The Digital Technology Boomerang:

New Intellectual Property Rights Threaten Global "Open Science"

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I am grateful to have been able subsequently to discuss the subject of *sui generis* copyright protection of databases with Wendy Gordon, and David Vaver, and for the comments received from other participants in the Intellectual Property Rights Seminar convened by Professor Vaver at St Peter's College, Oxford (23 November 1999). They improved my still tenuous grasp of many aspects of US and European copyright law, thereby contributing significantly to a paper entitled "The Digital Technology Boomerang," presented first at the ESF-IIASA-NSF Workshop held at IIASA, in Laxenburg, Austria (3-5 December 1999): "Building the Virtual 'House of Salomon' -- Digital Collaboration Technologies, the Organization of Scientific Work and the Economics of Knowledge Access,". On that occasion I benefited from the comments of Bronwyn Hall, Robert Kling, Irving Lerch, Clemente Forero-Pineda, and W. Edward Steinmueller. Legal scholars still found much in the revised version that remained in need of improvement, and I am indebted especially to Professors Rochelle Dreyfuss and Jennifer Litman for their discussion of my work at the Innovation Policy Colloquium meeting, convened (on 13 April, 2000) in the New York University School of Law's Engelberg Center on Innovation Law and Policy. In preparing the present version, I was further aided by excellent suggestions from one of the anonymous World Bank reviewers. None among the many whose help I have the pleasure of acknowledging here are to be blamed for whatever errors, omissions or too contentious opinions have survived in the text.

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ABSTRACT

There is a serious threat that ill-considered government support for expanding legal means of controlling access to information for the purpose of extracting private economic rents is resulting in the "over-fencing of the public knowledge commons" in science and engineering. Such a new "tragedy of the commons" would bring adverse long-run consequences for future welfare gains through technological progress, and re-distributional effects further disadvantaging the present economically less advanced countries of the world.

Radical legal innovations in intellectual property protection that seriously jeopardize the effective conduct of open, collaborative science have been introduced by the little noticed European Database Directive of March 1996. This initiative forms an emblematic and substantively significant aspect of the broader set of transformations in intellectual property rights institutions that have been initiated in response to the economic ramifications of rapid progress in digital information technologies. The EC Directive poses numerous contentious issues in law and economics that will create ambiguities for business and non-profit activities in this area for years to come. The terms on which those issues are resolved will materially affect the costs and organizational feasibility of scientific projects that are of global reach and importance, especially those that depend heavily upon the collection, management and analysis of large volumes of observational data that cannot be regenerated. This paper sets out the economic case for the effectiveness of open, collaborative research, and the forces behind the recent, countervailing rush to strengthen and expand the scope of intellectual property rights protection. Focusing upon innovations in copyright law and the *sui generis* protection of hitherto unprotected content, it documents the genesis and analyzes the economic implications of the EC's Database Directive, and related legislative proposals (H.R. 3125, H.R. 354 and H.R. 1858) in the US. Several modest remedial proposals are advanced to mitigate the adverse impact of "the digital technology boomerang" upon open science.

Keywords: intellectual property rights, copyright, *sui generis* protection of expressive material, economics of information-goods, open science, "fair use," scientific databases.

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Prologue: Digital Technology and the Potentialities for Global Scientific Collaboration

The explosive developments that currently are transforming computer-mediated electronic communications most certainly will impinge in various ways upon the organization and conduct of scientific and engineering research. The emergence of new, high-bandwidth digital networks linking massive data storage and distributed parallel processing computing facilities is continuing the amazing fall in the marginal costs of information goods. This revolution touches everything from the availability of electronic working papers and journal publications, and specialized dynamic database services, to the prospective growth of an upgraded Internet that will support enhanced information search, filtering and retrieval services, virtual laboratory environments, and remote shared access to large experimental research facilities.

These tools have the potential to profoundly alter the way that normal science research projects are organized, funded and carried out during the 21st century. The recent completion of the first phase of the collaborative Human Genome Project is perhaps a harbinger of things to come. But, whether that potential will be fully realized is not a certainty, not even a "virtual" certainty. There is no question that the technological feasibilities of real-time distant collaborations, involving the sharing of both physical and data resources on a global scale, are in the process of being greatly expanded. Nor can one doubt that this is creating an enormous capacity for the mobilization and expansion of global scientific and technical resources which might be focused upon providing the knowledge base necessary to address many of the world's pressing economic and social problems. Yet, a number of worrisome countervailing institutional developments are underway, and these already have become noticeable in the modifications being made in the legal protection of intellectual property.

Because these institutional innovations, as I shall suggest, are reactive in some considerable degree to the impacts of the technological innovations associated with the digital revolution, there is no compelling reason to suppose that they are self-limiting. But, if the already apparent movement to expand and strengthen legal protection of intellectual property rights is permitted to proceed unchecked, a real danger lies ahead – and not so far ahead as might be supposed. We really do not know how much further the current rush toward privatization of scientific and technological knowledge can go before it starts to seriously undermine the inherited structure of fragile conventions and institutions that support cooperative research activities, thereby setting in motion the contraction of the global domain of *open* scientific inquiry – that remarkable realm of human endeavors to which the philosopher Michael Polanyi attached the designation: "The Republic of Science." The situation of the latter territory in relation to that of the other principal modes of organization of scientific inquiry in the modern world is schematically described by Figure 1: the domain of the Republic of Science extends throughout those regions in which publicly funded research is carried on in general conformity with the norms of "open science," most notably under a regime of full disclosure of information regarding both methods and findings.[1]

It is upon this troubling prospect that I want to focus attention. This World Bank Annual Conference on Development Economics (Paris, 26 June 2000) was told by President Wolfenson in his opening remarks that it should attend to issues involving technology, as these often will be crucial in discussing alternative paths to development. Professor Sen then reminded us that global exchanges of scientific and technological knowledge historically have played a powerful role in advancing understanding of the human condition, and not only in progress as gauged by the material conditions of everyday life. From Minister Herfken we heard a persuasive argument that providing *access to assets* is critical in the design of strategies for growth, especially strategies that would prove effective also in improving the well-being of the poorest members of society. Surely "knowledge" about scientific and technological matters constitute a class of assets for which that proposition also holds true. This is so especially because knowledge is a

[1] On the nature and historical origins of "open science," see, e.g., Dasgupta and David (1987, 1994); David (1998).

peculiar kind of asset – an asset that can be possessed, enjoyed and efficiently exploited – so long as access to it is not curtailed by being made into a property subject to private ownership.

One implication that can be drawn from the foregoing simple truths is this: development economists ought to be concerned to analyze the impacts that alternative policy recommendations would have for the provision of *access to reliable knowledge* by members of the world's poor societies, as well as by the rich. Rather than considering only the impact upon research aimed at meeting the needs of today and tomorrow, development economists ought to take the long view. They should ask how the resulting conditions of access and information exchange will bear upon the pursuit of knowledge of the kind that is particularly likely to be useful in solving the problems that will be confronting our children's generation, and their children's generation. It is within just this context that I believe it is warranted to draw greater attention to the problematic nexus that has been formed between the digital technology revolution and the transformations taking place in intellectual property rights.

Boomerang – the Tool and the Metaphor

Technological innovation emerges within the context of a large and complex system, and the character of its effects upon economic development and growth also are shaped by systemic interdependences of equal complexity. Non-linear dynamical systems, as is well known from formal analysis of their properties, are capable of generating a wide variety of surprising behaviors. Such considerations prompted the subtitle chosen for this paper, for the story of the "digital technology boomerang" offers a vivid illustrative exemplification of the importance – if one wants to avoid perverse outcomes – of adopting a systems-analysis approach to setting policies for science, technology and economic development.

The boomerang we all know in actuality is a remarkable creation of Aboriginal Australian ingenuity: a curved wooden tool devised for hunting. My allusion to it in the sub-title of this paper, therefore, is wholly metaphorical: I suggest that when the effects of modern digital information and communications technologies are considered from the standpoint of the global communities engaged in scientific research, ICTs can be likened in some respects to a

"boomerang." The peculiarly interesting property of the artifact in question lies in its propensity (when properly thrown) to return to the origin point of its trajectory, should it miss its intended target. This proves quite handy, because it permits the skilled user armed with only one such projectile to make several attempts in reasonably close succession to stun small game at a distance. But the same property also means that failure to pay close attention to the path of the boomerang's flight is quite likely to bring the launcher, or those standing close by, a sharp knock on the head.

The boomerang's aerodynamic qualities in this regard make it a particularly suitable metaphor for the larger class of clever human contrivances that harbor the potential to react back, visiting injury upon those who have launched them. Even the indirect, curving nature of its return path to the launch point is apposite to the emerging situation that I wish to discuss on this occasion, as will soon become apparent. This metaphor is meant to fix your attention upon a number of recent developments in the statutory protection of novel forms of intellectual property. Although these legal innovations have been received in some quarters as essentially innocuous, if not salutary, in my view they may turn out to gravely injure the conduct of open science – an enterprise generally acknowledged to hold enormous potential for improving the well-being of people all around the world.

I am referring, in particular, to the indirect repercussions in the international regime of *copyright protections* that have followed in the wake of the recent, spectacular advance in information technologies. Although indirect, largely unanticipated – and too little noticed in the midst of the concerns raised over the patenting of transgenic organisms and genetic material – these legal *sequelae* of the digital technology revolution certainly are altering parts of the institutional infrastructure that has been supporting the pursuit of reliable and useful knowledge through open collaboration in scientific research.

The particular problem upon which I want to concentrate here is not so simple, inasmuch as mastering its details entails conversations with intellectual property lawyers, and such conversations never are simple. Yet, it is possible for me to begin by stating its generic features in the following, reasonably simple terms (summarized by Figure 2). Knowledge is not an

ordinary commodity; it has several properties that economists identify as those characterizing the general class of "public goods."[2] As is well known, competitive markets cannot be relied upon to perform well in allocating resources to the production and distribution of commodities that have public goods properties. There are knowledge "spillovers" from discoveries, inventions and the process of scientific research itself, and still others from transactions involving information goods; these spillovers inhibit the ability of private investors to appropriate fully the economic benefits created by their investments in such activities.

A variety of market and non-market institutional mechanisms may be deployed to address the so-called "appropriability problem," and, typically, several among these are found to be deployed simultaneously by modern states, in order to encourage the provision of public goods in the shape of scientific and technological knowledge. Some years ago, in another conference presentation to the World Bank, I referred to the three principal institutional devices as "the three P's": public *P*atronage, state *P*rocurement (or, alternatively *P*roduction), and the legal exclusive ownership of (intellectual) *P*roperty.[3] The term *Patronage* stands here for the institutional arrangements for awarding publicly or charitably funded prizes, research grants based on the submission of competitive proposals for scientific peer review, and other subsidies to private individuals and organizations engaging in discovery and invention – in exchange for full public disclosure of their findings. "Patronage" characterizes the pursuit of open scientific inquiry and is the dominant institutional and social mode of organization associated with the conduct of academic research in the democratic societies of the West.

Now the main point about "the Three P's" that needs to be appreciated in the present connection is that none among them offers a solution that is "best" in all respects; each exhibits some special deficiencies as well as some specific virtues in its effects upon resource allocation. In the case of the application of the Property solution to the production of information goods, one can review

[2] The three generally recognized properties are: (1) non-rival possession, which is made possible by the "perfect expansibility" of ideas; (2) low marginal cost of reproduction and distribution which makes it more difficult to exclude others from gaining access to them; (3) substantial fixed costs of original production. See section 4, below for further discussion.

[3] See David (1993), esp. pp. 226 ff. On the connection between patronage institutions and the historical emergence of open science, see, e.g., David (1998). Patronage contrasts most immediately with *Procurement*, which is associated with governmental contracting (or direct production) arrangements, generally, and for performance of scientific research in particular.

the virtues, and the "vices" or defects of granting copyrights in the summary form that is presented by Figure 3. It is apparent that while the problem of extracting economic rents from the stock of knowledge is effectively addressed by the clever social device of awarding private ownership rights, governing the practical, commercial uses to which already existing knowledge may be put, the property solution tends to constrain the scientific application of existing knowledge to generate and verify the reliability of *new* knowledge. In contrast, an open science regime, of the sort that the Patronage solution would support, is most favorable for rapid stock expansion of the stock of knowledge, but interferes with exploiting the latter for economic profit.

To obtain both rapid production and distribution of public goods in the form of scientific and technological knowledge, and to elicit the amount of investment needed in translating new knowledge into a rapid pace of economic welfare-enhancing innovation, it therefore is necessary to devise a system in which these distinct institutionalized mechanisms are kept working properly in conjunction with one another. In other words, the task of science and technology policy for economic development may be seen to be that of achieving and maintaining the right *balance* in the joint deployment of the institutional devices just discussed (see Figure 4a).

Recently, however, the opportunities and disruptive effects created by technological change itself have set in motion economic and political pressures that *are tending to unbalance the innovation systems of many of the world's economies by placing greater and greater reliance on the "property" solution* (see Figure 4b). The "un-balancing" effect is to be seen within the regime of intellectual property in the nature of the additions made to the ever-widening, and increasingly dubious range of applications found for established principles of patent, copyright and trade secrecy law. But it also is manifest in the creation of quite novel *sui generis* legal protections for business investments involving information-goods, which in some cases have departed radically from established principles. Recent initiatives to establish legal protection of databases provide a case in point, the specific of which will be considered shortly.

But, at the overall innovation system level, too, imbalances are appearing as a consequence of the strong and persisting policy consensus that presently favors subsidies for national industrial development in the form of monopoly rights to the exploitation of new knowledge. The problem

is not so much with the intellectual property rights mechanism itself, which although imperfect, has been found to work well enough when it comes to stimulating private investment in the exploitation of commercial opportunities based upon existing scientific and engineering knowledge.[4] What is more problematic, especially for the long run, is the continuing encroachment upon the domain of public information through the efforts to find new ways to privatize old knowledge, and efforts to devise stronger and more extensively enforced property rights with which to appropriate the benefits of new knowledge.

So much for this introductory, capsule sketch of the generic and necessarily rather abstract features of the situation that has developed. Now I must try to indicate briefly, but in considerably more specific terms, one particular set of issues that connects the present trajectory of the evolving legal protections accorded to intellectual property with the future vitality of the global communities engaged in open science research.

The current acceleration of the process of modifying statutory provisions for the protection of copyrights to better adapt them to the realities of the new technological milieu, has been set in motion by the astounding scientific and engineering achievements in digital computation and telecommunications. But, it should be recalled that publicly funded research groups in the international basic science communities historically have played pioneering roles in launching the digital revolution.[5] Therefore, what strikes me as being particularly ironic is that the likely effects of the reactions triggered in the intellectual property rights regime are of a kind so inimical to the health of other, long-standing practices and institutional arrangements for the exchange of information and data. Not by accident, however, the latter arrangements are the very ones that remain critically important for the continuing advancement of scientific knowledge.

Consequently, the digital revolution's unexpected legal side effects could vitiate the direct economic benefits that enhanced information and communications technology (ICT) otherwise might have been expected to provide to the international research community. That untoward

[4] It is true, of course, that consumers of the innovative goods and services that are provided under these arrangements will usually bear some burden in the form of the higher prices that monopoly-holders' may extract, so long as they enjoy their temporary freedom from the competition of imitators. But this already is widely acknowledged, and so does not require the same attention as the issue upon which this paper is focused.

outcome would deliver the strong "negative feedback" in the final stage of the causal circuit that is diagrammed in Figure 5, tracing in summary form the flight path of "the digital boomerang." Will the mode of scientific inquiry that was responsible in great measure for the technological foundations of the modern information revolution thus receive a collective "knock on the head" – through the agency of their own technical creations? Yes, quite possibly, especially if we are inattentive to the path along which the digital technology boomerang appears to be moving.

Sources of the Present Passion for "Property"– and the Resulting "Digital Dilemma"

The swing of the policy pendulum in the US and other highly advanced economies towards more extensive reliance upon strengthened patent and copyright protection for innovations, part of which has been the portrayal of these legal provisions as crucial for eliciting private investment in invention and commercialization of new products, has received impetus from a number of distinct sources:

First it was in some measure a defensive reaction to the emergence during the 1980's of intensified global competition from new producers who had acquired surprising technical capabilities.

Second, some added momentum was gained from undertakings on the part of fiscally straightened governments during the 1990's to cut expenditures by transferring to the private sector a range of data production and information distribution activities that formerly were publicly provided.

A third factor has been the rise of venture financing for new technology-based start-up companies, and the role that the existence of a portfolio of patents came to play in that context. Intellectual property is seen to signal both creative scientific and engineering competence, and the existence of a useful impediment to the rapid entry of competition into the market niche targeted by the new enterprise. Not only venture capitalists and business managers are attracted by these commercial advantages; in the US and Western Europe the more entrepreneurially inclined academic scientists and engineers increasingly are found seeking patents or copyrights

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ee, e.g., National Research Council (1999) for one recently documented part of this history.

for their discoveries and inventions. Indeed, recent changes in government policy affecting the technology licensing of activities of universities and public institutes have been encouraging this new trend.

Fourth, behind much of the impetus to adapt inherited regimes of copyright protection for use in the new technological environment of digital coding and electronic data transmission and copying, one can discern strong economic interests seeking to contain the disruptive effects upon traditional business models in the publishing industries, as well as to facilitate the commercial exploitation of these new digital technologies.

Fifth, and surely most significantly in recent years, in fields such as biomedicine, information technologies and telecommunication network services, the rapid pace of advance of discovery and invention has heightened the drive on the part of business concerns to find more effective mechanisms of protection against the profit-destroying entry of "copy-cat competitors." This reflects the fact that innovative commodities in those fields tend to be characterized by the combination of high fixed costs of development with very low unit costs of reproduction, rendering the position of the lead innovator especially perilous if others can simply copy and replicate their products.

Statutory modifications of the intellectual property regime are thus seen by many as essential if the new technical capabilities for electronic network distribution of digitized information are not to be crippled by an obsolescent institutional infrastructure, such as the protection of copyright that has evolved from the grants of monopoly privileges made to printers in the era of Guttenberg.[6] IPR innovations generally are being directed towards facilitating the continued workings of markets in the age of electronic publishing and distribution of entertainment products (music and video); and towards providing incentives for more private investment in developing convenient means for consumers to access the contents of digital message streams.

[6] On the historical evolution of copyright protections, see, e.g., David (1994) and references therein.

Nevertheless, a transformation of business models is now underway, induced by the prospects of a world of negligible information transmission and copying costs that daily is becoming more and more of a reality. The same prospects have strengthened the commercial impetus behind the development of countervailing techniques for preventing "piracy" – not by relying upon the legal enforcement of intellectual property rights, but instead by application of fast and cheap methods for data encryption and decryption that are being made possible by advances in digital computing. As a result of these two reactive trends, we may be moving towards a quite different state of affairs, one in which the current rush to tighten the copyright regime will come to be perceived as a serious mistake, because its consequences were antithetical to the development of new and profitable business opportunities.[7]

The phrase "the digital dilemma"[8] lately has begun to be applied in referring to the challenge posed by the need not only to accomplish this supply-side task, but also to do so without seriously sacrificing the economic interests of the ultimate users of data and information. The newly augmented, fully digital information infrastructure – comprising computer networks, the integrated set of technologies that constitute the World Wide Web, and the distributed libraries of information in digital form – is at once a remarkably powerful medium for publishing, distributing and controlling information, and the world's largest reproduction facility. It has the potential to enormously improve access to information, and, at the same time it affords technological means of inhibiting access in ways that were never before practical.

In discussions about how a proper balance between those effects might be managed through changes in intellectual property institutions, it is well recognized that it may not be possible to steer a course that avoids winding up with one or the other of the classic policy mistakes. On the one side, there is the risk of not leaving sufficient profit incentives for commercial producers of novel information goods and services; whereas, on the other side, there is the danger that society

[7] On the possibilities for publishers actually to enhance profits by permitting and even facilitating free sharing of information goods among socially connected producer- and consumer-groups (for which, it should be noted, academic scientific research networks provide a significant paradigm) see, e.g., Liebowitz (1985), and Bakos, Brynjolfsson and Lichtman (1999). These noteworthy contributions show that there is another side to the argument that digitally assisted "piracy" (unlicensed copying and redistribution) necessarily will be destructive to profitable publishing businesses.

[8] See National Research Council (2000), esp. pp. 1-3.

as a whole will have been burdened to an unnecessary degree by the inefficiencies in resource allocation that result from the legally sanctioned restraints placed on access to existing bodies of knowledge and information-goods. To be sure, there is in addition the vexed question of how the benefits from the induced innovations are to be shared. Is the societal need for more investment of the sort that will be forthcoming sufficiently great to justify giving intellectual property owners (particularly copyright-holders) the unrestricted power to charge whatever prices they wish? Should they thus be allowed to shift in their favor the distribution of whatever incremental producer and consumer surpluses have been created commercializing the innovation?

The essential nature of the "trade-offs" between opposing economic interests that currently animates these questions is not new. Indeed, it has been aired thoroughly in the long history of policy debates over the benefits and costs of creating temporary intellectual property monopolies in order to encourage investment in commercially-oriented innovation activities. Yet, those national and international debates have been much preoccupied with patent issues; and even in the past and recent discussions of "the digital dilemma," relatively little attention has been devoted to the ways in which the protection of intellectual property rights in the digital age may obstruct shared access to reliable and up-to-date information and data, and thereby seriously impede the systematic accumulation of scientific knowledge. As a consequence of the construction of novel and potentially legal rights in intellectual property, and the encouragement of public and quasi-public institutions in making use of these to attract private sector funding as a way of meeting the high first-costs of making digitized archives available on electronic networks, larger and larger portions of the public data "commons" are being "enclosed" and transformed into private monopolies.

The Case of the European Commission's 1996 Database Directive

The possibility that this unintended consequence of the digital technology revolution actually may sap the future vitality of the global public science system has been rendered worrisomely plausible by the case of the European Commission's Directive on the Legal Protection of Databases, which was issued on March 11 1996. Even today, not many among those who should

be concerned actually are aware of the provisions that it requires the EU member countries to implement in their national statutes.

Briefly told, the Directive in effect established a new form of copyright in databases, one that (1) extends legal protection to content previously in the public domain and otherwise not copyrightable; (2) removes the distinction in the treatment of pre-existing expressive material and original expressions, permitting repeated renewals of protection on old database material; (3) permits virtually indefinite renewal of copyright protection for databases without requiring the substantial addition of new and original content; (4) abandons significant exclusions (such as exist in copyright law) for "fair use" – such as scholarly and literary criticism, use in scientific research, and education; (5) allows the database owner to set any licensing charges, or deny licenses to second parties wishing to extract any portion of the database; (6) omits provision for compulsory licensing or other remedies for abuse of market power when there are no practical means of third party regeneration of the contents and the database producer also holds copyrights on substantial portions of the contents; (7) jettisons the principle of "national treatment" (embraced by the Berne Convention and TRIPS Agreement), and explicitly threatens retaliatory denial of the protection of rights under EU law to foreigners whose countries do not subscribe to a new WIPO convention on database protection convention containing the same language as the Directive.

A noteworthy aspect of the proceedings in the European Commission reflected the pre-committed policy position advanced by the 1994 report on *Europe and the global information society*, prepared for the European Council by a "High-Level Group" under the chairmanship of Commissioner Martin Bangemann.[9] Intellectual property was embraced as central to the "Vision" of the Information Society projected in the Bangemann Report (1994: Ch. 3):

> "In this global information market place, common rules must be agreed and enforced by everyone. Europe has a vested interest in ensuring that protection of IPRs receives full attention and that a high level of protection is maintained."

[9] See Vaver (1999) for the broader context of European innovation policy approaches within which recent copyright directives have been developed.

This commitment sufficed in place of any inquiries as to whether recourse to *sui generis* copyright protection really was needed to stimulate European investment in database creation. How American database vendors had managed to surge so far ahead of Europe in this field, especially without the benefit of any special copyright protection, does not appear to have been a point on which the High-Level Group sought empirical enlightenment. Indeed, only the year before the draft Directive appeared, the US Supreme Court decision in *Feist v. Rural Telephone* (1991) had removed the remaining shreds of legitimacy draped around the argument that the producer of a database was entitled to the protection of copyright law on the basis of the sheer "sweat of the brow" effort invested in the activity of compilation, whether or not any significantly original contribution had been made to its contents.[10] Had the Commission subscribed to the proposition that economic policy measures should be "evidence-based," and actually studied prevailing business practices, it would have been found that a wide variety of other appropriation devices other than intellectual property protection was available and was being successfully deployed by US database businesses.[11] Certainly the performance of the industry in the US after the *Feist* decision could not have lent support to the idea that *sui g*eneris protection was required to repair the damage done by that ruling. (See Table 1). But, to be fair to the Commission, their actions in this case were not aberrant: the entire legislative history of patent and copyright laws reflects a systematic disregard for either evidence or economic analysis.

[10] The importance of the "sweat of the brow" argument for the legal protection of database investors has tended to be exaggerated. Both before and following the 1991 *Feist* ruling, copyright applied to the original selection, co-ordination, and arrangement of data within a database; many defendants in the US therefore have been found liable for copyright infringement since 1991. It has been claimed by industry proponents of *sui generis* legislative protection that comprehensive electronically stored databases could not meet the standard set by copyright law, and such arguments conceivably may have influenced the EC's High-Level Experts Group, members of the European Parliament, or advisers to the Council of Ministers. The comprehensive character of the compilation was said to imply that no "selection" was made by the database author; and the digital nature of the contents supposedly meant that rather than having been "arranged" by the compiler, the data were "arranged" by the user employing a search engine. But apart from cases involving a comprehensive electronically stored database consisting of telephone listing, US courts have not issued rulings that would confirm such fears. Most commercially valuable databases contain many linked fields, and the selection and arrangement of data in these is a sufficiently complex task to constitute some minimal level of creativity on the part of the author. US copyright law clearly prevents the wholesale copying of such (non-trivial) database structures, and thus affords their publishers significant protection even in the post-*Feist* era.

[11] See Maurer (1999): pp. 19-21.

In addition to initiating mimetic legislative proposals in the US Congress, the radical innovations introduced by the European Database Directive have posed a number of contentious issues in law and economics which are likely to create ambiguities for business and non-profit activities in this area for years to come. The ways in which these are resolved will materially affect the costs and organizational feasibility of carrying through some kinds of scientific projects that are of global reach and significance, especially those in the fields of geology, oceanography and climatology that depend heavily upon the collection, management and analysis of very large volumes of observational data.

Thus, the specter before us is that of a new and different "tragedy of the commons." It would be the tragic destruction of the public knowledge base necessary for scientific and technological research by "over-fencing" – the erection of artificial barriers whose purpose is the extraction of economic rents.[12] Unless systematic monitoring of such incursions can be organized on a global scale, and unless countervailing measures (such as compulsory licensing provisions) can be mounted quickly both at the national and international levels, the conduct of open, collaborative science – along with many of the benefits that flow from it, for the developed and the developing economies alike – may be seriously jeopardized. Ironically, and surely it would be a wicked and avoidable historical irony, serious damage could be done to the institutions and norms of open science by these unintended repercussions of the very same digital technologies to whose development public sector science itself contributed so crucially, and from which it otherwise might derive so much reinforcement.

Some Modest Remedial Proposals – Toward Protecting Open Science in the Digital Age

When considering the available courses of action to counter threats to the pursuit of knowledge arising from recent innovations intended to strengthen intellectual property protections, distinctions of two kinds help to simplify the discussion, although not the problems that need to be addressed. Firstly, there is an obvious difference between the altered terms and scope of

[12] The "tragedy of the anticommons" is a phrase coined by Heller and Eisenberg (1998) to refer to the problem of excessive fragmentation of patent rights in the technological knowledge base for commercially-oriented innovation activities, which may inhibit private investment by imposing heavy transactions costs in assembling the necessary licensing rights. Use of this label is eschewed because the focus of concern here is on a different problem, involving obstacles to academic researchers' rapid access to informational inputs required for their work.

statutory intellectual property protections, on the one hand, and on the other hand, legislative steps designed to reinforce the use of technologies of "self help" which enable copyright owners to more perfectly control the dissemination of digital content (whether legally protected or not). A second distinction has to be drawn between the situation of countries where legislative innovations affecting intellectual property may be under consideration, and those cases in which such statutes already are *faits accomplis* – so that the questions of practical interest concern implementation and enforcement.

For most of the nations of the world, the appropriate recommendations in regard to both the technological and the legal measures that would restrict access to digital data used for research and training would seem to follow Nancy Reagan's admonition to youths who are offered the opportunity to experiment with addictive drugs: "Just say 'No'!" It is relevant that this option remains one that is open to all the countries, developed and developing alike, that are signatories to the TRIPS Agreement, and, of course to those who have not yet joined the WTO. To date, at least, there is no international convention in force for the legal protection of databases and the articles of the TRIPS Agreement do not pertain to database protection *per se*. Thus, unless a case were successfully to be made for interpreting the *sui generis* protections for databases created by the EC Directive of March 11, 1996 as somehow being covered under copyright, nothing in the TRIPS agreements would oblige other nations to follow the (misdirected) leaders in this particular regard. Such an interpretation, moreover, would be utterly tendentious in view of the numerous respects in which the terms of the EC Database Directive has been seen to deviate from the principles embraced by national and international copyright law.

Much the same general position may be advanced in regard to the possible products of the legislative drive to provide legal reinforcement for technological measures of "self help" on the part of copyright owners. As has been noted (in section 4, above), the US Digital Millennium Copyright Act (1998) includes language making it illegal to furnish – whether by importation or manufacture, and whether by sale or free distribution – all means of circumventing "any technological measure that effectively controls access" to a copyrighted work. As dubious, and in some respects as counter-productive as these sections of the DMCA have been found to be, by

both legal and technical experts,[13] it remains quite conceivable that an effort will be made to press other countries into following suit. In an immediate sense, however the issue in this case is not one of legal principle, but instead belongs to the wider and unresolved debate about the feasibility and desirability of uniform international standards of *enforcement* of intellectual property rights.

Nothing presently compels countries that are signatory to the TRIPS Agreement to arrive at uniformity in the degree of enforcement of their intellectual property laws. It is true that the international conventions and laws governing patents, trademarks, copyrights, trade secrets, industrial designs, semiconductor mask works, and still other protections, all must be "effectively implemented and enforced" by each of the nations belonging to the WTO. Nevertheless, the term "effectively" remains subject to considerable variations in interpretation.[14] In addition, the Agreement explicitly recognizes several bases for exemptions from the provisions made for protection of the rights of owners of intellectual property, including appeal to "fair use" or "public interest" (Articles 13, 17, 24, 27: 2, 30 and 37). It may be argued, therefore, that inasmuch as national governments under the Agreement retain the right to create a haven for "fair use" of protected intellectual property in the public interest, their ability to effectively exercise that right would be impeded by requiring that they prevent their own nationals from circumventing unilaterally imposed access blocking technologies in order to avail themselves of those "fair use" exemptions for those very same scientific research and training purposes.

The preceding remarks obviously apply to the situation in which the developing economies find themselves with respect to intellectual property protections that would have seriously inhibited worthy, "public interest" activities, had not the latter gained statutory exemptions under the laws' provisos for "fair use." It remains an interesting question as to whether it sphere of applicability

[13] On the question of "counter-productive" effects, Dam (1998) notes the testimony by cyptography experts to the effect that the wording of the 1998 DMCA (US Code, 17, §1201) would make it illegal even to devise and distribute algorithms used in testing encryption systems by trying to defeat them., and, more generally would greatly impede research aimed at making such devices cheap and faster to apply. This point nicely recapitulates the larger theme, viz. that the would-be protectors of technological innovation frequently fail to grasp that information is an input in the process of generating new knowledge.

[14] See Reichman (1998) on the interpretation of the enforcement articles included in Part III of the TRIPS

extends still farther: could it also encompass retroactive remedial legislative actions on the part of the economically advanced member states of the EU that have not yet implemented the EC Directive on the Legal Protection of Databases in their national laws? Whereas some countries, such as the United Kingdom, were quick to implement the Directive without entering any exceptions or liberalizing interpretations, other European states, such as the Netherlands as well as Greece, Ireland, Italy, Portugal, and Spain, have not rushed to comply with its terms. This has opened a window for attempts to modify the Directive's force by suitable interpretations in the way it is implemented. But, rather than leaving it to individual members to undertake to ameliorate the harm that a literal acceptance and enforcement of the text of the Directive might do to the scientific research community in Europe, it would be far more satisfactory for the EC to now propose a "harmonized" set of fair use exemptions, as a minimal remedial step.

That solution, however, is not likely to emerge spontaneously, not even in the wake of the departure of EC Commissioner Bangemann, and the scandal-prompted reforms undertaken by the new leadership of EC President Romano Prodi; some very considerable amount of political pressure would have to be brought to bear upon the Commission, and a coalition formed among the smaller member states who have yet to implement the Directive would seem to be among the few plausible ways in which such pressure could materialize. Yet, in view of the politically fragmented condition of Europe's basic science research communities, the prospects of an effective coalition emerging would remain rather remote unless it were to be energized by business corporations similar to those in the US who have lobbied actively against counterpart database legislation. The political economy of the question, therefore, is likely to turn not upon the longer-run implications for science and technology in Europe as the logic of economic analysis might dictate; but instead upon whether or not there exists a significant section of European industry that comes to perceive a direct and immediate source of harm to their economic fortunes, in the extraordinary nature of the protections allowed by the EC's Database Directive.

According to the American writer and wit, Mark Twain, "the man who would rid the world of a cancer is not obliged to put something in its place." Nevertheless, the reality of the situation is

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Agreement, and the survey of implementation issues in Keely (2000).

that in the wake of the EC initiative to legally protect databases, regardless of whether or not there was empirical evidence to suggest that such measures were required for the growth of the database industry in Europe, this particular protection genie has got out of the bottle and won't be stuffed completely back in. What this means is that remediation cannot simply take the form of a return to the *status quo ante*. As some alternative recommendations for intellectual property protection in the market for scientific databases are in order, I should not conclude the discussion without considering these, however briefly.

In the view of most economists, the "first best" allocation system in situations where goods are produced with high fixed costs but far lower marginal costs, is to apply what is known as the "Ramsey pricing" rule. This fits the case of information products such as scientific publication and data, where the first-copy costs are very great in relationship to the negligible unit costs of copies. Ramsey pricing in essence amounts to price discrimination between users whose demands are inelastic and those users for whom the quantity purchased is extremely price-sensitive. The former class of buyers therefore will bear high prices without curtailing the quantity purchased of the goods in question, and hence not suffer great reductions in consumption utility on that account, whereas the low prices offered to those in the second category will spare them the burden of economic welfare reducing cutbacks in their use of the good.

The case might then be made for treating scholars and public sector, university-based researchers as having highly elastic information and data demands. Such a characterization would follow from considering that this category of knowledge-workers is employed on projects that have fixed budget allocations from public (or non-profit) entities, organizations that are expected to promote the interests of society at large. Since there is strong complementarity between their data and information requirements, on the one hand, and on the other resources they use in their research, the effects of raising the real price of this input are tantamount to sharply reducing the quantity of useful work that such projects can accomplish so long as their budgets remain fixed. Obviously, there is no workable economic or political mechanism that would serve to "index" the nominal value of public research budgets on the prices of commercially provided data. Even were such mechanisms to be found, commitment to implement them on the part of the rich

societies would most likely result in pricing the use of scientific information and data beyond the reach of many poorer societies. The general conclusion of this line of reasoning is simple: statutes that would establish legal ownership rights for compilers of scientific and technological databases also should include provisions mandating compulsory licensing of scientific database contents at marginal costs (of data extraction and distribution) to accredited individuals and research institutions.

Of course, a second-best version of such a policy would be to grant researchers (and educators) broad "fair use" exemptions from the legal enforcement of database owner's rights, dispensing with recovery of marginal costs except where special, value-adding facilities were used to extract the contents from protected databases. One reason against dispensing entirely with marginal cost charges is that it may well be the case that marginal extraction and copying costs might be lower for the database owner than for the research user, but, in the absence of quoted prices for the service, research groups may not be aware of this and so waste time and resources in performing tasks that could be more efficiently undertaken by the commercial database firm. In other words, allowing users to "do it for themselves" could deny both parties the benefits of the economies of scale and scope as were available. On the other side of the argument, it would be desirable to limit the incentives for database producers to bundle unwanted and costly extraction and reproduction services with the contents of their database, including services whose costs cannot be readily established and which give rise to opportunities for cross-subsidization among different classes of users.

Compulsory licensing has further attractions as a remedy in this context. No protections are provided in the 1996 Database Directive against the abusive exploitation of market power arising in cases of sole supply of data; or where high set-up costs tend to preclude competitive entry into niche markets already occupied by early commercial database generators. The obvious remedy here would be to stipulate conditions (derived in accord with the principles underlying existing competition laws) that would trigger the "regulatory" imposition of compulsory licensing of database contents at the marginal costs of data provision. Such provisions would not be inconsistent with the TRIPS Agreement, Part II of which (under Article 40) sets out conditions

under which anti-competitive licensing practices that are shown to prevent dissemination of a technology may be restricted.[15]

But the foregoing modest proposals are just the beginning of what must become a more intense discussion, involving participants drawn from many disciplines in the sciences, legal scholars and business lawyers, representatives of the affected industries and policy-makers from the developed and developing countries alike. There is much to do to protect the vitality of the global science system of open collaboration, and the time to do it has become short.

[15] See Keely (2000), pp.6-7.

Table 1: Performance of US Database Industry after the 1991 Decision in *Feist v. Rural Telephone*

Performance indicators	1991	1997	% change
Number of databases	7637	10338	35%
Number of files within databases (billions)	4.0	11.2	180%
Number of online searches (millions)	44.4	(88.1)	98%
Private sector's share in number of databases*	0.70	0.78	

Note: * The private sector's share in 1977 was 0.22.

Source: http://www.databasedata.org/hr1858/legalprt/hegalprt.html.

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Figure 1. THE MODERN SOCIAL ORGANIZATION OF SCIENTIFIC RESEARCH

	DOMINANT FORM OF FUNDING ARRANGEMENTS		
INFORMATION DISCLOSURE REGIME (below)	Public and Private Patronage	Public Contracting and Expenditures	Private Business Contracting and Direct Expenditures
Public Knowledge	***REPUBLIC OF*** *Universities and Non-Profit Institutes*	***SCIENCE*** *Government Civilian Laboratories and Institutes*	Corporate Basic Research 'Campuses'
Proprietary Knowledge	University - Industry Research Centers, Contracts	***REALM OF*** *Government Defense Laboratories*	***TECHNOLOGY*** *Corporate R & D Organizations*

Figure 2. A Primer on the Economics of Knowledge

- Research outputs are information
- Information is a key research input, too
- Information is not a normal (private) commodity
- Two properties of “pure public goods”:
  - “infinite expansabilty,” i.e., negligible marginal transfer costs
  - Significant costs of exclusion from access and ‘possession’
  - High fixed costs of production
- Implications:
  - Competitive markets fail to allocate ‘public goods’ efficiently
  - ‘mc pricing’ leaves most costs uncovered, even at large scales
  - external use benefits not properly valued by private willingness to pay

Figure 3.
Economic Virtues and Vices of Copyright Protection

Analytical justification*:* Copyright protection addresses the problem of high fixed (first copy) cost and low marginal (added copy) cost.

Virtues:

- Incentives for creative productions
- Reward for derivative innovation benefit s ('droite de suivre' principle rewards bias towards breadth/development potential)
- 'Versioning' permits price discrimination based on urgency of demand for information

Vices:

- 'Deadweight' burden of monopoly, heavy for 'minority taste' users
- 'Super-inefficiencies' when applied to network goods (especially compatibility standards, interface standards)
- Impediments to cumulative innovation, unless mitigated by 'fair use' exclusions
- Inhibits development of modular system innovation (e.g., software system design)

Figure 4a. "The Three P's" and the Mix of Solutio to the Knowledge-Appropriation Problem

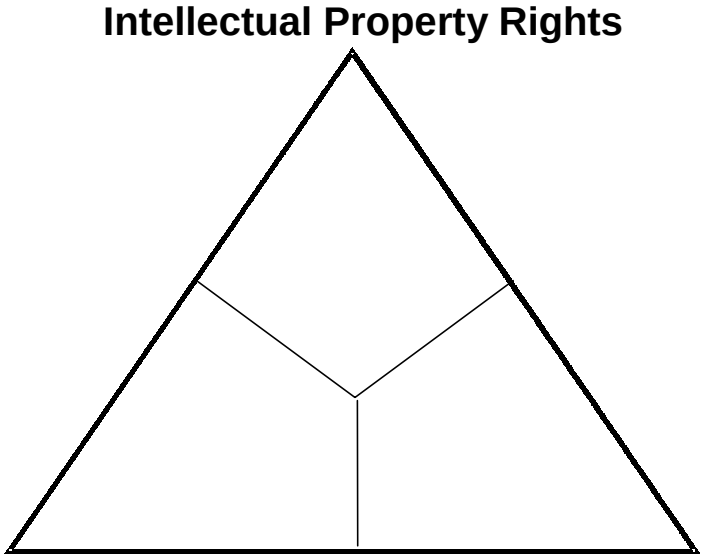

Figure 4b.The Shifting Balance Among "The Three P's"

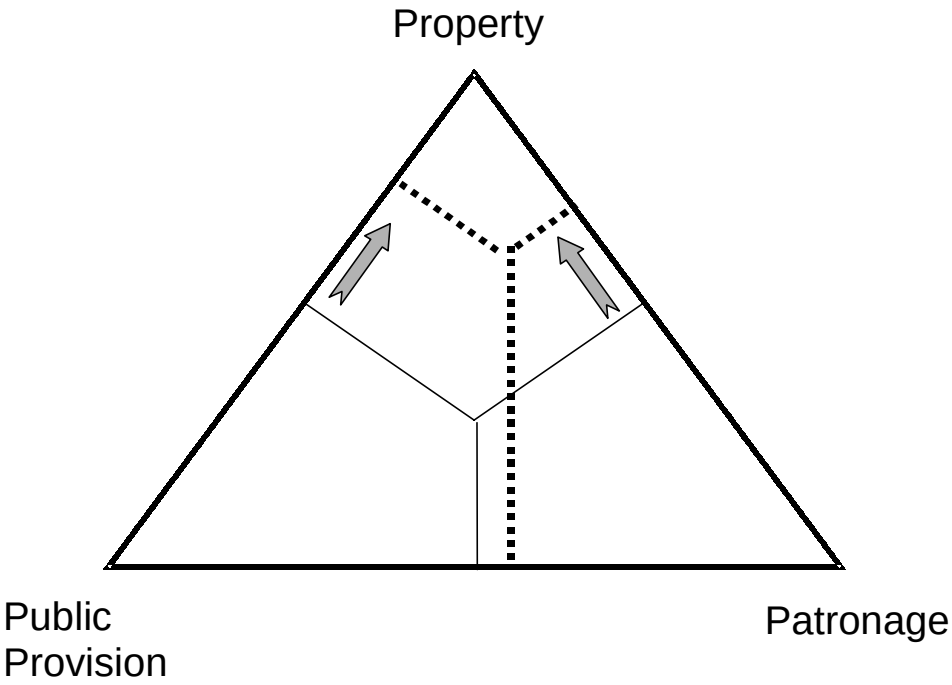

Figure 5. The Digital Technology Boomerang

(*A schematic for getting 'a surprise knock on the head'*)