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PEER-REVIEWED JOURNAL ON THE INTERNET

The unacknowledged convergence of open source, open access, and open science
by John Willinsky

Abstract

A number of *open* initiatives are actively resisting the extension of intellectual property rights. Among these developments, three prominent instances — open source software, open access to research and scholarship, and open science — share not only a commitment to the unrestricted exchange of information and ideas, but economic principles based on (1) the efficacy of free software and research; (2) the reputation–building afforded by public access and patronage; and, (3) the emergence of a free–or–subscribe access model. Still, with this much in common, the strong sense of convergence among these open initiatives has yet to be fully realized, to the detriment of the larger, common issue. By drawing on David's (2004; 2003; 2000; 1998) economic work on open science and Weber's (2004) analysis of open source, this paper seeks to make that convergence all the more apparent, as well as worth pursuing, by those interested in furthering this alternative approach, which would treat intellectual properties as public goods.

Contents

The poet John Donlan has an image in his recent poem, "An Economics of Happiness," that is drawn from his childhood days in rural Ontario, when the Orange Day Parade was one of the summer's big events. In those days, a child could make a dollar carrying a sign in the July 12th parade that read, "Our Guide to the Open Bible," while following carefully behind Orange King Billy (William of Orange), who led on horseback what is the longest standing annual parade in North America [1]. The parade celebrates the Glorious Revolution of 1688 in which William defeated the King, James II, a convert to Catholicism and, as such, a threat to English Protestantism and its open–book approach to the Bible. In looking into prominence given to the Open Bible in the parade, I was struck by how pervasive themes of openness were during this period. When William summoned his wife, Princess Mary, by royal yacht from Holland after his victory, she made a point of bringing along John Locke, one of the revolution's intellectual backers, who had been very busy during his exile in Holland composing what turned out to be major statements on natural rights, representative government, and the pursuit of life, liberty, and property. The subsequent reign of William and Mary from 1689 to 1702 saw not only a re–opening of the Bible (although James had never really closed it), but a shift of power from crown to Parliament, creating a democratic opening for, among other things, one of the first bill of rights, securing freedom of speech for members of Parliament (even as the Penal Laws, introduced in 1691, began to rob Irish Catholics of rights to education, voting, and land) [2].

Adding to the period's somewhat shaky spirit of openness was the rise of the periodical, filling the streets and coffee houses with news and opinion, and an increasing public interest in scientific inquiry. The Royal Society of London for Improving of Natural Knowledge, founded in 1660, is but the most famous of dozens of science clubs that sprang during this period, with women, as part of that openness, playing a considerable role in their formation (Reynolds, 1920). It was not long before the meetings of the Royal Society were being made public each month through the 16–page *Philosophical Transactions,* which was but one of dozens of "scientific" periodicals launched across Europe during the 17th century (Kronick, 1976). In the eyes of Stanford economist Paul A. David, it adds up to an "open science revolution," signaling "a profound epistemological transformation effected by the fusion of [17th century] experimentalism with Renaissance mathematics," which "represented a break from the previous dominant ethos of secrecy in the pursuit of "'Nature's Secrets'" [3]. This new openness in scientific matters was also bolstered by the legal recognition of intellectual property rights, beginning with the Licensing Act of 1662 and leading up to Queen Anne's 1710 Act for the Encouragement of Learning. The 1710 Act was, in effect, the first copyright law; it recognized an author's work as form of property, arguably based on Locke's notion that property results from the personal investment of labor [4].

This brief parade of Protestantism, Enlightenment, empiricism, and experimental science might well be accompanied by a child carrying a placard that read, "Our Guide to *Open* Knowledge." Certainly, the convergence around themes of openness during that era has been noted before [5]. However, this earlier convergence also speaks to me of a similar, if unrealized, convergence around these same themes Today. It is

taking place among traditional and new open approaches to knowledge, open to access, use, and exchange in ways that are otherwise in danger of being unduly restricted and foreclosed within the current knowledge–based economy.

At the forefront of today's open initiatives is *open source software,* which has proven a viable alternative to the proprietary software products offered by Microsoft and other companies. The leading instance of open source software is the operating system Linux, which is an option when ordering IBM and Dell computers, and is used to run the large server farms maintained by Google and eBay. Linux alone challenges fortress Microsoft, and is proving the software hope for developing nations. It can be downloaded without charge, with a large global community of supporters who gather around Web sites such as SourceForge.org, which provides ready access to over 60,000 open source software projects.

Open source software is often portrayed as a breakthrough in the free and open exchange of intellectual property, without precedent in the prevailing global capitalist mentality. It is usually treated as an isolated economic anomaly, as "counter–intuitive" [6] and an "aberrant form of behavior" in the world of business [7], or more benignly, "somewhat mysterious" [8], a "quite amazing phenomenon" [9], and an "'impossible' public good" [10]. If you look at open source strictly within a business framework, then indeed, it is pursuing a radically different approach to intellectual property compared to the approach taken by Microsoft and other manufacturers of proprietary software. But to pursue a strictly business perspective on open source software only serves to prevent readers from realizing open source's close connections to the long–standing traditions of open science. It also keeps the *open source* movement from forming a greater alliance with the more recent open access movement, which is attracting considerable attention today among government agencies involved in research, scholarly publishers, and university libraries in its efforts to provide a viable alternative or supplement to commercially driven forms of scholarly publishing (Willinsky, in press) [11].

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The principle of open access is simple enough. It is about being able to find and read research and scholarship online at no additional cost. At this point, only a small proportion of the peer–reviewed literature is available to readers and libraries without charge, although a number of economic approaches to open access have been developed over the last decade (Willinsky, 2003). For example, the vast majority of journals now grant their authors permission to post their work in open access institutional repositories (also known as e–print archives) run by their universities or other groups. There are also open access journals in most disciplines that make the author's work immediately available to readers at no charge [12]. And not surprisingly, articles which are made open access are cited more often than those that can only be viewed by subscription.

Both open source software and open access to research represent innovative responses to the particular restrictions placed on the sharing and exchange of software code and research publications, respectively, imposed by current intellectual property economics. Those same economics are also affecting, not surprisingly, open science. Access to scientific knowledge is increasingly subject to "proprietary rules" related to "industrial profit–goals," in David's terms, or to being classified as "defense–related" [13]. Just as new information technologies promise "unprecedentedly rapid and unfettered access to new knowledge," industry is ensuring that "the proliferation of intellectual property rights and measures to protect these is tending to inhibit access to such information" [14]. David uses the property rights granted over scientific databases (to the exclusion of fair use) in the European Community, which he sees as nothing less than a "tragedy of the public knowledge commons," [15]. The response from science's defenders has taken the form of an open data movement, which has had a substantial impact on a range of important scientific initiatives, from the Human Genome Project to the Global Positioning Satellite system [16].

The extension of these property rights — and the very high cost of utilizing the properties in question — against the prospect of unfettered access, is very much the issue behind open access initiatives. The publishing economy of scholarly journals is dominated by a rather perverse property relation, in which the last investor in the research production chain — consisting of university, researcher, funding agency, and *publisher* — owns the resulting work outright through a very small investment in relation to the work's overall cost and value [17]. The great increase in journal subscription prices over the last two decades, largely as a result of corporate concentration in scholarly publishing, has led to what economists would term the "dead–weight burden of monopoly," in which "some people's desires will remain unsatisfied even though they could have been fulfilled at virtually no additional cost" [18].

Open source and open access are responses to new technologies running under old economies. They are resisting the knowledge–lockdown approaches of corporate intellectual–property concentration. Or to put it another way, the relatively recent phenomenon of open source software, dating back to the 1980s, and the even more recent open access movement in scholarly journal publishing, are responding to pressing contemporary threats to that original and continuing spirit of science and scholarship as defining one important aspect of what Locke termed the "commonwealth of learning" [19].

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While this paper focuses on how the *common wealth* of the open source movement relates to open access and open science, these are but three of a good number of *open* initiatives. Think of the *open* university movement, which was born in the United Kingdom during the 1960s and in "the 'White Heat of Technology' era," as its Web site puts it (Open University, 2005) [20]. Open universities are now found in Hong Kong, Israel, Sri Lanka, Canada, and elsewhere. MIT, to its credit, can point to its leadership in the Open Knowledge Initiative, Open Courseware, and DSpace, all devoted to opening access to intellectual resources, including software and research, often with corporate patronage. The online publications *AlwaysOn* and *Technocrati* recently announced their list of the Open Media 100 (Perkins, 2005). I would also count the Creative Commons as a further extension of the open theme, intent as it is on opening copyright to the possibilities of sharing work in new ways (Lessig, 2004) [21]. The advocates and champions of these different initiatives have yet to unite in any noticeable way around their shared interests in the commonwealth of learning and access to public goods [22].

While the ideals and economics of *open science* may link a good number of these open initiatives, it will not do to go any further in this discussion without recognizing that, in reality, science has rarely if ever been any more open than the times in which it operates, and often less so. Consider the scientific involvement of women (Keller, 1985; Harding, 1991), working classes (Rose, 2001), or non–Westerners (Kumar, 1991; Drayton, 2000). Think about how susceptible science proved to the forces of tyranny, under National Socialism in Nazi Germany (Renneberg and Walker, 1994). But then it is not always completely open to new ideas (Kuhn, 1962) or to reporting on the complete laboratory process behind experiments (Latour and Woolgar, 1979).

In recent times, the shortcomings of open science have taken a new twist with the rise of what Etzkowtiz (1983) identified some two decades ago as the "entrepreneurial university." A raft of books and articles are sounding the alarm over what former Harvard president Derek Bok, in *Universities in the marketplace: The commercialization of higher education,* identifies as a threat to "basic academic principles," as faculty members no longer see their work as "a calling rather than just another way to earn a living" [23]. While these books generally hold the university's entrepreneurial tendencies responsible for undermining the quality of intellectual life on campus, this may seem to have little to do with securing greater access to software and journals.

However, open source and open access are nothing less than two practical and proven means of resisting that constant capitalization of knowledge work that marks this economy [24]. They are ways of affirming the university's ability to contribute to the public good. Those who would resist the commercialization of higher education would do well to recognize the convergence of interests among open source, open access, and other open initiatives, in a world that can otherwise seem all–too–ready to allow shareholder–value to drive the pursuit of knowledge [25]. I would go so far as to argue that this alignment is underwritten by three closely related economic principles that make possible an open realm that is deeply committed to sharing and exchanging intellectual properties and resources.

The first of these principles is that when it comes to being open, the price of admission matters. Open source software may be free in the sense of free speech, but having *free access* to this software is critical to its effectiveness, just as any reasonable hope for global participation in the circulation of knowledge depends on open (or free) access to research and scholarship.

The second principle, in a point owed to Paul A. David, is that this intellectual openness has been traditionally supported by various forms of patronage. This patron–economy still has a very strong place for intellectual property rights, although those rights are not concerned with excluding and restricting access, but just the opposite, with a focus on authorship claims related to priority (who was first) and propriety (proper citation). It is a focus, within open intellectual economies, that appears cable of both feeding rivalries among reputations (*e.g.,* prizes and awards), as well as consistent patterns of collaboration and cooperation (*e.g.,* multi–authored projects and peer review).

The third principle is that open alternatives to intellectual property regimes still operate within the dominant economy. The alternative economy of ideas may be quick to exploit new technologies to preserve its openness — whether one thinks of the mimeographed underground press of 1960s Eastern Europe or today's open access journals and archives — even as it is subject to economic forces outside its purview. In the case of open source and open access, this mixed economy is taking the form of a *free–or–subscribe* model. It is still too early to judge the long–term sustainability of a free–or–subscribe model for accessing intellectual properties and public goods, but then the very convergence among these various open economies has yet to be realized, which is why I wish to spell these principles out in some detail.

Principle One: Before software was open, it was free

During the 1960s and 1970s, software was not a commercial product. For scientists and engineers in academic and corporate laboratories, as Eric von Hippel points out, "the normal part of their research culture [was] to freely give and exchange software they had written, to modify and build on another's software, and to freely shape their modifications" [26]. The code that ran the computers was not treated as the sort of intellectual property that we now associate with software sticker prices, licensing fees, and piracy protection. Judging by John Markoff's (2005) recent book on "how the sixties counterculture shaped the personal computer industry," as he puts it in his subtitle, there was something other than a business ethic at work in certain segments of this developing enterprise.

Once the commercialization of software had begun in the 1980s, a turning point was quickly reached, when Richard Stallman resigned his professorship from the Artificial Intelligence Laboratory at MIT in 1984. He left MIT essentially over its decision to license computer code developed there to commercial interests, which would restrict access to the source code [27]. At some level, it can be said that the open source movement arose out of a rejection of this approach to higher education. In 1985, Stallman set up the Free Software Foundation and went on to compose the widely used GNU General Public License, which protects much open source software. Stallman has worked hard over the years to differentiate the exact sense in which software needs to be free, enabling it to be reworked, made compatible, and freely distributed. Perhaps his most famous declaration on this issue is his not–as–in–free–beer statement: "'Free software' is a matter of liberty, not price" which he tries to illustrate by suggesting that "to understand the concept, you should think of 'free' as in 'free speech,' not as in 'free beer.' Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software" (Free Software Foundation, 1996–2004).

The jarring clash between *free speech* and *free beer* is the sound of Stallman making a constitutional claim on the American conscience, removing his software from frat party mentality and Napsterism that *free* might otherwise be thought to entail. As it turns out, of course, open source software is also free like *free beer,* in most instances. Keeping the entry cost close to zero for using open source software, whether in adding to this software or posting it online for others to use, has proven a very efficient and effective method of production. The efficacies of open source software stand in sharp contrast to what is otherwise the systematic economic exploitation of intellectual property rights, in a point made by Yochai Benkler: "Strong intellectual property rights, in particular rights to control creative utilization of existing information, harm peer production by raising the cost of access to existing resources as input. This limits the capacity of the hundreds of thousands of potential contributors to consider what could be done with a given input" [28].

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However, the GNU General Public License does permit developers to charge for the distribution and support of open sources software. Still, the confusion and disputes over what this sense of freedom entailed led to a search in the 1990s for an alternative term, with "open source" coined by Christine Peterson in 1998 (as the *Oxford English Dictionary* now records in its definition of the term). It has quickly grown into the standard term for this class of software, although Stallman has stayed with his original Free Software Foundation, which still makes the free speech distinction on its home page [29].

In 2001, the Soros Foundation's Open Society Institute brought together in Budapest the leaders of what was loosely construed as the "free online scholarship movement," as Peter Suber named his newsletter devoted to this issue. What emerged from that historic meeting was the Budapest Open Access Initiative [30]. And "open access" has since become the common term for research and scholarship that is made freely available online, although again, disputes remain over what sort of access is truly open [31]. While *open* has become the term of choice for those seeking an alternative approach to software and the journal literature, it is worth noting that at the origins of both open source and open access is this concept of freedom. It is, in the first instance, about freedom of speech. But no less important, in both cases, is how this freedom is situated in a specific economic sense. That is, the price of admission and the real costs of access do matter, and certainly no less when it comes to freedom of speech. When Thomas Jefferson (1816) spoke of a free press — "Where the press is free, and every man able to read, all is safe" — he was referring to people's ability to read a newspaper, in ways also having to do with access to education and newspapers.

The openness of research and scholarship to review and critique, as well as people's rights to the knowledge needed to participate in a democracy, have always had something to do with who can afford access to what. Such was the 19th century case for public education, which is also implied in Jefferson's support for the press, just as it was a fervent part of the era's support for mechanics' institutes, public libraries, Sunday schools, cheap postage, and cheap books.

Today, public libraries, schools, and homes — as well as universities with very small and often dwindling libraries — are obtaining access to resources they would never have seen otherwise, whether in the form of articles that have been archived by their authors (with blessings of most journal publishers) or through open access journals directly. As part of the current open synergy forming around these new technologies, open access is being supported at every turn by the use of open source software that is available for managing and indexing both institutional repositories (*e.g.,* DSpace, eprints.org, and Fedora) and journals (*e.g., HyperJournal, DPubS, and Open Journal Systems).* In this way, open source and open access work together to increase access to research and scholarship. These approaches not only reduce the cost to zero for a small but growing proportion of the

literature needed to do research; open source software also makes it possible to manage and publish online journals at very little cost. This is an especially salient point when it comes to fostering the development of local review cultures and research capacities at institutions in developing countries. In combination with open access to the research literature, this use of open source systems hold the promise of a more global exchange of knowledge.

Principle Two: The economics of patronage

Steven Weber, in his recent book, *The success of Open Source,* begins with how open source software turns the notion of property on its head, insofar as property traditionally refers to "the right to exclude you from using something that belongs to me" [32]. In the case of open source software, the opposite is true, for this software is "configured around the right to distribute, not to exclude" [33]. I could end my case for the value of the extended open source and open science analogy on this point alone. For when it comes to intellectual property, modern scholarly inquiry has always been about the opening up and sharing of sources, and more than that it has been about the rights and the means of distributing such work. What Weber claims is a "counterintuitive" notion of property rights among a "community of producers" is every part the norm for the research community [34]. If patent awards have altered the "community" climate in the modern university in recent times, at least within a fairly narrow range of research, it is still the case that the production of research and scholarship as a whole is dependent on how hundreds of thousands of researchers and scholars have managed to organize themselves into a vast series of self–governing units devoted not only to the distribution of their intellectual property, but to freely collaborate on its improvement through, for example, peer review [35].

That said, further parallels among open source, open access and open science are to be found in what Weber identifies as open source's three problems: (a) how are individuals motivated to contribute free code; (b) how are their efforts coordinated and organized; and, (c) finally, how can complicated pieces of software be developed on an ongoing basis [36]. In the course of providing detailed answers to these questions, Weber does not have recourse to draw on the longstanding openness of the research community, which might otherwise have a good deal to do with what distinguishes the open source approach to intellectual property.

To begin with what motivates software programmers to contribute to open source code, consider how the same question applies to the research community. That is, the research community's "highly talented" (as Weber identifies open source programmers) have always produced a level of research and scholarship that is in excess of what could be matched by the financial rewards for productive scholarly work [37]. While there are famous exceptions — such as the fortune generated by the countless editions of Paul Samuelson's ubiquitous economic textbook — far more typically, the talented among the scholarly publish articles in numbers and quality well out of proportion to their salaries in relation to their less productive colleagues. It was not so long ago that publishing to any substantial degree in the university was largely a form of "voluntary" behavior, to use Weber's term for open source contributions. And while publishing at some basic level is not entirely voluntary among faculty members, so many programmers work on open source code for use by their employers.

Weber speaks of the motivational force of open source code as lying in how it provides "cool opportunities to create new and exciting functions or do hard things in elegant ways" [38]. Again, he could, of course, be describing the work of scholarship, just as it is no less true to say of research that "a cool [research] program is really only as cool as others say it is" and that "the program needs to be used," which in the case of research amounts to being cited [39]. One can hear the crossover between the *cool factor* in academic and programming settings in the words of Chris Hanson, a Principal Research Scientist at MIT and "maintainer" in the Debian Linux community, as he reflects on the motivation question: "Creation is unbelievably addictive ... Good programmers are compelled to program to feed the addiction ... A free software project is the only context in which they can write a program that expresses their own vision ... Part of this is that programmers want to earn respect by showing others their talents" [40]. A survey of open source programmers by the Boston Consulting Group (2003) identified intellectual curiosity as the driving force behind this work.

For Paul David, the roots of this addictive economy of "cool opportunities" lie deep in the European system of pre–capitalist aristocratic patronage of the highly talented, which favored "ornamental benefits [as opposed to utilitarian contributions] to be derived from their sponsorship of philosophers and savants of great renown," and this chain of ornamental patronage gradually evolved into a post–Renaissance "institutionalization of new reputation–building proceedings" based on earning the regard of one's scientific peers [41]. The particular need to build a publicly recognized reputation within the patronage economy fostered more open forms of science.

This public dimension first took shape in the 16th century, with virtuosi competing over mathematical puzzles, scientific challenges, and other tests of talent and knowledge. Patrons had begun to look to these open demonstrations, supported by the judgment of experts, in deciding who to support [42]. The openness was economically driven by, in David's terms, "the informational requirements of a system of patronage in which the competition among noble patrons for prestigious clients was crucial" [43]. It was not long before governments were playing the patron's role. In 1609, for example, an early Strasbourg newspaper reported that Galileo had seen his salary increased (in an early form of merit pay) at the University of Padua by Venetian authorities as a result of his success with the telescope [44]. Today's public patronage of research and scholarship stands as, in David's words, "European feudalism's great gift to the economic vigor of capitalism in the modern age" even as it remains at one remove from it [45]. David defends the continuing efficacy of this patronage economy, against commercial systems that depend on "the control of knowledge through secrecy or exclusive possession of the right to its commercial exploitation" [46]. He speaks of a needed balance between the Republic of Science and the Realm of (proprietary) Technology, a balance which open source and open access advocates are trying to sustain, as they turn to the market economy for their laptop and the desk they are working at [47].

With the use of open source code, no less than with scholarly work, the *property right* at issue is almost entirely a matter of respecting the authorship of the original work.

David also inadvertently offers a further motivational parallel between open source and open science, when he points to how open science is both communal and competitive, open to free exchanges and proprietary claims. Two of the more famous works in the history of science, Newton's *Principia* and Darwin's *On the origin of species,* were both spurred to publication to forestall prior claims to ideas by other scientists [48]. The "norms of disclosure and demonstration" marked by "cooperative rivalries," which characterize for David the "open–science revolution," are no less present among open source software developers, where issues of ownership have a great deal to do with control and decision–making over the future of the software [49]. Now open source's patronage economy has not been honed to anywhere near that of the academy, with each citation counted, each field awash in its own awards; reputation and contribution remain hard and fast drivers there, too, exceeding other sorts of measures in more traditional businesses. While much open source software represents acts of personal philanthropy on the part of the programmers, there are a growing number of instances in which the development of this software is receiving institutional support [50].

With the use of open source code, no less than with scholarly work, the *property right* at issue is almost entirely a matter of respecting the authorship of the original work. This sense of propriety, however, operates with a rigor in scholarship that exceeds the bounds of copyright law. Copyright only protects the author's expression and wording of an idea from being used by another beyond the realm of fair use. Within the academy, a scholar does not want to get caught using an idea, however worded, that is clearly derived from the work of another scholar. Please be as open and clear as possible, one instructs the young scholar, when it comes to the sources you used for a work. The recognition granted is not begrudging or perfunctory. As with the development of open source software, sharing the underlying source *code* is a point of professional pride. One of the intellectual properties of scholarly work is its reflection on how ideas take shape among groups of people over time. The scholarship's value, in turn, is entirely determined by those who later come to utilize and then build upon a given property without remittance to the original author, beyond this acknowledgement. Such an approach to property, to return to an earlier point, is clearly not about *ownership,* in the common sense of *a right to exclude.*

Scholarship has long strived to open its processes to critique and contribution, even if at best those processes are shaped in historically contingent ways. The open access movement is no less devoted to lowering barriers by enabling more researchers and students to read the current published literature.

Now that we have a handle on the motivation question, we can turn to the second problem that Weber identifies as posed by open source software: how do open source software developers coordinate the contributions of volunteers in developing a complex software product? In extending the parallels between open source and open science, I would begin by pointing to how the research literature has long been structured and organized, discipline by sub–discipline, through conferences, journals, bibliographies, and indexes, much of the work done by faculty taking voluntary leadership roles, often in combination with commercial services. Entire fields of inquiry emerge, as one article builds on another, sometimes by critique and refutation, and sometimes by replication and extension. The growth comes of the academic freedom faculty possess to strike out in new directions, or as Weber puts it, in terms of open source programming, "the essential freedom of free software is precisely the right to fork the code at any time" [51].

It takes little imagination to see the research literature, as a whole, acting like an operating system that enables others to run new programs of research and to contribute, in turn, to the learning of others. The academic researcher creates an "open source" research program that can be freely replicated and improved upon by others. Scholars carefully document their research methods, data sources, and references in ways that enable others to run the same experiment and consult the same resources. (In light of this point, I've gone the extra distance in citing and footnoting sources for this paper). Research methods are like software routines for managing and processing the flow of information. They are not copyrighted — although research instruments may be — while re–use can lead to further refinement and validation. The research article is part of a larger, very complex code on which other researchers build, debug, and extend, always with the intent of turning it back to the research community [52].

After motivation and organization, the third problem that open source poses to business–as–usual is what Weber

identifies as "potentially durable and possibly deserving of the term 'revolutionary'" which is, in the case of Linux, "the process itself" [53]. "If there is a general principle of organization here," Weber goes on to say about open source, "it is to lower the barriers to entry for individuals to join the debugging and development process" [54]. Scholarship has long strived to open its processes to critique and contribution, even if at best those processes are shaped in historically contingent ways. The open access movement is no less devoted to lowering barriers by enabling more researchers and students to read the current published literature. The gains that are made, whether through publishers' willingness to permit author self–archiving of published work or programs such as the Health InterNetwork Access to Research Initiative (HINARI, http://www.healthinternetwork.org/) and Access to Global Online Research in Agriculture (AGORA, http://www.aginternetwork.org/en/) that are making research in medicine and agriculture freely available to developing countries, hold much promise for increasing the global scale of the scholarly exchange. Yet it also needs to be a two–way street, a global exchange, in which access is necessary but not sufficient. So open source software, such as Open Journal Systems (which we developed at the University of British Columbia) is being used by the International Network for the Availability of Scientific Publications (http://www.inasp.info/) to set up their African Journals Online (AJOL, http://www.ajol.info/) portal. AJOL currently provides online access to the Table of Contents and article abstracts for 205 journals published in Africa, as part of a document delivery service, that we hope will eventually lead to complete online access to this content.

Principle Three: Free or subscribe

An interesting economic model has emerged with open source software that is divided between product and service. Open source software is typically made available for downloading at no charge from sites such as SourceForge.net. But in those cases where open source software has a large number of users, with many of them working in corporate settings, as is the case with Linux, then new companies have managed to create businesses around providing services and support for the software. Red Hat is the best known of the companies that offers this sort of support for Linux, and it provides upgrades, support and training on a subscription basis to clients. Red Hat provides, in its own words, a "rock–solid foundation for the open source enterprise" [55].

The free–or–subscribe approach to open source programs has proven a very powerful economic driver for increasing the widespread use of Linux as an operating system. Red Hat has the U.S. Army, City of Chicago, Ticketmaster, and Vanderbilt University among its clients, even as Linux's continuing free status enables, for example, a group of scientists seeking to build the equivalent of a super computer to use it, without third–party support. Red Hat supports the development of open source software, through its Open Source Now program (http://www.redhat.com/opensourcenow/), and it is hardly alone in this approach to open source software. Covalent, on the other hand, is a company devoted to supporting through subscriptions the widely used Apache software for Web servers, and currently has contracts with 70 percent of the Fortune 100 companies. Open source users and developers benefit from this corporate participation, even as they have a range of economic options (beginning with free access to the software) that enable much greater access to this information technology than they could otherwise achieve with proprietary software [56].

...perhaps 15 percent of the current literature is being posted by authors in archives...

Open source's free–or–subscribe model has its parallels in scholarly publishing. With publishing, the free–or–subscribe model takes two forms. While subscription services for open source software have followed on the successful utilization of this free software, in the field of publishing, most of the freely available research is published in subscription–based journals. The two approaches work like this. As noted earlier, a good number of journal publishers now permit authors to upload their published work to open access institutional repositories or e–print archives at their institutions. A second, smaller number of journals make their contents open access after a period of months or years. Definite numbers are hard to find on what proportion of the literature is currently open access, but Stevan Harnad (2005b), who has done more than anyone to promote the self–archiving route to open access, calculates that perhaps 15 percent of the current literature is being posted by authors in archives, meaning that the same article is available — or almost the same article, which can be a very real issue when citing scholarly work — by subscription to the journal or through an open access archive. In addition, some publishers offer open access to the back issues of subscription journals, with Highwire Press, for example, offering open access to more than 900,000 articles, which have been made freely available up to 24 months after publication [57]. In addition, there may another 2,000 or so open access journals that make their contents immediately available to readers at no charge, accounting for perhaps five percent of current peer–reviewed titles.

While both open source and open access account for a small proportion of intellectual properties in their respective fields, both open initiatives are seeing growth and impact on the current knowledge economy. For example, IBM recently placed 500 software patents under an open source license while making it clear that this was part of a new stance on their part (Galli, 2005) [58]. In scholarly publishing, the U.S. National Institutes of Health and other research funding agencies have begun to put albeit fairly gentle pressure on grant-holders to self–archive. And while journal publishers rightly continue to take the heat for charging prohibitively high subscription prices, their relatively generous self–archiving policies place their support of open access well ahead of many universities who have yet to establish institutional repositories that would support self–archiving among their faculty [59].

Open access has the potential to make very close to the entire body of literature available to anyone with an Internet connection ... This would make a considerable difference to a wide range of scholars, students and others who are otherwise unable to obtain or afford access. What is holding back this far greater circulation of knowledge, at this point, is general lack of faculty awareness and interest in increasing access to published literature.

Now some might point to the use of the free–or–subscribe model in television and more recently radio broadcasting, and others will hold up this model as further instantiating society's class basis. Yet it is by no means clear yet what open access means for the future of scholarly publishing or, if it prevails, all of the forms that it will take (author self–archiving, author fees, subscription journals offering delayed open access, sponsored open access journals, etc.) [60]. What is clear is that under current economic arrangements, open access has the potential to make very close to the entire body of literature available to anyone with an Internet connection through this free–or–subscribe model. This would make a considerable difference to a wide range of scholars, students and others interested in these public goods, but who are otherwise unable to obtain or afford access. What is holding back this far greater circulation of knowledge, at this point, is a general lack of faculty awareness and interest in increasing access to published literature [61]. It may be, as David holds with regard to open science generally, that this would create an entirely favorable arrangement for "maximizing the rate of growth of the stock of knowledge," while the increased access would serve to promote reputations and rewards, but it has yet to fully register with those who are in a position to make a difference [62].

The unacknowledged convergence

Given the extent of the analogies that seem readily apparent among open source, open access, and open science, I was a little surprised when Weber asks in his analysis of the open source phenomenon: "Are there knowledge domains that are structured similarly to the software problem?" [63]. Wouldn't one place to turn for an answer to this question be his own line of work, as a professor of political science at the University of California, Berkeley? Academic labor within open science would also help answer his further question: "Is it possible to build a working economic system around the core notions of property rights as distribution?" [64]. Now I have no objection to Weber seeking to set out the terms that might lead to implementing open source approaches in other parts of the economy — and he mentions open–cola and openlaw — but I also think it important to see that scholarship has operated under a property–rights–as–distribution system for centuries, just as I think it urgent that he and others recognize that these property principles are currently at risk and need redressing [65]. For while scholarly communication is being distributed far more widely, in far greater quantity than at any point in this history, it cannot be said to be any more open to the world of readers and users (as their numbers have also grown considerably). It cannot be said to yet take full advantage of new publishing technologies to ensure that a greater proportion of the literature is available to a greater proportion of potential readers.

This brings me back to David's defense of open science as constituting a "public/academic research sector" which is "uniquely well suited to the goal of maximizing the rate of growth of the stock of reliable knowledge" [66]. Although David may not have addressed open access as a movement — even he practices it actively enough through Research Papers in Economics (RePEc, http://repec.org/), where many of his papers are available — he identifies the common issue at stake across these open initiatives: "High access charges imposed by holders of monopoly rights in intellectual property have overall consequences for the conduct of science that are particularly damaging to programs of exploratory research that are recognized to be vital for the long–term progress of knowledge–driven economies" [67].

What is currently missing among these open movements, whether in software development, scholarly publishing, or science more generally, is what was missing a few decades ago, Peter Suber recently pointed out to me, from the environmental movement. In those days, people were deeply concerned with local issues, or with particular aspects of the environment, be that water quality or air pollution, or with specific approaches to conservation issues, such as recycling. With time many of those involved in what we now call the environmental movement come to realize the common cause among all of their different efforts. Through such a realization, they were able to build make environmentalism into a popular movement and an everyday reality, and this served, of course, to further all of the original goals [68].

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■■■■■■■■■■■■■■■■■■■■

The current convergence among various *open* approaches to intellectual property represents a common commitment to a larger public sphere. These approaches extend well beyond the university and yet it remains the primary institutional force in sustaining this open economy. Still, its commitment to this openness has come into question, with talk of campus commercialization of knowledge. You can hear the ambiguity (if not temptation) around these issues, if you listen closely, in the recent words of Lee C. Bollinger, President of Columbia University and a First Amendment scholar: "We are now at a new period where universities are re–entering the world. If we don't understand issues like poverty, modern communications and how the world looks from Nairobi and Bombay [Mumbai], we will not serve the world" [69].

Are universities currently re–entering the world on the side of a greater openness among intellectual properties or are they getting in on a greater share of knowledge–based property rights? Up to this point, the universities have fostered open science, and advanced open source software, even if both originated off campus in large measure. With the more recent of these open initiatives — open access — it falls almost entirely to the universities and their faculty to take the lead. Universities "re–entering the world" with the intent to "serve the world" would do well to support faculty participation in open access archives and journals. Open access to research and scholarship would foster a global exchange of public goods. It would extend and sustain an open, alternative economy for intellectual properties. It would strengthen the links between open source software — which is vital to providing open access to research — and the university's long–standing tradition of open science. Given the encroachments, not to mention the temptations, of the knowledge business, this is no time to take the commonwealth of learning for granted. It falls to the members of that commonwealth to recognize and support the current convergence of open initiatives that represent dedicated efforts to ensure the future of that learning. 🄵🄼

About the author

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Notes

1. Donlan's "An Economics of Happiness" (2002–2004) begins:

*I'll see your mistake, and double it.
Orange King Billy, Our Guide To the Open Bible,
proclaims, "It's just a text," but we suspect
plant scents, or cloud ripples on ponds*

*are irreducible, pointing at nothing ...
but themselves, our efforts to capture them
bright innocent chalk smears on slate,
unwitting self–portraits
made for praise, half–consciously, the food
we need to grow into our loneliness ...*

2. Marx (1887, VIII, chapter 27) offers a tempering of this celebrated event, for in his estimation, "the 'glorious Revolution' brought into power, along with William of Orange, the landlord and capitalist appropriators of surplus–value." Marx illustrates the point by pointing to the enclosure (and thus appropriation) of the commons by the landed classes, introducing yet a further historical parallel with the Creative Commons' efforts to recast copyright law by providing creators with a new range of licensing agreements, based on retaining limited rights while opening up others for public use.

3. David, 2004, pp. 574, 572. David draws principally on William Eamon (1985) for the concept of open science, as Eamon analyzed the growing openness and public quality of early modern experimental science, in a move away from the medieval "book of secrets," even as Eamon warns that "the debate over the secrecy versus openness in science continues" and cautions scientists (if not publishers) "not to impede the flow of information for private gain" (pp. 346–347).

4. Locke: "The labour of his body, and the work of his hands, we may say, are properly his. Whatsoever then he removes out of the state that nature hath provided, and left it in, he hath mixed his labour with, and joined to it something that is his own, and thereby makes it his property" (2002, pp. 12–13).

5. See, for example, Robert Merton (1970, pp. 80, 87, 88) on the 17th century Protestant ethic: "Its ascetic imperatives established a broad base for scientific inquiry, dignifying, exalting, consecrating such inquiry," as well as upholding "the good of the many," which Merton supports by citing Robert Boyle's last will and testament in 1691, which wished success for those who would "discover the true Nature of the Works of God" for "the Comfort of Mankind." J.R. Jacob (1978) challenges this view, at least in the case of Robert Boyle, for whom Jacob feels that Cromwell's English revolution (1649–1660), rather than Puritanism was the instrumental force in pushing science to the fore as both a private interest and public good, in Boyle's case.

6. Weber, 2004, p. 1.

7. Dalle, *et al.,* 2005, p. 2.

8. Ghosh, 2005, p. 1.

9. Benkler, 2005, p. 169.

10. Kollock, 1999, p. 230.

11. Among the sources consulted on open source software, Benkler's (2005) conception of peer production and Love and Hubbard's (2005) work on public goods acknowledge the link, if only in passing, between open source and open access.

12. Authors are able to self–archive their published work, using open source systems often hosted by their university libraries (using eprints.org or DSpace) that ensure that archived work appears in indexes of open access materials and by the more than 92 percent of journals published today that permit some form of archiving, judging by the substantial sampling of the policies for some 8,460 titles represented on SHERPA Publisher Copyright Policies & Self–Archiving database (http://romeo.eprints.org/).

13. David, 1998, p. 15.

14. David, 2003, p. 27.

15. David, 2000, p. 1; see also Rodriquez, 2005.

16. The U.S. National Academies has become involved in open data questions through its Committee on Data for Science and Technology, which is devoted to "improving the quality and accessibility of data" (http://www7.nationalacademies.org/usnc-codata/). See for example, the Strategies for Preservation of and Open Access to Digital Scientific Data in China Conference, 22–24 June 2004 (http://www7.nationalacademies.org/usnc-codata/chinese_workshop.html).

17. If the average U.S. National Institute Health article represents US$40,000 worth of research funding (with US$26 billion a year in NIH research funding leading to the publication of 60,000 articles) and perhaps US$20,000 of university support above that covered in the grant, the publisher invests no more than US$2,000 but not before securing the copyright for the resulting research article.

18. David, 2003, p. 28.

19. Locke, 1812, n.p.

20. At the risk of overloading the historical cart here, the Open University also has a 17th century precedent in Gresham College, where the Royal Society of London took shape in the mid–1600s, as it had been established in 1598 with seven professorships lodged in Thomas Gresham's London mansion for the purpose of, along with their studies, reading public lectures in Law, Rhetoric, Divinity, Music, Geometry and Astronomy (Johnson, 1940, p. 422).

21. Creative Commons "is a nonprofit that offers a flexible copyright for creative work" (http://creativecommons.org/). See also BIOS — Biological Innovation for Open Society "a new initiative ... to extend the metaphor and concepts of open source and distributive innovation to biotechnology and other forms of innovation in biology" (http://www.bios.net/daisy/bios/15); *Nature's* editorial, "Open–source biology" (2004); and, to keep things in perspective, the Campbell, *et al.* report, "Data Withholding in Academic Genetics" (2002).

22. While I touch on the relation of "open" to "free" in this paper, the twentieth–century politics and metaphysics of the *open* metaphor waits to be told, going back at least to Karl Popper's *The open society and its enemies* (1971), which he started in the 1930s in taking aim at fascist and communist regimes, and leading up to post–Soviet critiques of the threats that the major corporate interests pose to freedom, liberty, and creativity (Lessig, 2004).

23. Bok, 2003, pp. 206–207; see also, Washburn, 2004; Geiger, 2004; Gould, 2003; Aronowitz, 2000; Slaughter and Leslie, 1997.

24. Andrew Abbott (2002, p. 223) does a good job of identifying the underlying economic change in higher education (although without naming the counter "open" initiatives): "A second broad change is the move of

capitalism — and of capitalistic conception of intellectual property — deep into the academic world ... . Like the commons of early modern England, academic knowledge is essentially an enormous public resource that the commercial sector will simply claim as property (as no one else has) or buy up at cheap rates." One exception to note is Johns Hopkins University, established as the first research university in the United States in 1876, which refuses to turn away from the public sphere, judging by the stance taken by Hopkins' president, William Brody: "When Hopkins scientists discovered restriction enzymes, one of the bases of the biotechnology industry, we put the discovery in the public domain — losing millions and millions in potential royalties. Foolish? Perhaps. But I know that we didn't slow science down or diminish the leading role [that] American industry plays in this field" (cited by Feldman and Desrochers, 2004). On recent, positive efforts by state governments to move beyond "technology transfer" in their support for basic university research, see Geiger and Sá (2005).

25. In terms of scope, it is interesting to note how Richard Stallman (2005, p. 332) has gone so far as to position "free software and the allied questions of other kinds of information" in alignment with the anti–globalization movement in "resisting the tendency give business power over the public and governments."

26. von Hippel, 2005, p. 97.

27. Stallman (1998) writes of the decision to leave MIT: "If I had remained on the staff, MIT could have claimed to own the work, and could have imposed their own distribution terms, or even turned the work into a proprietary software package. I had no intention of doing a large amount of work only to see it become useless for its intended purpose: creating a new software–sharing community."

28. Benkler, 2005, p. 197.

29. Of the 64,000 open source projects available through SourceForge.org, over 50,000 use a GNU General Public License (GPL) from the Free Software Foundation. From Stallman's (2004) perspective, "the Open Source Movement was founded specifically to discard the ethical foundation of the free software movement," namely to "be free to pass [the software] on to others. Free either to give away copies or sell copies." See Open Source Initiative's (2005) "Definition of Open Source," which explicitly addresses compatibility issues with the GPL. Among other titles, FLOSS (Free/Libre/Open Source Software) coined by Rishab Aiyer Ghosh in 2000, has gained Stallman's endorsement, as a way to, in Stallman's words, "mention both movements and give equal weight to both" (*ibid.*).

30. See Peter Suber's "Timeline of the Open Access Movement" at http://www.earlham.edu/~peters/fos/timeline.htm.

31. Compare, for example, Harnad (2005a) on the need to tighten up the definition of open access and Willinsky (2003) on the diverse forms that open access has taken.

32. Weber, 2004, p. 1. The optimism of Weber's title, *The success of Open Source* (2004), bears comparing to the far less secure subtitle of my *The access principle: The case for open access to research and scholarship* (in press).

33. Weber, 2004, p. 1.

34. *Ibid.*

35. In his work on democratizing innovation, von Hippel also positions open source as a special case with few precedents, that he ends up pointing to a series of nineteenth century instances of "collective invention" including the development of mining engines in Cornwall (Nuvolari, 2004) and iron industry furnaces in Cincinnati (Allen, 1983). A striking parallel with scientific publishing is found in Nuvolari's (2004) study of how in 1811, "a group of mine 'captains' (mine managers) decided to begin the publication of a monthly journal reporting the salient technical characteristics, the operating procedures and the performance of each engine. The explicit intention was twofold. First the publication would permit the rapid identification and diffusion of best–practice techniques. Second, it would create a climate of competition among the engineers entrusted with the different pumping engines, with favourable effects on the rate of technical progress. Joel Lean, a highly respected mine captain, was appointed as the first 'engine reporter'. The publication was called *Lean's Engine Reporter.* After his death, the publication of the reports was continued by his sons and lasted until 1904."

36. Weber, 2004, pp. 11–12.

37. Weber, 2004, p. 11.

38. Weber, 2004, p. 73.

39. Weber, 2004, p. 74.

40. Cited by von Hippel 2005, p. 124.

41. David, 1998, p. 17. David (2003, p. 19) refers to open science's patronage economy as a "non–market reward system" and "collegiate reputational reward system." In *Homo academicus,* Pierre Bourdieu (1988, p. 79) analyses the "types of capital" at stake in this reputation system, cataloguing both the "symbolic capital of renown" and the "power of consecration," that are found in, on the one hand, belonging to the Académie Française and, on the other, appearing in the popular weekly, *Le Nouvel Observateur.* Weber (2004, p. 143) coins "reputonics" for such capital. It is also worth considering the pleasures of working in "the commonwealth of learning" as John Locke (1812, n.p.) puts it in the Epistle to the Reader for *An Essay Concerning Human Understanding,* where, after paying homage to Boyle and Newton, he holds that "it is ambition enough to be employed as an under–labourer in clearing the ground a little."

42. David, 1998, p. 18.

43. David, 1998, p. 20.

44. Kronick, 1976, p. 70.

45. David, 1998, p. 20.

46. David, 2003, p. 23.

47. David (2003, p. 30): "A delicate attempt at regaining a better balance between protection of the public domain of knowledge from further encroachments by the domain of private property rights, is needed at least in regard to some sectors where services are recognized to profoundly affect human well–being (*e.g.,* health, education)."

48. Hooke's letter to Newton in 1679, asking for comment on Hooke's theory of celestial motions, is said to have inspired Newton's return to his earlier work on gravitation, with further promptings from Halley's visit in 1684, culminating in Newton's 1687 publication of the *Principia,* in a career marked by delayed disclosures (Merton, p. 218).

49. David, 1998, p. 17; Weber, 2004, p. 163.

50. As well, the Andrew W. Mellon Foundation has been a patron of at least a dozen open source software development projects (http://juicy.mellon.org/RIT/MellonOSProjects/), while, to take a specific example, Open Journal Systems, a piece of open source software that supports open access, has been supported by a variety of patrons, including the Canadian government's Social Science and Humanities Research Council, as well as the Max Bell Foundation and the John D. and Catherine T. MacArthur Foundation.

51. Weber, 2004, p. 64. For Yuwei Lin, the organization of open source software is based on it being a "hybrid innovation" between community and corporation. Rather than the closely coordinated collaboration among professionals more typical of such partnerships, Lin sees open source development operating under an "open and tolerant social structure ... where others have the right to express their views" (in press, p. 16). Similarly, Ilkka Tuomi (2005) points to how open source possesses "this community–centric developmental model" in which "the novices could enter the community gradually, by first gaining access to the community, then internalizing its values and world–views, and eventually becoming full, competent members." Noting that "modern legal systems simply do not acknowledge the existence of such open, productive communities," Tuomi observes the liability protection is missing, which is something Microsoft has picked up on its in advertising campaign targeting the "true costs" of open source.

52. Stallman identifies four open source freedoms which apply research methods: the freedom to run the program for any purpose, to study how it works, to redistribute copies, to change and improve the program and redistribute those improvements (Weber, 2004, p. 48).

53. Weber, 2004, p. 14.

54. Weber, 2004, p. 63.

55. Red Hat's subscription model ensures the delivery of upgrades, training, and support for Linux: "The subscription model allows us to develop and deliver technology as it's released, based on customer feedback. And to provide unlimited support over the life of an agreement. To create an actual relationship between the company and the customer before there's a problem. This is low–cost, high–value computing" (Red Hat, Inc., 2005). Weber (2004, p. 193) describes the economic advantages using open source software in terms of how it "dramatically reduces the potential of supplier lock–in" which solves "a huge problem of potential opportunism" and reduces the chances of ending up in "a dependent relationship."

56. In addition, a good number of businesses offer support services for open source applications. OpenWeb Analysts Limited maintains a catalogue of companies that provide support (http://www.owal.co.uk/oss_support/).

57. The major economic and legal difference between the open source and the open access subscription–or–free model is that the creators of open source software retain the copyright over the work, while researchers turn that copyright over to the publisher, who then grant back to the author the permission to post the work in an open access archive.

58. John E. Kelly, IBM's senior vice president for technology and intellectual property: "Our pledge today is the beginning of a new era in how IBM will manage intellectual property to benefit our partners and clients. Unlike the preceding Industrial Economy, the Innovation Economy requires that intellectual property be deployed for more than just providing the owner with freedom of action and income generation" (Galli, 2005).

59. See, for example, the Institutional Archives Registry at the University of Southampton with a listing of 431 archives worldwide at this point (http://archives.eprints.org/).

60. In high–energy physics, a very large proportion of the literature has been made freely available from arcXiv.org over the last 12 years, and subscription levels in the relevant journals have not been unduly affected. That is, the circulations of these journals declined at about the same rate as related journals in the field, as part of a larger publishing phenomenon that also speaks to the need for open access (Swan, 2005).

61. The underwhelming response on the part of authors to this opportunity to contribute published work to institutional repositories, with a few exceptions such as in high–energy physics, has led to initiatives to establish institutional and granting agency mandates that would compel associated researchers to self–archive their published work (Harnad, 2005c).

62. David, 2003, p. 19.

63. Weber, 2004, p. 17.

64. *Ibid.* Weber (2004, p. 136) does speak of open source programmers choosing their own project "like a tenured professor able to write a book on whatever she wants" — but does not go beyond that level of connection between open source and open access. The open access parallel is also missing from von Hippel's

(2005, p. 177) analysis of open source software, despite his pointing to how it provides "major new opportunities for us all" in a democratization of innovation that is taking place "in firms and communities," and is "driven by steadily better and cheaper computing and communications." While Lerner and Tirole (2005, pp. 116, 118) note that the open source movement and academia have "many parallels," they still seek to explain the mystery of open source through the "labor and industrial organization literatures," while posing as "an interesting question ... whether open access will have the same appeal for the economics community." The question flies in the face of Research Papers in Economics (RePEc, http://repec.org/), which offers perhaps 200,000 working and published papers online, and the Social Science Research Network (SSRN, http://www.ssrn.com/index_sf.html), which makes only somewhat fewer resources freely available in economics and management.

65. Weber, 2004, p. 267.

66. David, 2003, pp. 19. 22.

67. David, 2003, p. 19.

68. Environmental historian Samuel P. Hays (1998, p. 316) writes of how "the environmental thrust took its shape largely from the concerns of people in their daily lives: home, work and leisure ... a preoccupation with a given place and the environmental quality of that place." Against this personal impulse, Hays posits that political forces lead people to see the need to, on a national scale, "bring environmental objectives to the public arena and to focus on these public values in continuous and progressive fashion" (p. xxii). Ashok Swain (1997) points out that in India, convergence among three groups — which he identifies as the Crusading Ghandians, Appropriate Technology, and Ecological Marxists — has led to an "ideological plurality [which] in Indian Environmentalism has helped sharpen the terms of the debate ... [and] advanced the formation of and collaboration among environmental organizations" (p. 829).

69. Arenson and Kleinfield, 2005, p. A25.

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