly discourse. Nevertheless, simplicity and ubiquity of use and low financial and administrative barriers contribute to the popularity of email lists. In addition, email lists have been shown to

encourage inclusivity and equality (Kavada 2010). Common in many fields and disciplines, email lists make use of asynchronous communication in ways that can increase the diversity of topics, scale of participation, and continuity of discourse across time. However, it should be noted that reliance on email lists to ensure an informed group of participants can result in a fragmented community when both email and face-to-face meetings are required to stay informed. Inevitably, not all participants can attend all face-to-face meetings, thus potentially creating inequalities of information access (*ibid.*).

The Association of Internet Researchers administers an email list known as Air-L. As of 2010, it had more than 2,000 subscribers. Scientists, scholars, researchers, activists, and technologists engage in communication about societal aspects of the Internet. Participation is open but requires registration. Contributions to Air-L discussions cannot be made anonymously, but the list is not moderated. When a registered user sends something to the list, it is instantaneously distributed to all other users.

Most present-day email lists archive contributions. Air-L's archive represents nearly ten years of active engagement, which is open on the Web and can be queried with public search engines. The archive consists of HTML-coded webpages with an ordered list of links, each corresponding to an individual email. Emails are sortable by subject, date, author, or discussion thread. The resulting link structure is internally robust, providing easy navigation throughout the archive with connections to external content through active links embedded in the original email correspondence. Because each email has a unique URL, email content can be linked to as a resource and the archive itself is open to indexing by public search-engine robots. However, the content of the archive is completely static. Other than the internal link structure, its contribution to intertextuality occurs passively, if and when content is linked. Even so, linked content is likely to be findable, and in some cases eminently discoverable, owing to the influence of hyperlinking on search-engine rankings (Tatum 2005).

ACADEMIC BLOGS

Academic blogs are used in a wide range of forms. Some common examples include publication of scientific results, discussion of new ideas, and reflection about scholarly life and culture. Configurations are similarly diverse, ranging from individual blogs to a variety of network structures, such as a loose network of blogs connected through individual contributions to

particular topics and a highly selective set of blogs, the content of which is aggregated and presented in a topic-specific stream. In principle, anyone with Internet access and a browser can read and comment on academic blogs. The blog format typically includes published texts presented in reverse chronological order, a place for readers to comment, a display of links to other relevant blogs, and a variety of options for navigating and consuming content. In comparison to email lists, discourse is nonlinear and unbounded, and participation is typically open to the public.

Hyperlinking is a common practice in blogging. Linking documents, collections of documents, and related audio and visual resources creates a content structure that is independent of where (that is, in which servers) the individual pieces are located across the Web (Halavais 2008, 43). This “textured connectivity” of scholarly discourse is created with hyperlinking, by either human or machine (such as databases) actors (Beaulieu and Simakova 2006). In contrast with traditional citations in printed text, the immediacy of hyperlinks facilitates the construction of intertextual discourses, which are dynamic in both production and consumption. A text published on a blog can be commented on by others, updated at a later time, and reacted to in other blogs that link back to the text. The potential for response is both immediate and enduring, something Gray et al. (2008, 114) refer to as the anticipation of “intertextual orders of meaning” that can be created by future “reader/writer contributors.” The suggestion is that meaning is more fluid in the co-construction of hyperlinked discourses when the potential for new contributions can develop over time (*ibid.*). Consumption of hyperlinked discourses is influenced by the opportunities to follow unique paths of hyperlinks in a particular text and by the potential for additions and changes over time.

Syndication protocols, such as RSS or Atom, enable users to subscribe to content from a variety of sources, thereby creating a customized aggregation of content readable in a single location (usually by means of an RSS reader). Through aggregation techniques, a short announcement of the most recent content, often a blog post, is automatically compiled, thus enabling readers to follow the progress of multi-site interactions in a single place. These same aggregation techniques are used to present content from multiple individual voices on, for example, a single institutional website. The website of the Oxford Internet Institute⁹ and that of the Humanities, Arts, Science, and Technology Advanced Collaboratory¹⁰ (figure 6.8) are examples of

institutional websites that aggregate and publish members' blog posts prominently on their respective home pages.

Being the first person to present findings or to make particular claims on a blog does not formally register intellectual priority, as would be the case in a journal publication, but it does provide a sounding board among peers. In some cases, it signals interest in a particular intellectual territory. These practices seem to serve as groundwork for later submission of manuscripts intended for publication. Ideas and findings communicated on a blog before publication in a journal establish a registration of intellectual priority, insofar as blog content on the Web has a date stamp. One of the main attributes of

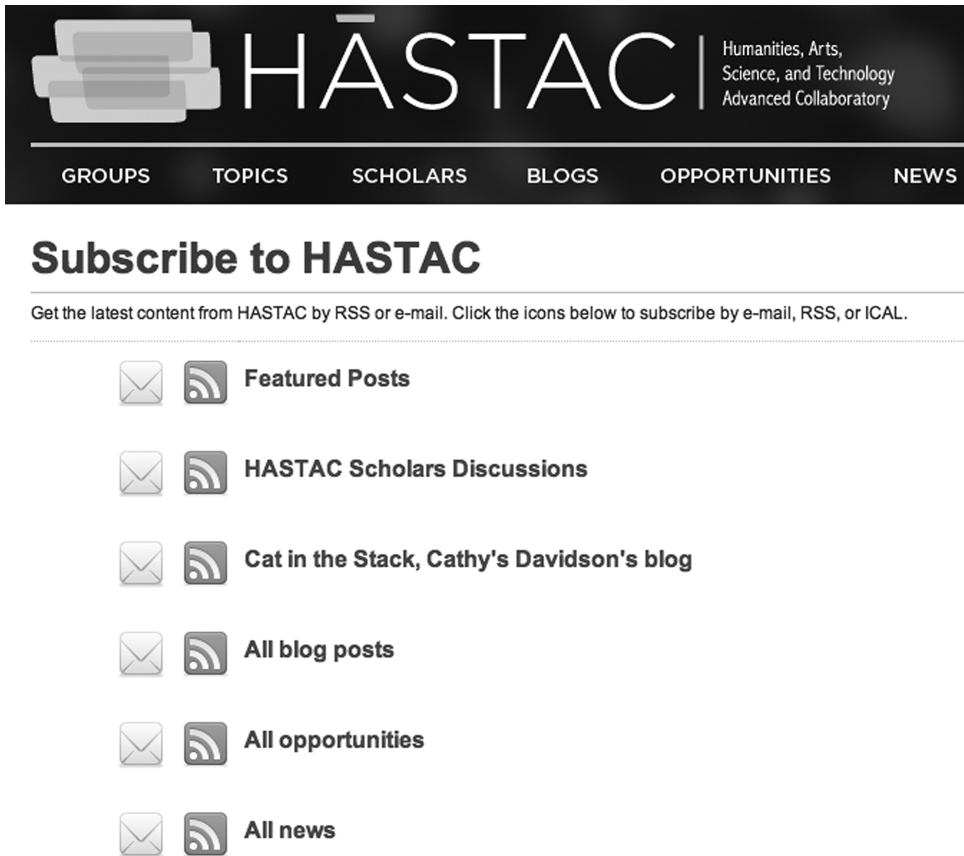


FIGURE 6.8

RSS feeds from HASTAC Humanities Collaboratory (source: <http://hastac.org>).

blogs (both private, password-protected blogs open only to a select group of individuals and publicly accessible blogs) is the way in which content is contextualized through intertextual hyperlinking, tagging, and aggregation.

SOCIAL TAGGING

Tagging (often referred to as *folksonomy*) is a collaborative form of indexing in which user-generated keywords and associations contribute to a co-produced organization of content. Common sites of tagging include social bookmarking (exemplified by Delicious), photo sharing (exemplified by Flickr), and blog posts. Keyword tags have a dual role: they communicate meaning and they contribute to content structure. Both producers and consumers of digital content can add keyword tags to content. Aggregation of user-generated tagging results in a bottom-up structuring, or taxonomy, of content. Thus, tagging serves to imbue individual content objects with meaning and to establish associations between content—irrespective of formal hierarchy, type, or kind—that would otherwise be imposed by a formal classification system. For example, the tags such as *1950s*, *musician*, and *Jacques Brel* can be simultaneously attributed to a blog post, a video, an image, a music collection, and a top-level website. Implications of social indexing include the abilities to add description to individual content objects, to contextualize content locally and globally, and, in doing so, to categorize these objects among other Web-based content related to each descriptor tag.

Figure 6.9 illustrates the Science Studies Network tag cloud application, which was developed to facilitate contact between researchers with similar interests. The size of individual tags is related to frequency of use. Users enter keywords describing research interests and can click keywords to locate researchers with similar interests.

ENHANCED PUBLICATIONS: A HYBRID APPROACH

The final example brings into focus contemporary tensions between the top-down structure of formal scholarly communication and the bottom-up, emergent structure of informal scholarly communication. For illustrative purposes we will use something we contributed to an enhanced publications project (Jankowski et al. 2011).

Enhancing scholarly publications involves presentation in a Web environment with interlinking of the “objects” of a document, such as data on which the publication is based, supplementary materials, post-publication

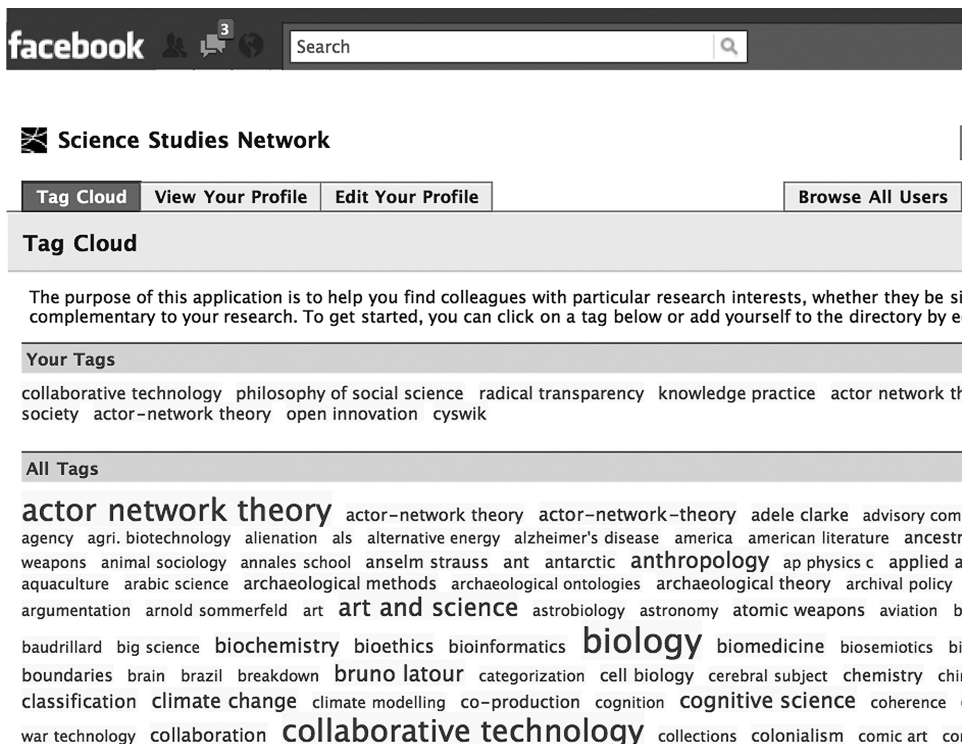


FIGURE 6.9

Tag cloud application developed for use on Facebook by the Science Studies Network (source: <http://apps.facebook.com>).

reactions, and secondary analyses. The outcome of our project is the development of enhanced publications for traditionally published books, intended to introduce book content into the Web environment.

As an important mode of scholarly communication, particularly in the humanities, the academic book format has seen relatively little enhancement from the affordances of digital media, networked content, and database technologies. Rather than attempting to redefine the book format in a digital environment, our project¹¹ focuses on the book in its present form. The WordPress¹² Content Management System (CMS) is used both for its relative ubiquity and for its ease of use. Custom plug-ins were developed to make use of Web 2.0 participatory modes of scholarly communication in combination with formalized content structures imposed by Semantic Web formats. (See figure 6.10.)

The hybrid approach reveals tensions between the participatory practices common in Web 2.0 environments (practices associated with informal scholarly communication) and formalized content structures imposed by Semantic Web content ontologies typically envisioned for use with formally published content. A common Web 2.0 practice is to use hyperlinks when citing references and related resources. In this way, books are contextualized within related discourses. This sort of situating of book content actively increases its exposure on the Web through increased access within a network and through increased visibility in search-engine queries. At the same time, book content is also structured through formal object relationships defined in book/website (hybrid) ontology. Exposing book content to the burgeoning Semantic Web also increases its exposure, but in a more passive way and potentially in a more precise way. The benefit of this structure is uncertain,

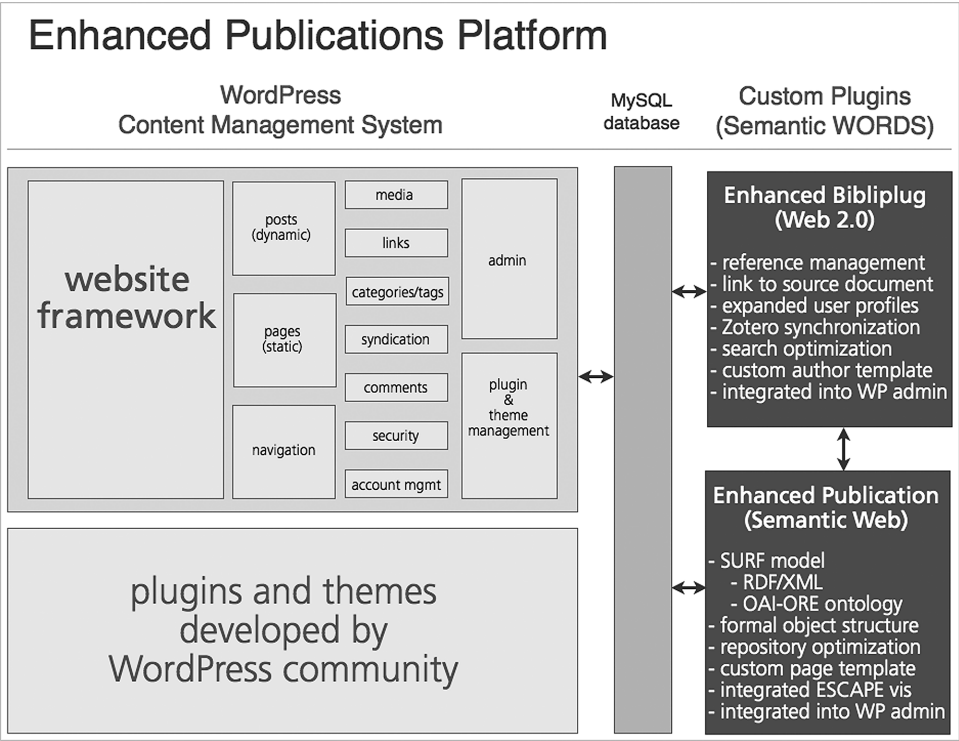


FIGURE 6.10
Semantic WORDS is a suite of plug-ins developed to facilitate Semantic Web formats for the WordPress platform (source: <http://ep-books.ehumanities.nl/>).

insofar as access to Semantic Web aggregation is still somewhat limited to specialized repositories and machine aggregation that adds additional layers of mediation between humans and the sought-after content. Though Semantic Web projects seem to be increasing in numbers and diversity, which presumably increases interoperability of content on the Web, the expected contribution to scholarly communication is still envisioned as a longer-term investment.

The juxtaposition of formal and informal communication with respect to the emerging practices enabled by Semantic Web and Web 2.0 provides an opportunity to reflect on normative roles within scholarly communication. Both Web 2.0 and Semantic Web provide content structures that facilitate interoperability within and among knowledge domains. Semantic Web structures are often envisioned as a way to create more precise interoperability between concepts and terms within and across knowledge domains while retaining a rigorous hold on the accumulation of new knowledge. Meanwhile, the popularity of Web 2.0 applications in academic use is associated with an evolving form of scholarly communication.

CONCLUSION

Facilitated by the use of digital media, formal and informal modes of scholarly communication have evolved in different ways. In this chapter we have discussed the incorporation of advanced features into digital versions of academic journals and books, and the ways in which increased openness facilitates the interconnecting of communication content between and among informal communication venues. Not surprisingly, formal modes of scholarly communication are slow to adopt aspects of openness beyond open access. Journals that provide a digital version of published articles tend to rely on the pdf format. Though compliant with Web standards, publishing articles in pdf format limits the possibility of intertextual linkages to the document level.

In a Web environment, a pdf document can be linked to as a downloadable document, and links in the text of a pdf document can be made active. In spite of its utility, the logic of document portability employed by the pdf is at odds with the content-interoperability logic of open Web standards. For that reason, the content within a pdf document is excluded from intertextual hyperlinking, a form of networked discourse that creates

more precise associations and at the same time contributes to a structuring of domain-specific content. Experiments with online forms of academic book authorship and peer review display a much broader adoption of openness, but at the expense of certification of validity. In the book projects reviewed, open peer review was conducted in the form of comments to the book text published on a blog. The review activity was inclusive, and both the text and the comments were interoperable with linking and tagging techniques. However, it isn't clear what role the open comments may play in the printed text. If the open peer review process is used exclusively in preparation of the final version, it isn't clear what sort of academic certification and recognition the primary author and the publisher can grant.

Informal modes of communication exhibit openness in a variety of configurations. In some cases, informal communication practices also contribute to functions of formal communication. In contrast with traditional accounts of informal communication (communication characterized by smaller audiences and limited distribution), it is now common to register intellectual priority first on a blog or in a video posted online, whereas a journal article would still be locked in a procedure of blind peer review that typically takes months. Numerous Internet venues are being employed to help disseminate new research beyond the formal publication of the article itself. And to some extent, informal communication platforms, content repositories, and networked discourse preserve the scholarly record, both through the automatic date stamping of contributions and through intertextual associations created over time. Something as unsophisticated as the published archive of an email list provides a chronological account of discipline-specific debates, events, and controversies.

We do not interpret the overlap of roles as a competitive threat to the journal publishing industry. Nor do we see the diversity of open practices as somehow disrupting the normative structure of science. Rather, the openness framework stimulates interesting questions about perceptions of open science versus how scholarship is actually practiced. Scholarly communication in a digital context makes these informal practices more visible and, at the same time, gives users and developers the capacity to fine-tune the configuration of openness for each new platform. This seems particularly salient in the humanities and the social sciences, where situated practices preclude some of the more overarching visions of standardized e-science infrastructure (Wouters and Beaulieu 2006). Further empirical research is needed to determine how informal communication media are being adapted in the humanities and the social sciences.

The openness framework developed in this chapter provides an analytical lens for developing a better understanding of informal communication practice. Introduction of this framework is intended to facilitate future development of a theory of openness in scholarly communication, one that will address new questions informed by emerging scholarly practices. For example, can the concept of openness help researchers to generate useful insights about the deployment and utilization of e-science infrastructural resources for humanities and social science research? How is openness configured (or how might it be configured) to facilitate the heightened situatedness and methodological reflexivity of social science and humanities research? What is, or should be, the role of content interoperability standards in relation to e-research? In light of the dynamics discussed in this chapter, how might structure and agency, with regard to technology, be mobilized to explain the role of openness? What theoretical resources can be mobilized to strengthen the knowledge of openness in academic research? If we understand the system of scholarly communication as discursive, there is significant potential in the kinds of intertextual practices identified here as primarily in the purview of informal communication, and as primarily facilitated through the construction of interfaces and infrastructures of openness. These questions, albeit general, provide direction for exploring the potential of Web 2.0 and the Semantic Web in relation to scholarly publishing as conceived through a theory of openness.

The technological capacity envisioned by Vannevar Bush in his 1945 essay “As We May Think” is today quite common and taken for granted. Scholars often “store books, records, and communications” which can be “consulted with exceeding speed and flexibility” (Bush 1945/1995) and can be selected on the basis of association rather than only by indexing. However, the challenge noted by Bush in the passage quoted at the beginning of this chapter is still present. Aided by digital media, the volume of research produced continues to grow, and efforts to structure this content between and among disciplines lack a comprehensive understanding of the potential of openness.

NOTES

1. Detailed in Fitzpatrick's presentation at the University of Michigan in February 2010 and archived at <http://deepblue.lib.umich.edu>.

2. <http://ssrn.com/>

3. <http://www.slideshare.net/>

4. Investment in digital and network technologies intended to enhance research is often referred to as *cyberinfrastructure* in North America and as *e-infrastructure* in Europe. See, for example, Hey and Trefethen 2005 and the introduction to the present volume.
5. International Organization for Standardization (<http://www.iso.org>).
6. This section of the chapter draws from a presentation made at a research meeting of the Virtual Knowledge Studio for the Humanities and Social Sciences on January 15, 2009. The PowerPoint slides used in that presentation are available at <http://www.slideshare.net>.
7. As of 2012, the MIT Press has published, in collaboration with and support from the MacArthur Foundation, six book-length titles in the series Digital Media and Learning. These publications are available for sale in printed form or may be downloaded free of charge.
8. Press release (available at <http://www.elsevier.com>).
9. <http://www.oii.ox.ac.uk/>
10. <http://www.hastac.org/>
11. We were primary contributors to this project.
12. Plug-ins developed by WordPress and by the community are available at <http://wordpress.org/>.

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