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Self-governance in science: what can we learn from FOSS?

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The Intellectual Property Rights (IPR) elements of the DIME Network currently focus on research in the area of patents, copyrights and related rights. DIME’s IPR research is at the forefront as it addresses and debates current political and controversial IPR issues that affect businesses, nations and societies today. These issues challenge state of the art thinking and the existing analytical frameworks that dominate theoretical IPR literature in the fields of economics, management, politics, law and regulation theory.
Self-governance in science: what can we learn from FOSS?

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Contents
1 Introduction 2
2 Self-governance in scientific research 3
3 Threats to self-governance in science: motives and methods 5
  3.1 Copyright and trademarks 6
  3.2 Patents 8
  3.3 Self-governed threats 11
4 Free and Open Source Software (FOSS) 12
  4.1 Brief history of software research and development 13
  4.2 The defense of open science in software 14
  4.3 A commitment to open science 14
  4.4 Commercial open science in software 16
5 Restoring self-governance for the scientific community 18

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Abstract

Academic researchers regard themselves as members of a self-governed community. Scientists set goals, conduct research, publish findings and evaluate results according to community standards. In recent times, there have been growing concerns that decisions in science are influenced by outside interests that may not be aligned with the scientific endeavor. In particular, scholars have tried to address the effects of intellectual property rights on the scientific community. In this paper, we contrast science with Free and Open Source Software (FOSS), a community that grew out of academia to defend open science principles in one field. We find that FOSS may offer a model for better preserving – or even expanding – academic freedom.

1 Introduction

Scientists have long maintained that self-governance is essential for a well functioning research system. Authors like Merton (1938) and Stokes (1997) warn that outside actors are tempted to shape science according to their own value systems and thus jeopardize the mission of science.

Their general claim is undisputed in policy, despite some debates over specific aspects, such as the influence of policy makers on high level goal setting for science. Private sponsors and government agencies use targeted funding to direct research efforts into areas of their interest, but research organization and processes are widely accepted as internal affairs of the “Republic of Science”, as evidenced by the extensive freedom policy makers grant the scientific community.

In recent years, however, academic researchers have seen an important aspect of their autonomy infringed: the freedom to use previous results as they see fit. Research communities and university libraries find themselves unable to replace scientific communication channels they consider overprized or otherwise lacking (Frazier, 1998; Rambler, 1999:40-42). Researchers face also demands to not only pay for their use research tools, but to grant the seller exclusive rights on results (Heller and Eisenberg, 1998; Marshall, 1990). Intellectual property rights are increasingly used to limit the free reuse of previous results in both cases – copyrights and trademarks in the first, patents in the second.

These problems have been documented and analyzed in the literature. However, efforts to solve them saw mixed success. The Open Access movement, for example, has raised public awareness of rising costs in scientific publishing, but its goal to make scholarly publications more widely accessible remains distant. With regards to patents on research tools, some fund-
ing agencies require that grantees not seek or agree to exclusive patent licensing; but a uni-
versal, coherent policy is unlikely to emerge from ad hoc measures (Boettiger and Bennett,
2006).

In this paper, we expand our understanding of these issues by studying them as aspects of a single phenomenon rather than as isolated events. They are all evidence of the scientific community’s struggle to address intellectual property rights and their role in academic research. Starting in section 3.1, we show that the community was complicit in effecting the changes that created barriers for the reuse of research results. The community bears more responsibility than commonly admitted not only for the current state but also for ongoing developments.

In section 4 we use the example of Free and Open Source Software (FOSS) to show that the growing importance of commercial activities in some areas of science does not have to result in undue influence on the working of science; it is perfectly possible for the community to contain the impact of commercial actors. FOSS allows us to learn lessons from an alternative development. FOSS was created to preserve the very autonomy that is curtailed in many fields of research – the right to freely reuse previous results. Taken together, the recent histories of science and FOSS strongly suggest that the scientific community could restore the rights it once took for granted.

2 Self-governance in scientific research

Academic researchers regard themselves as members of a self-governed community. Over three hundred years ago, Gottfried Leibniz promoted the “Republic of Letters” – an independent, self-defining network of scholars that transcends national and religious boundaries. Its wealthy patrons funded research in return for immortality – but not control (Ultee, 1987).

This basic notion has not changed. Independence and self-governance have become defining attributes of the scientific community, both in theory and in practice.

In this paper, we differentiate four major aspects of self-governance in the scientific community. First, the right to organize itself. Decisions on internal organization, production processes, or evaluation are taken within that community. Polanyi (1962) contends that “[t]he soil of academic science must be exterritorial in order to secure its rule by scientific opinion.” His “Republic of Science” is based on the “self-co-ordination of independent scientists”; authority “is established between scientists, not above them.”\(^1\) This first right is almost universally recognized.

The second aspect of self-governance, the autonomy in setting goals, has been much more

\(^1\)original emphasis.
controversial. Citizens, politicians and even some scientists have argued that public authorities should guide publically funded research towards higher social utility. The scientific community, however, mounted fierce resistance. Polanyi argues that scientific research is its own purpose, and guiding it to more directly serve the public interest impairs the advancement of science. (Merton, 1938:260) explains the “persistent repudiation by scientists of the application of utilitarian norms to their work” with the danger of allowing any extrascientific criteria to control science. Vannevar Bush’s famous report on science policy, *Science: The Endless Frontier* (Bush, 1945), was motivated by similar concerns. Bush, who directed the U.S. research programs during World War II, strongly opposed bills to “mobilize science and technology [...] for application of science to national problems when peace came.” (England, 1976:42). His fears that public funding agencies would open the door for undue political interference were shared by many other scientists at the time. The report was an attempt to preserve federal research funding but with a drastically reduced level of government control. In trying to restore the autonomy of science, the report emphasized the importance of allowing scientists to explore their interests without concerns about practical applications.² (Stokes, 1997:114-118) notes that scientists are better at recognizing the social value of their work than political authorities are at comprehending its scientific merits. He concedes that nonscientists may be better at the analysis of prospective revenues and costs or complex moral and ethical issues (115) and he sees a legitimate role for external deciders at the wholesale, macroallocative level of research funding (141), where many fields are affected and any particular expertise is unlikely to make a significant difference (142). Even then, any judgments of societal need must be joined with informed estimates of scientific promise (142). In goal setting, the community prevailed. It is still setting research agendas. The anticipated erosion of autonomy in basic science did not materialize (112; Schachman, 2006).

The third, and most controversial aspect of autonomy in science is the control of results. Two influential camps within the community take different positions on this matter. Many subscribe to Merton (1942:273)’s view that “property rights in science are whittled down to a bare minimum by the rationale of the scientific ethic.” They allow “no special rights of use and disposition” for the discoverer. Bush, on the other hand, saw the community’s autonomy threatened by the idea that all rights resulting from federally supported research discoveries should be public property (England, 1976). With regards to patents, Bush (1945) argued that the proposed federal funding agency should “leave the cooperating organization with adequate freedom and incentive to conduct scientific research.” In this regard, the autonomy of science

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²Stokes (1997:18, 107) argues that this emphasis was successful beyond expectations, with an unfortunate consequence. It gave rise to the misconception holding that true basic science must – rather than may – be far removed from practical applications.
was not only protected but strengthened by subsequent changes in regulation.

The fourth and final aspect of the scientific community’s self-governance has received the least attention until recently. It is the freedom of science to use and build upon previous results. It has long been little more than a tacit understanding implied by other aspects of autonomy: without it, science would no longer be free to pick any research subject or method. Most previous research results had been produced within the community, and even those that had not were used by scientists anyway, without fear of repercussions.

3 Threats to self-governance in science: motives and methods

The scientific community’s autonomy has been challenged and compromised many times. Every successful attack combined two elements: a motive and a method.

The motives lie usually outside the scientific realm. In times of war, and occasionally in times of peace, nations try to derive more direct utility from science and to do so exclusively. Among the most well-known examples is the US Office of Scientific Research and Development (OSRD) which coordinated the nation’s scientific efforts in World War II. In more peaceful times, patents can be used to ensure preferential treatment for the domestic industry. That is, for instance, the idea behind the U.S. Bayh-Dole Act which regulates patents on federally funded research states as an objective “to use the patent system [...] to promote the commercialization and public availability of inventions made in the United States by United States industry and labor” (35 U.S.C. §200). Where science changes the world by playing a role as society’s arbiter of truth, it is a natural target for those who have vested interests in differing views and outcomes. This happened, for instance, with the origin of species, the effects of smoking, and global warming. They became major battle grounds as science played a decisive role in school curriculae, lawsuits, or public policy.

The obvious method for constraining the scientific community’s autonomy is to convince citizens or their agent, the government, of the need to take action. Public campaigns or private lobbying may result in some research losing public funding or being prohibited altogether. Of those who have a motive, only few have been able to use that lever. Few governments want to be seen as interfering with the progress of science.

Where high stakes are involved, external actors may expend effort to delay an unfavorable

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3Only few research projects, such as those involving animal test subjects, are opposed on principle, regardless of their outcomes or practical impact. Fortunes spent on linear accelerators or large telescopes have been remarkably uncontroversial.
consensus, for instance by sponsoring dissenting voices. Very rarely, a whole field comes to rely on external sponsors to a degree that jeopardizes the integrity of research.\(^4\)

In this paper, we focus on an entirely different method: intellectual property rights. They grant exclusive control over scientific output and by doing so create a commercial incentive that potentially conflicts with a scientific community that sees previous research results as a freely available input factor. Why this became a growing concern in the past few decades requires some explanation – copyright, patents, and trademarks have been around much longer, after all.

### 3.1 Copyright and trademarks

Copyright provides an incentive for authors by automatically vesting in them exclusive rights over their works. In particular, copying and the creation of derivative works require the permission of copyright owners. In practice, copyright has long been a non-issue in academia. Scientific authors do not need copyright as an incentive to write. They want their works widely distributed and read – they are often even willing to pay for that. Usually, printing and other costs of publishing are still paid for by the readers – or their institutions. Until a few decades ago, the dissemination of scientific publications was limited mostly by the cost of physical copying, and copyright did not interfere with the advance of science. A number of developments changed that. The sequence of seemingly innocuous events is instructive, because it explains why the scientific community failed to protect its autonomy.\(^5\)

First, scientific journals turned from commodities to valuable collectors items. When libraries found they could not afford to buy all scientific publications, they tried to identify and keep the most important ones. Standard metrics for evaluating journals, particularly the impact factor introduced by the Institute for Scientific Information (ISI), ensured that libraries took decisions based on the same rankings. A positive feedback loop started to gain momentum: Libraries subscribe to highly rated journals. Journals kept in many libraries are more likely to be read and cited by scholars. Journals frequently cited by scholars receive high ratings. These developments were welcomed by many. Mechanisms to guide the best research papers into limited number of journals carried by most libraries seems a good way for libraries to cut costs and for scientists to reduce information overload. The prestige associated with top journals serves now as a proxy for research quality. Institutions and even individual scientists are often evaluated based on the prestige of the journals that publish their results, adding pressure

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\(^4\)In biomedicine, for instance, undisclosed conflicts of interest have become a major problem, especially for clinical trials (cf. Abbasi, 2004; Davidoff et al., 2001; Schafer, 2004).

\(^5\)For a more detailed account, see Guédon (2001).
to existing incentives for submitting papers to highly rated journals.

Second, however, ownership on scientific publications became highly concentrated among a few external actors. The opportunity to command premium prices for top journals attracted commercial publishers who relieved academic institutions from the burden of publishing. These publishers are not part of the scientific community – their primary responsibility is to make money for their owners, and they act accordingly. The resulting price hikes for scientific journals were key to what is known as the “serials pricing crisis”. According to a near consensus among university librarians and administrators, the present system of scholarly communication has become unsustainable (Thorin, 2006).  

Commercial publishers are almost universally made responsible for many of its ills (McCabe, 2002). Retaliating against these external actors became increasingly difficult as mergers and acquisitions created publishing giants that libraries cannot afford to boycott (Policy Perspectives, 1998:4; Tamber, 2000; Willinsky, 2006:21).

The situation became more tense when third, technological progress enlarged the rift between publishers and the community. Electronic distribution saves costs for printing and distributing paper – it should make scholarly communication much cheaper. Large scientific publishers found another use for these cost savings: the consolidation of their market power. They offer large discounts on “big deal” packages that include their entire offering (Frazier, 2001). This practice creates a way for non-essential journals to return into research libraries – provided they are backed by a publisher large enough to offer big deals. Digital media provide also new methods for gathering and exploiting usage information. Download statistics give publishers unprecedented insights into the popularity of their products, broken down by locations and individual articles (cf. Nicholas et al., 2006). Digital media can enforce arbitrary restrictions including but not limited to printing or copying; pay-per-view and expiration dates are entirely possible; the groundwork is already being laid as interlibrary loan services disappear with the transition to electronic distribution (Frazier, 1999). Not all of these new levers are currently used in scientific publishing, but they have some scholars concerned (e.g. McCabe, 2002; Suber, 2003). The scientific community, on the other hand, found that electronic distribution could be used to lessen the importance of publishers. Scientists and librarians promote open access models to take advantage of marginal distribution costs approaching zero. They try new work flows and forms of scholarly publications – in many cases only to discover that publishers resist any changes that threaten their lucrative position.

Only a tiny minority argues that the crisis may appear overblown as in typical university budgets, library expenses are dwarfed by other costs of doing research (Cronin, 2003). Whatever the merits of this argument, it does not address the problems caused by the community’s losing control over its outputs, of which rising prices are only a relatively minor, albeit very noticeable, symptom.
Technological progress transformed the conflict between publishers and the scientific community. It opened new opportunities for both sides to change scholarly communication to their own advantage. Publishers discovered new methods for consolidating their market power, and they have a previously unheard of ability to collect and exploit information about the users of scientific publications. The scientific community, on the other hand, opposes these ambitions and hopes to use modern information technology to wrestle control over scholarly communication back from publishers who own most intellectual property in scientific papers and journals and thus have exclusive rights to decide over their use. The battle is not only about the cost of publishing, but about control of processes for scientific knowledge production.

So far, the results for the community were mixed at best. What began as the serials pricing crisis is now in its fourth decade and no end is in sight (Suber, 2003). It appears that digital technologies have not only failed to bring relief – they added to the power of intellectual property and increased the threat to the community’s self-governance.

It would be both naïve and pointless to blame commercial publishers for doing what they were designed to do: making money. It was the community that, by handing over copyrights and other intellectual property related to scientific publications, lost the freedom to adapt its production processes to fit its goals. Had it retained the copyrights or released scientific publications into the public domain, there would be no serials crisis.

3.2 Patents

Patent systems offer exclusive rights to the use of new, useful inventions. Inventors apply for a patent by disclosing their new knowledge to the patent office and – with some delay – to the world. For the scope of this paper, patents fall into the same broad category as copyrights and trademarks. Patents, too, grant exclusive rights over scientific output and as such can be used to overcome community decisions. The nature of patents and their role in science, however, is idiosyncratic enough to warrant a separate discussion.

Advantages of patents Patent systems are meant to reward investments in research and development. As such, they should be well aligned with the goals of the scientific community. And indeed, patents are first incentives to share information, not to limit access to it. Patent applications disclose to the public previously private information that may be freely shared. Second, patents provide incentives for cumulative research. Substantial improvements of previous inventions can be patented irrespective of any patents on the original design. Third, patents are relatively rare. Unlike copyrights, patents are not obtained automatically. Taking out a patent is time-consuming and expensive, especially if it is to cover more than one coun-
try. Most research results do not qualify for patent protection, and even fewer justify the extra expense. Most fields of academic research remain unaffected. Fourth, scientists often ignore patents they might be infringing (Walsh et al., 2005). Scientists in many European countries and in Japan are protected de jure by exemptions in national patent laws (Eisenberg, 2003). The industry has often given university researchers a de facto research exemption (Nelson, 2004). The potential for conflicts between private patent owners and scientists is limited because science is rarely a major market for patented inventions. Therefore, patent owners do not rely on scientists for revenue the way scientific publishers do. Fifth, many scientists find patents on their own results useful or necessary. The key argument has not changed since Bush (1945) argued that patents are important for “small industries to translate new ideas into processes and products of value to the nation”. According to biomedical researcher Hans Wigzell, “if you have discovered something worthy of development, the best way to kill it is to publish without a patent” (Fox, 1996).

It seemed reasonable for scientists and policy makers to embrace patents on scientific research. In the past decades, university patenting increased dramatically (Mowery et al., 2001), and policy initiatives such as the U.S. Bayh-Dole Act have been written to encourage patents on publicly funded research. Patents proved quite effective for commercializing research results, since they protect investments required to bring new technologies to market. Howard Schachman, a biochemist who spent more than half a century in research points to the “triumphs of commercialization” in biomedicine, after decades of research results had remained unexploited by companies “because of the lack of exclusive rights to manufacture drugs” (Schachman, 2006).

Problems with patents With the proliferation of patents, however, came also a number of problems. First, the forays of publicly funded research institutions into the private sector lost goodwill with many companies (cf. Eisenberg, 2003; Nelson, 2004:467). Universities compete with private research departments for patents on the same technologies, and when they succeed – a frequent outcome given their status as research powerhouses – they can play a decisive role in markets by picking an exclusive licensee. Universities have also grown more aggressive about collecting money and enforcing their rights in court, and by doing so, “they have compromised their claim to disinterested stewardship of knowledge in the public interest, leaving themselves more vulnerable to patent infringement claims as defendants” (Eisenberg, 2003). Many in the industry who used to give university researchers a de facto research exemption reversed their policy (Nelson, 2004). Second, the case for research exemptions has become fragile. This point was forcefully made in 2002 when the US Court of Appeals for
the Federal Circuit found that research universities are liable for patent infringement because their research projects are “in furtherance of the alleged infringer’s legitimate business”.  

*Third,* an increasing number of patents covers inventions that are mainly useful to scientists, such as research tools (cf. Andrews et al., 2006). The broadening scope of patentable subject matters extends beyond inventions to discoveries. Scientists are puzzled by patents granted on expressed sequence tags (ESTs) even when their functions were entirely unknown Schachman (2006). A test case “involving whether scientific information can be patented” (Kintisch, 2006) failed to bring the relief some had hoped for: in 2006, the U.S. Supreme Court let a lower court decision stand that protected exclusive rights on a correlation between a symptom and a cause (Klein and Mahoney, 2008). *Fourth,* patents interfere with scientific process. They make collaboration among scientists, who find themselves competing for the same patent rights, more difficult. The outbreak of Severe Acute Respiratory Syndrome (SARS) gave the world a glimpse of what electronically mediated scientific collaboration could be like; it “focused scientific endeavor and stimulated global collaboration” (Skowronski et al., 2005:357). Reports praised the “almost instantaneous communication and information exchange” (Gerberding, 2003:2030) and the “real-time application of accumulating knowledge” (Skowronski et al., 2005:357), “the power of the Internet” (Drazen and Campion, 2003), and the quick identification of the virus by a dozen collaborating laboratories across the world (Stöhr, 2003). The celebrated case study in international scientific collaboration was immediately followed by a race to patent the virus genes (Nature, 2003). Non-profit institutions explained their patent applications as defensive measures – experience had taught them to fear private control over the genes; but some of them also found the prospect of collecting royalties attractive (Rimmer, 2004). Biological materials that used to be transferred upon simple requests between scientists are now entangled in bureaucracy; Technology Transfer Offices, originally created at universities to promote and sell research results are now accused of “impeding the exchanges of scientific materials and knowledge” (Schachman, 2006:6901). Scientists face patents they can no longer afford to ignore, but licenses are sometimes not only costly but subject to onerous restrictions. So-called “reach-through license agreements” have been used by owners of patents on upstream inventions to establish rights on subsequent downstream discoveries (Heller and Eisenberg, 1998:699-700). The costs of bureaucratic and legal obstacles to researchers and scientists are unknown, but Schachman (2006:6902) offers a glimpse at related costs when he notes that “in fiscal year 2004, there were 425 new ‘start-up’ companies fueled by discoveries of professors on university campuses and a record number of patents and licenses. Legal fees incurred in the commercialization of this research in academic institutions amounted to more

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than $189 million.”

The discussion above indicates that scientific community’s position is vastly more complicated for patents than for copyright. Few voices within the community extol the benefits of copyright on scientific publications, and they tend to be associated with profitable publishing ventures. Patents on publically funded research, on the other hand, have many advocates within the community, even though a need to address some problems is widely acknowledged (e.g. Nelson, 2004; Rai and Eisenberg, 2003).

3.3 Self-governed threats

Intellectual property rights curtail several aspects of the scientific community’s self-governance already. The community can no longer assume that all knowledge is free for it to use; that assumption is not even true for its own outputs. A lack of permissions may prevent researchers from working towards the goal of their choice. Intellectual property may even interfere with the community’s ability to adapt its internal processes, as the case of scholarly communication demonstrates.

It is tempting to blame external actors such as commercial publishers or corporations and their patents. But the community is largely responsible for the problems. The community made copyright and trademarks in scientific publishing highly valuable, and then handed them over to outside actors that have no interest in the mission of science. The community argued for the freedom to take out patents to spur commercialization, but then failed to keep its members from repurposing patents as money makers and alienating commercial firms. The community’s essential freedom to build upon any existing knowledge has been compromised by its careless use of the right to control its outputs.

More significantly, the problems are perpetuated by members of the community. Universities resisted legislative efforts to fix issues with the Bayh-Dole Act. They also fought a proposal for public access to raw research data on the ground that it would impede their patenting of new discoveries. The Royal Society of Chemistry’s director of publishing reportedly called open access “ethically flawed”, warning that rapid, open access publication could be used to establish priority ahead of more time-consuming patent applications from rival groups (Sanderson, 2006). The editor in chief of the American Chemical Society’s (ACS) Chemical and Engineering News wrote that “open access, in fact, equates with socialized science”; the ACS paid lobbying firms to oppose PubChem, a free database on small organic molecules launched by the National Institutes of Health (NIH) (Biello, 2007). The society’s goal was to protect a major revenue source; its Chemical Abstracts Service (CAS) employs 1200 people and “makes a significant contribution to the society’s $317 million in annual revenue from
publications” (Kaiser, 2005).

The fundamental problem is created by the presence of intellectual property rights in science. These rights are designed to be strong incentives and as such, they frequently win when colliding with traditional incentives in science. Collisions are likely because these rights are antithetical to open science: they are designed to reward their owners with the right to compromise the scientific community’s freedom to build upon previous results. Whenever they influence decisions in science, they compromise the mechanisms the community built.3 Within the community, institutions are particularly susceptible to favor intellectual property over the progress of science when they are managed as businesses, as illustrated by the examples above. That does not necessarily mean that intellectual property rights are bad per se – not even in publically funded science. For instance, patents – licensed with utmost care – could still play an important role in the commercialization of some research results. But the community should not let the market forces play freely in its realm if it wants to preserve its self-governed, autonomous status. Obviously, community members should not be allowed to wield intellectual property rights as a weapon to override community decisions. Presumably, a consensus could be reached that outputs created within the community should not be transferred to external actors to use as a lever against the community.

An open question is, however, if the community should try to minimize its use of intellectual property rights even when dealing with the private sector. As long as scientists and universities continue to enforce patents on their own behalf, they are unlikely to get their patent exemptions back – de facto or de jure.

4 Free and Open Source Software (FOSS)

The developments we discussed for science took slightly different trajectories in various disciplines. One case, that of software, is particularly interesting. A young, fast moving field characterized by the free exchange of results turned into the epitome of closed development. And yet, the most significant long-term trend in software is the return of development in a community that eschews the power of intellectual property rights in favor of collaboration and freely shared results.

8This point should be uncontroversial. We are at least not aware of any deliberate efforts by the community to give intellectual property right owners greater authority in science.
4.1 Brief history of software research and development

Computer science and software engineering have not been exempt from the intrusion of private monopolies into academic research. Quite the opposite: software is a textbook example for the corporatization, enclosure, and secrecy of research. It took only a few years for software research to turn from a self-contained, happy play-ground for academics into a privately owned industry. Many factors contributed to this transformation. Increasingly sophisticated software and falling hardware costs made software creation a significant investment and its funding a challenge. The number of computers exploded with the introduction of microcomputers in the 1970s and personal computers in the 1980s; distributing development costs among many users by selling licenses for the use of software became a viable business model, especially after legislators extended copyright protection to software. Software vendors who reserved the right to change their software became gatekeepers to progress for many types of software. Even users skilled enough to improve the software they had bought lacked both the permission to do so and access to the source code. With software growing more complex, research and its results became increasingly reliant on proprietary tools and building blocks.

On top of that, patents on software became increasingly important. A 1983 patent granted to three MIT researchers for an encryption algorithm known as RSA was still rather unusual, but in the 1990s software patents became pervasive. Experts both in academia and in the industry noticed that the change in patent policy was detrimental to progress. Eminent computer scientist Knuth (1994) observed that the programs he used would not “exist today if software patents had been prevalent in the 1960s and 1970s”, and even Bill Gates agreed that “the industry would be at a complete standstill today”. Computer scientists were dismayed by what they considered “an alarming trend ” and (Knuth, 1994) and “bad for software”(Garfinkel et al., 1991), while Gates reckoned that for Microsoft, the solution was “patent exchanges with large companies and patenting as much as we can.” University spin-offs commercialized technologies and tried to establish exclusive control over software that owed much to academics who had shared their contributions for free. Tensions between academic development and commercial interests were inevitable and famously demonstrated in 1992 when AT&T’s Unix System Laboratories sued the University of Berkeley to stop their popular software distribution (McKusick, 1999).

4.2 The defense of open science in software

Some developers who had enjoyed unconstrained collaborative work on software watched with dismay the rise of privately owned or – as they would later call it – proprietary software. They decided to carve out their own little niche of freedom by creating and distributing free software which later became also known as open source software, or FOSS. According to FOSS luminary Richard Stallman, the free software movement was “inspired by the application of the ideal of scientific cooperation” (Stallman, 2005). Building their own world based on the principles of open science, they published their results for public review, permitting anyone to use and improve their work. The model attracted contributors of all kinds and by the late 1990s, even large corporations such as IBM got involved in FOSS communities. The success of FOSS was not limited to firms grudgingly accepting open science collaborations with academia. Many companies embraced the principles for their own development projects. What started as a niche for programmers longing for the good old days has, according to market research company IDC, become “the most significant all-encompassing and long-term trend that the software industry has seen since the early 1980s” (IDC, 2006). FOSS developers had not only demonstrated that non-proprietary development was economically viable, they did so while competing with companies that had become deeply entrenched using a proprietary model. They had not only defended open science principles, they had established a beachhead for open science deep inside proprietary territory.

4.3 A commitment to open science

FOSS was successful because it preserved the rights of anyone to use its outputs. In this regard, its most notable achievement was to establish a consensus that limited the threat of intellectual property rights.

That consensus was not a foregone conclusion. Like the scientific community, the FOSS community is very heterogeneous. Fierce competition between projects, disagreements over license policies, and even personal animosities create tension. Dozens of different licenses are used in the community. A rift persists to this day between a free software community which draws its arguments from ethics and open source software proponents who emphasize practical arguments such as the quality of the resulting software.

And yet, the FOSS community shares a common base. All FOSS licenses grant the freedoms listed by the Free Software Definition\(^{10}\) and meet the conditions set forth by the Open

\(^{10}\)http://www.gnu.org/philosophy/free-sw.html
Very simply put, all licenses and both definitions codify one fundamental principle: *Anyone is free to use results and build upon them.*

That principle corresponds to the fourth aspect of self-governance as described in section 2. The licenses limit the freedom of community members to exploit the powers of intellectual property rights and thus work to prevent the problems described in sections 3.1 and 3.2.

The agreement to allow anyone to build upon existing results is universal – except when it comes to protecting the FOSS world from enclosure. Opinions and licenses differ widely where FOSS meets proprietary software. Some licenses, for instance, prohibit derivative works of FOSS from being sold as proprietary software. More specifically, a clause used in many popular FOSS licenses requires that any derivative works be distributed under the exact same terms. “Copyleft”, as the clause is called, is frequently portrayed as a defining trait of FOSS (cf. Gambardella and Hall, 2006) but it has been a contentious point to this day. A vocal minority of FOSS developers sees no harm in having their software built into proprietary projects. After all, they wouldn’t be any poorer for it – they would still have the software they wrote. Among the high-profile FOSS projects distributed without a copyleft clause are the Apache web server, the BSD operating systems, the database management system PostgreSQL, and the programming languages Perl and Python. Similarly, while FOSS developers are virtually unanimous in their rejection of software patents, there is no agreement on whether or how to address the issue in licensing (cf. Zhu, 2007). A similar dispute remains simmering over non-disclosure agreements (NDAs); some developers sign NDAs to get access to confidential documentation, usually in order to write FOSS with interfaces to proprietary hardware or software components. Even if the resulting software is freely available, it will be hard to understand and maintain for anyone not privy to the proprietary documentation – an unacceptable state of affairs to some.

In spite of disagreements over the best interpretation of open science principles, FOSS licenses have done a good job at drawing the line between acceptable and unacceptable behavior. FOSS did not succeed by effecting a complete transformation – most software is still produced under proprietary regimes –, but by creating a sustainable alternative for those interested. It is a parallel system that remains true to its ideals because those who violate the principles of open science have automatically, by definition, left the FOSS world.

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11http://www.opensource.org/docs/osd
12The most widely used FOSS license, the GNU GPL 2, states in the preamble that “we wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone’s free use or not licensed at all.”
4.4 Commercial open science in software

The FOSS community was shaped early by conflicts with commercial firms. In this section, we will show how it learned to reconcile commercial interests with its open science mission.

The benefits of radical openness were not immediately obvious to software developers – not even to everyone willing to share their work freely. Initially, many were suspicious of commercial software. Larry Wall, the creator of the Perl programming language, stated in 1985 that anyone could copy his software “as long as you don’t try to make money off it” (Williams, 2002: p. 125) and the release notes for the early Linux kernels stated that “[y]ou may not distribute [sic] this for a fee, not even ‘handling’ costs.” Some developers experimented with licenses containing a “non-commercial use” clause. At best, these clauses allowed developers to charge money for commercial use and fund further development. But they limited the appeal of FOSS for some users and potential contributors. Clauses treating some users differently disappeared quickly, and they are not allowed by any current definition of FOSS.

FOSS projects explored many paths for collaboration with commercial interests. Developers insisting that all their code be released to the world as FOSS found that some companies were willing to fund development regardless, provided their own utility made the investment worthwhile. Some projects received contributions from companies selling complementary goods; hardware companies, for instance, were interested in having their products work well with FOSS. One variation of the discredited “for non-commercial use only” clause turned into a widely accepted business model for projects using copyleft licenses: some FOSS projects obtain their funding through dual-licensing; they lift the copyleft clause for a fee, allowing other firms to incorporate the code into closed, proprietary products. Companies such as MySQL and Trolltech use this business model for their key products.

In the late 1990s, large corporations got involved, too. In 1998, IBM approached the Apache project because it wanted to adopt the software as its Web server platform, across all its server offerings (McCool et al., 1999). Apache was distributed without copyleft clause, so IBM did not need permission to extend and sell it as proprietary software. And yet IBM asked for permission to join the project as a contributor. IBM developers were invited to earn a place in the Apache Group by their contributions to the project, just like everybody else. The project kept exclusive control of the Apache name, and IBM kept some non-essential extensions to Apache proprietary when they believed they would give up an edge over their proprietary competition otherwise.

Occasionally, the community had to find an answer to proprietary intrusions into its space. One of them took place around the same time as IBM’s early work with Apache. KDE, a new desktop environment for Linux and other FOSS platforms became increasingly popular
It was based on a software library, Qt, that could be used at no cost and came with source code but did not meet all the criteria to qualify as FOSS. Red Hat, the leading Linux distributor – at the time and today – refused to include the software in its offerings, creating a market niche for a new, rapidly growing competitor who started by basically offering Red Hat plus KDE. Red Hat and many others in the FOSS community joined forces to create a FOSS desktop environment named GNOME instead. Qt was eventually relicensed as FOSS and Trolltech, the company that owned the library, became an ardent supporter of FOSS licensing.

The FOSS community has even managed remarkable lobbying campaigns when their self-governance appeared threatened. For instance, when the standards body for the World Wide Web, the W3C, proposed in 2001 to allow patent-encumbered standards in the future, they were met with stiff resistance from the FOSS community which openly threatened to develop competing standards – and the W3C gave in (Cox, 2001; OSI, 2001). A few years later, when the European Union planned to officially make software patentable subject matter, the FOSS community, together with small and medium enterprises, mounted a campaign to stop the legislation; it succeeded in the EU parliament, despite the best efforts of the EU commission and most large software companies – including IBM.13

Today, most of the highly prominent FOSS projects receive substantial contributions from corporate sponsors. The key developers working on the Linux kernel have their salaries paid by a variety of hardware and software companies. GNOME and KDE, the leading desktop projects depend on corporate sponsors, as do Mozilla Firefox and Apache. Some popular projects, such as MySQL and OpenOffice.org are even largely controlled and written by a single company. And yet, none of these projects can ever become a powerful monopoly. The FOSS licenses guarantee a universal right to use, change, and distribute the software. The principles they encode provide safe boundaries for experiments in collaboration and funding. The community has a high tolerance for free riders who make use of FOSS without contributing back, even though in recent years, parts of the community have become more aggressive in enforcing copyleft clauses.14 For many firms, however, the reputation associated with significant contributions is a valuable asset, and they act accordingly. In the long run, few companies have managed to make money with FOSS without being at least reasonably good citizens. And so, little if any controversy remains over commercial involvement with FOSS.

13See Mueller (2006) for a detailed account.
14See recent activities by the gpl-violations.org project and the Software Freedom Law Center (SFLC).
5 Restoring self-governance for the scientific community

Before discussing suggestions based on the experience with FOSS, we offer a brief overview of solutions for preserving or restoring self-governance in science.

The first approach is based on Bush (1945) and has, in many nations, been dominant for most of the past half a century. In order to establish the freedom for scientists to conduct research with no practical application in mind, Bush emphasized its importance and long-term utility. His report was an answer to political challenges of the time. Some of his points are still valid. The practical benefits of many basic research projects are too far off to attract private investors, or entirely impossible to foresee. Some research projects have little hope of practical relevance and may be undertaken solely to satisfy the curiosity of investigators and others with an interest in that subject. They all fit traditional criteria used to justify public funding. Bush was also correct in seeing the potential of patents on research as an incentive to commercialize publicly funded research results.

Bush’s report failed to anticipate, however, the problem created by intellectual property rights on scientific inputs. That is why Nelson (2004) contends that the traditional case for publically funded, open science is insufficient. He argues that most science takes place in what Stokes (1997) called “Pasteur’s Quadrant”. It is equally driven by interests in deeper understanding and practical applications – even researchers who explore basic phenomena often pick a subject because they believe knowledge in that area will be useful. Patents can help turning useful knowledge into products that are widely available, and they are not a concern to Nelson if their scope is limited to a particular use that is directly useful. The path from research results to practical solutions, however, is not only costly, as suggested by proponents of university patenting, but it is also frequently shrouded by uncertainty. In such cases, the owner of an exclusive license is unlikely to try all avenues and fully explore its potential. The incentives for exploration are limited for everyone else; they need permission for their research and in all likelyhood a license for any practical application they may find. This may slow down development since empirical research on technology shows that progress is generally made if a wide variety of efforts compete with each other, with the winners determined in a ex-post selection process. In addition, Nelson criticizes the widespread belief that technology is scientific understanding transformed by applied science. Advances in practice can lead to better understanding. Practice and understanding tend to coevolve. If science is confined to fields of no practical interest, it can not be effective. And that is Nelson (2004)’s point. He fears for the ability of the scientific community “to work freely with and from new scientific findings”
While the “serials pricing crisis” is widely recognized as a real problem, however, the same has not happened for patents in science. By Nelson’s own admission, “the evidence that there already is a problem, that access to scientific research results having high promise of enabling solution of important practical problems is being sharply limited by patent holders, presently is very limited.” (464)

That does not mean that the threat has been contained. As our recounts of the events in sections 3.1 and 3.2 demonstrate, problems such as these are often slow in coming and are much harder to address once they become widespread. Besides a theoretical threat to the community’s self-governance and some, albeit imperfect empirical evidence, there are also a number of reasons to expect suboptimal results from the market for intellectual property on scientific inputs. First, we have shown that intellectual property rights hinder the free flow of information. Embargo policies in publishing and the race for patents prevent a timely disclosure of current research. Access to scientific publications and patented research tools is constrained. Second, there are the costs to the economy at the macrolevel. For instance, universities and other publicly funded institutions may or may not benefit financially from patents in science, but the people who work on patent applications, licensing negotiations, lawsuits etc. have to be paid – eventually by consumers and tax payers. Third, costs change investment decisions. Time and money required to negotiate permissions make it more difficult for scientists to follow their intuition and explore new, unlikely paths. Even if they are willing to spend more of their own time, they may not be prepared to explain extra expenditures with a hunch. Fourth, some globally beneficial market transactions never happen for reasons other than transaction costs. Heller and Eisenberg (1998) cite strategic behaviors and cognitive biases of patent owners who overestimate the value of their invention.

A solution should prevent outputs produced within the scientific community from becoming a threat to its autonomy. Ideally, that would include indirect threats such as the retaliation of commercial firms due to aggressive patent enforcement by universities.

As a consequence of the criticism of Bush’s ideas, Nelson (2004) discusses a second approach applicable to patents – an exemption for research, of which he finds numerous variations. It could apply to all patents, or only to those not available at reasonable terms. It could protect universities, non-profit research organizations, or any research organization. And to have a chance to be accepted by the private sector, it would likely have to include a provision that access to research permitted by the patent exemption could not be limited. Under such a regime, patents in science would turn into a lesser problem. The principal obstacle to such a

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15Based on an unpublished manuscript by R. Dreyfuss.
deal, according to Nelson, is within the community: the universities themselves.

Nelson and others also put forward a third approach that focuses on the specific contributions universities with patents could make. Universities should retain rights to sublicense their patents “to all who want to use them at reasonable fees” (Nelson, 2004) or for research and education (Benkler, 2004). Noting that universities earn a minuscule portion of their revenue from patent royalty and licensing, Benkler suggests that their patents be used “to alleviate impediments of the patent system when applied to research tools and distribution in poor nations” (1110). However, Nelson points out that “a policy of open licensing of research results of certain kinds is not likely to be adopted voluntarily by universities, because this practice will not always be seen as maximizing expected revenues from intellectual property. And that is what many universities are aiming for now.” (469) Therefore, the freedom of universities to use patents as they please would have to be limited by law. It seems unlikely, however, that the resistance of universities can be overcome in the foreseeable future; they have successfully fought similar proposals before (Boettiger and Bennett, 2006).

Therefore, we prefer a fourth approach: reinvigorating open science by taking FOSS as an example. The FOSS community, once inspired by cooperation in science, now in turn serves as an example for the scientific community (Stallman, 2005). Research areas include electronically mediated collaboration (e.g. Benkler, 2004; Schweik and Grove, 2000) and licensing of patents, software, or databases (e.g. Gambardella and Hall, 2006; Rai and Boyle, 2007). Also, Open Access declarations are calls for scientific authors to publish their works under licenses that are very similar to those used for FOSS.\footnote{See, for example, the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities at http://oa.mpg.de/openaccess-berlin/berlindeclaration.html}

The scientific community should also consider following FOSS licenses in drawing its outer boundary. Rather than trying to find “an appropriate place to draw the line between pre-commercial open access data and research materials and commercial proprietary technologies” (Nicol, 2007), it may be easier and more helpful to draw the line between proprietary and non-proprietary use. Scholars who insist on “limitations on commercial reuse by others” (Hoorn, 2005) demonstrate a curious understanding of their job – at least when they receive public funding. The public paid for the creation of public knowledge and has no interest in restrictions.\footnote{Within a single economy, collecting royalties that are simply passed on to consumers makes little sense – especially considering the costs inflicted on consumers by companies taking advantage of their patent monopolies. Whether firms located in other countries should be allowed a “free ride” is an open question.} Copyleft licenses may be useful for further protecting and expanding open science (Graeber et al., 2004; Rai and Boyle, 2007). There are many other FOSS licenses to inspire scientific self-governance. Interestingly, FOSS licenses show that the most important
aspect of self-governance is the one that initially received the least attention: the freedom to use and build upon previous results.

Comparing the four approaches, we prefer the fourth because it helps to restore self-governance in science neither by relying on laws nor on market forces. Instead, it uses self-governance to restore self-governance.
References


