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Koyaanisqatsi in Cyberspace

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The economics of an 'out-of-balance' regime of private property rights in digital data and information

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SUMMARY

Koyaanisqatsi is a Hopi Indian word that translates into English as "life out of balance," "crazy life," "life in turmoil," "life disintegrating," all meanings consistent with indicating "a way of life which calls for another way of living." While not wishing to suggest either that the international regime of intellectual property rights protection scientific and technical data and information is "crazy" or that it is "in turmoil", this paper argues that the persisting drift of institutional change towards towards a stronger, more extensive and globally harmonized system of intellectual property protections during the past two decades has dangerously altered the balance between private rights and the public domain in data and information. In this regard we have embarked upon "a way of life which calls for another way of living."

High access charges imposed by holders of monopoly rights in intellectual property have overall consequences for the conduct of science that are particularly damaging to programs of exploratory research which are recognized to be critical for the sustained growth of knowledge-driven economies. Lack of restraint in privatizing the public domain in data and information has effects similar to those of non-cooperative behaviors among researchers in regard to the sharing of access to raw data-steams and information, or the systematic under-provision the documentation and annotation required to create reliably accurate and up-to-date public database resources. Both can significantly degrade the effectiveness of the research system as a whole

The urgency of working towards a restoration of proper balance between private property rights and the public domain in data and information arises from considerations beyond the need to protect the public knowledge commons upon which the vitality of open science depends. Policy-makers who seek to configure the institutional infrastructure to better accommodate emerging commercial opportunities of the information-intensive "new economy" – in the developed and developing countries alike –therefore have a common interest in reducing the impediments to the future commercial exploitation of peer-to-peer networking technologies which are likely to be posed by ever-more stringent enforcement of intellectual property rights.

The Argument

Koyaanisqatsi is a Hopi Indian word. Almost unpronounceable for English speakers, it translates as "life out of balance," "crazy life," "life in turmoil," "life disintegrating," all meanings consistent with indicating "a way of life which calls for another way of living." For those who have already encountered this word as the title of the powerful 1983 documentary film without dialogue directed by Godfrey Reggio, and who therefore heard the ominous chanting of "Koyannisqatsi" over the score by Phillip Glass, its resonance may seem rather too doom-laden for the context in which I am invoking it on this occasion.[1] In truth, I do not mean to suggest either that the international regime of intellectual property rights protection scientific and technical data and information is "crazy" or that it is "in turmoil". But, I will argue that the persisting drift of institutional change towards towards a stronger, more extensive and globally harmonized system of intellectual property protections during the past two decades has dangerously altered the balance between private rights and the public domain in data and information; that in this regard we have embarked upon "a way of life which calls for another way of living."

To put the argument more concretely and specifically, I share the view of some observers that the emergent conjunction of statutory protections for technical systems of "self-help" for copyright holders and *sui generis* legal protection of property rights in databases does threaten the "disintegration" of a cornerstone of the historical regime of copyright.[2] I refer to the precept that whereas ideas, facts and their modes of expression "naturally" belong in the public domain, granting private parties *temporary* possession of exclusive rights to exploit these may serve important, socially beneficial purposes. Instead, in the increasingly "out-of-balance" regime towards which we seem to be headed, the premise that "information-goods" that can be fixed in digital form are "intellectual assets" and should be treated symmetrically with all other forms of private property, which is to say they should be subject to *perpetual* private ownership under the protection of copyright and copyright-like statutes, and technical means of enforcing those rights.

These developments, and the latter view in particular, carry worrisome implications for the long-run vitality of scientific and technological research, and all the societal benefits deriving therefrom. The advancement of knowledge is a cumulative process, one that depends on the rapid and widespread disclosure of new findings, so that they may be rapidly discarded if unreliable, or confirmed and brought into fruitful conjunction with other bodies of reliable data and information. "Open science" institutions provide an alternative to the intellectual property approach to dealing with difficult problems that arise in the production and distribution of information under competitive market conditions. Although not a perfect solution to those problems, and one that requires public patronage of research agents who are

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[1] See Wikipedia, the Free Encyclopedia (text available under the terms of the GNU Free Documentation License) at http://www.wikipedia.org/wiki/Koyaanisqatsi [last modified 07:47 Feb 16, 2003]. The film consists mostly of slow-motion and time-lapse footage, starting with a cave painting, progressing to footage of various natural environmental phenomena such as waves and cloud formations, and then to footage of man-made events including traffic formations, bombings, and desolate urban landscapes; it invites comparison between various natural and technological phenomena, by following a slow-motion images of crashing waves with those of clouds billowing around a mountainside, and an aerial shot of a cityscape with a closeup of a computer chip. At the film's end an extended sequence of a booster rocket slowly disintegrating as it falls to earth culminates with the presentation of a number of generally dour Hopi prophecies, warning against human disruption of the nature order in efforts to exploit it: "If we dig precious things from the land, we will invite disaster."

[2] See, particularly, J. H. Reichman and Paul F. Uhlir, "A Contractually Reconstructed Research Commons for Scientific Data in a Highly Protective Intellectual Property Environment." Paper presented to the National Research Council Symposium on *the Role of the Public Domain in Data and Information*, held at the National Academy of Sciences (Washington, D.C.), 5-6 September 2000. Review draft: 6 November 2002.

enjoined to quickly disclose and freely share information about their methods and findings, as a mode of generating reliable knowledge, "open science" depends upon a specific non-market reward system to solve a number of resource allocation problems that have their origins in the peculiar characteristics of information as an economic good. The collegiate reputational reward systems conventionally associated with open science practice in the academy and public research institutes do create conflicts been the ostensible norms of 'cooperation,' on the one hand, and on the other, the incentives it creates for non-cooperative rivalrous behavior on the part of individuals and research units that are drawn into racing to establish "priority." Despite those sources of inefficiency in the allocation of research resources, open science is properly regarded as uniquely well suited to the goal of maximising the rate of growth of the stock of reliable knowledge.[3]

High access charges imposed by holders of monopoly rights in intellectual property have overall consequences for the conduct of science that are particularly damaging to programs of exploratory research that are recognized to be critical for the sustained growth of knowledge-driven economies. Lack of restraint in privatizing the public domain in data and information has effects similar to those of non-cooperative behaviors among researchers, especially in regard to the sharing of access to raw data-steams and information, and the systematic under-provision the documentation and annotation required to create reliably accurate and up-to-date public database resources. Both can significantly degrade the effectiveness of the research system as a whole. Considered at the macro-level, open science and commercially oriented R&D based upon proprietary information constitute complementary sub-systems. The public policy challenge that now needs to be faced, consequently, is to keep the two sub-systems in proper balance. This requires not only adequate public funding of "open science" research, but deliberate action to halt, and in some areas reverse the excessive incursions of claims to private property rights over material that would otherwise remain in the public domain of scientific data and information.

Yet, today there are many writers in the business press, academic economists, lawyers and policy makers who see the matter quite differently. The centrality of information technologies and information goods in the phenomena that are associated with the New Economy has suggested that the world has now leaving behind the epoch of material capitalism and entering that of "Intellectual Capitalism." Accordingly, on this view, assuring the continued vitality of the market system requires in new institutional and technical innovations to protect intellectual property rights from the potentially disruptive effects of the rapid advance of digital information technologies and computer-mediated telecommunications.

Much of the justification for that view, and hence for the sanguine and in some quarters enthusiastic view of recent trends in the elaboration and extension of IPR protections, rests on little evidence and inadequately careful economic analysis. There are a number of respects in which the new technological environment is increasing the seriousness of the drawbacks of using legal monopolies to solve the problems that the "public goods" features of information pose for competitive markets. The urgency of working towards a restoration of proper balance between private property rights and the public domain in data and information arises from considerations beyond the need to protect the public knowledge commons upon which the vitality of open science depends. Economists lately have come around to the view that the "public goods problems" which recently have been heightened by the dramatically falling costs of reproducing and distributing digital information, may, for related reasons, also have become more manageable under market competition without recourse to copyright and copyright-like protections. Protections for producers of "the first copy" from "unfair dealing" constitutes

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[3] For further development of these points, which are not treated extensively in this essay, see Paul A. David, "The Economic Logic of 'Open Science' and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information : A Primer,", Paper presented to the National Research Council Symposium on *the Role of the Public Domain in Scientific and Technical Data and Information*, held at the National Academy of Sciences (Washington, D.C.), 5-6 September 2000. Final draft:

an alternative approach to copyright, and one that is more directly responsive to the economics issues of unfair competition that have beset publishers from the era of Gutenberg onwards. On that reading, policy-makers who seek to configure the institutional infrastructure to better accommodate emerging commercial opportunities of the information-intensive "new economy" – in the developed and developing countries alike – may have a common interest in reducing the impediments to the future commercial exploitation of peer-to-peer networking technologies which are likely to be posed by ever-more stringent enforcement of intellectual property rights.

The following sections of this paper adumbrate and elaborate on this argument, beginning with the economics of information and taking notice of the existence of alternative solutions to the problems of appropriating value in the case of commodities that have the properties of public goods.

Knowledge, Information Economics and the "Three P's"

Knowledge may be viewed as a commodity. But, it is not a commonplace commodity. Nor is information, which we may distinguish from the cognitive human capabilities subsumed under the label of 'knowledge." Through the process of codification, some, but not all forms of knowledge, can be reduced to information, which renders it more readily transmitted, classified and stored. Even so, information, like knowledge remains highly differentiated, and not being homogeneous it has no obvious natural units of measurement. It can have utility as a pure consumption good or as a capital good, and often as both. It is unusual in that, as a pure capital good yielding a stream of material benefits when combined with other kinds of assets, information and knowledge possess intrinsic values. Such is the case, for example, with regard to information about the operation of a cost-saving manufacturing process, or the design of a product with better quality attributes.

A property still more remarkable than those already noticed is information's extreme *indivisibility*, coupled with its durability: once a a bit of knowledge has been obtained, there is no value to acquiring it a second time, or a third. There is no societal need to repeat the same discovery or invention, because a piece of information can be used again and again without exhausting it. Related to this, and of even greater import, knowledge differs from ordinary "private" commodities in being what economists refer to as a *non-rival* good: it can be possessed and enjoyed jointly by as many as care to make use of it. While this observation forms the point of departure of the classic analysis of the economics of R&D due to Kenneth Arrow (1962), it hardly can be claimed as a modern insight.

Consider the following passage in a letter written in 1813 to Isaac McPherson, a Baltimore inventor, by Thomas Jefferson:[4]

> "If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it. He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me. That ideas should freely spread from one to another over the globe, for the moral and mutual instruction of man, and improvement of his condition, seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without

[4] A. Koch and W. Peden, eds., *The Life and Selected Writings of Thomas Jefferson*, New York: Modern Library Editions, 1972: pp. 629-630.

> lessening their density in any point, and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation."

It seems clear that Jefferson grasped the essential point that the cost of transmitting useful knowledge in codified form is negligible in comparison to the costs of creating it; and saw that were it not for society's need to encourage the pursuit of ideas by rendering such pursuits economically viable, such information should be distributed freely.[5]

Non-rival possession, low marginal cost of reproduction and distribution which makes it difficult to exclude others from access, and substantial fixed costs of original production, are the three properties familiarly associated with the definition of a "public good". As is well known, when these characteristics are present competitive markets -- in which price tends to be driven down to the costs of supplying the marginal unit of the commodity -- in general perform quite badly; competitive producer's revenues will not even cover their full costs of production, much less appropriate anything approaching the use value of the goods to the public. Indeed, the attempt to make the beneficiaries pay for value received would so reduce demand as to result in an inefficiently low level of its consumption.

In the literature of public finance economics, three principal alternative allocative mechanisms are proposed as solutions to "the public goods problem". One is that society should provide independent producers with subsidies financed by general taxation, and require that the goods be made available to the public freely or at a nominal charge. A second mechanism would have the state levying general taxes to finance its direct participation in the process of production and distribution, furnishing and managing the requisite facilities, and contracting where necessary with private agents to carry out this work. Here, again, the objective is to supply the good without having to charge prices for it. The third solution is to create a publicly regulated private monopoly, which would be able to charge consumers prices that will secure a "normal" rate of profit. This does not guarantee that consumers will be lined up to purchase the goods and services in question. In other words, the legal right to exclude other producers from the market for a product does not, in and of itself, create a profitable monopoly of that line of business.

While the elements of non-excludabilty and “non-rivalry” that are present in information qualifies this commodity to be regarded as a “public good” for purposes of economic policy analysis, ideas and information remain distinguished in two respects from the mass of conventional public goods, such as traffic lights, flood control systems, airport beacons and radar landing beams, and the like. The first difference is that the attributes of the commodity -- i.e., typically, the complete contents of the information itself -- will not be known beforehand. Indeed, it is not known automatically to all the interested parties even when the new knowledge becomes available in codified form. This *asymmetry in the distribution of information* greatly complicates the process of arranging contracts for the production and use of new knowledge.

The second differentiating feature is *the cumulative and interactive nature of knowledge* . It is particularly evident that the stock of scientific and technological knowledge grows by incremental

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[5] This does not mean that knowledge of all kinds can be transferred a low marginal costs. Uncodified knowledge, which in many instances resists codification and remains “tacit” is more difficult to transmit between agents, except through personal communications that take the form of demonstrations. On the implications of tacitness in regard to science and technology policies, and the economics of codification of knowledge, see, e.g., R. Cowan, P. A. David and D. Foray, “The explicit economics of codification and tacit knowledge,” *Industrial and Corporate Change*, , 9(2), (Summer) 2000: pp. 211-253.

additions, each advance building upon and sometimes altering the significance of previous findings in complicated, and often unpredictable ways.[6]

The importance of the foregoing differentiating features notwithstanding, it is useful to notice a striking correspondence between the three solutions for the standard public goods problem -- subsidies, direct production, and regulated monopoly -- and the three main institutional arrangements that may be deployed to address the so-called "appropriability problem" to which the public goods characteristics of information gives rise. In order to encourage the provision of public goods in the shape of scientific and technological knowledge, modern states typically are found to be deploying several of these concurrently. For the sake of brevity, I have referred on previous occasions to the three principal institutional devices as "the three P's": public *P*atronage, the legal exclusive ownership of (intellectual) *P*roperty, and *P*rocurement by State agencies through contracting arrangements.[7] Each of these mechanisms, however, exhibits some special deficiencies as well as some specific virtues in its effects upon resource allocation; none among them offers a perfect solution to the problem. We focus here on intellectual property rights, and examine the virtues and deficiencies of in the less often discussed case of the protections afforded by the copyright system.

The term "patronage" stands for the system of awarding publicly financed prizes, research grants based upon the submission of competitive proposals, and other subsidies to private individuals and organizations engaged in intellectual discovery and invention, in exchange for full public disclosure of their creative achievements. It may be said to characterize the pursuit of "open" scientific inquiry, and the dominant institutional and social mode of organization associated in the western democratic societies with the conduct of academic science.

"Procurement" is associated with governmental contracting for intellectual work, the products of which it will control and devote to public purposes. Whether or not the information thereby produced will be laid open for public use is a secondary issue, albeit an important matter for public policy. "Sensitive" defence-related research usually is conducted under government auspices in secure, closed laboratories; whereas, much public contract R&D, and the scientific work of governmentally managed laboratories and (agricultural) experiment stations, is undertaken with the intention of wide dissemination of the findings.

The third arrangement is for society to grant private producers of new knowledge exclusive property rights to the use of their creations, thereby forming conditions for the existence of markets in these forms intellectual property, and enabling the originators to collect (differential) fees for the use of their work by others. Here, under the Property rubric, are found the specific legal contrivances of the patent and copyright, and, somewhat more problematically, the trade secret.

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[6] Thomas Jefferson remarked upon this, too:"The fact is, that one new idea leads to another, that to a third, and so on through a course of time until someone, with whom no one of these ideas was original, combines all together, and produces what is justly called an new invention." (Jefferson/Koch and Peden 1972: p. 686)

[7] See, e.g., P. A. David, "Intellectual Property Institutions and the Panda's Thumb: Patents, Copyrights, and Trade Secrets in Economic Theory and History," in *Global Dimensions of Intellectual Property Rights in Science and Technology*, (M. Wallerstein, M. Mogee, and R. Schoen, eds.), Washington, DC: National Academy Press, 1993), esp. pp. 226 ff. On the connection between patronage institutions and the conduct of "open science', see, e.g., P. A. David, "Common Agency Contracting and the Emergence of 'Open Science' Institutions," *American Economic Review*, 88(2), May 1998.

Intellectual Property Rights Protections in Economic Theory and History

The creation and assigning of intellectual property rights convey a monopoly right to the beneficial economic exploitation of an idea (in the case of patent rights) or of a particular expression of an idea (in the case of copyright) in return for the disclosure of the idea or its expression. This device allows the organisation of market exchanges of "exploitation rights," which, by assigning pecuniary value to commercially exploitable ideas, creates economic incentives for people to go on creating new ones, as well as finding new applications for old ones. By allocating these rights to those who are prepared to pay the most for them, the workings of intellectual property markets also tend to prevent ideas from remaining in the exclusive (secret) possession of discoverers and inventors who might be quite uninterested in seeing their creations used to satisfy the wants and needs of other members of society.

Thus a potential economic problem that is addressed by instituting a system of intellectual property rights is the threat that unfair competition, particularly the misappropriation of the benefits of someone else's expenditure of effort, may destroy the provision of information-goods as a commercially viable activity. The nub of the problem here is that the cost of making a particular information good available to a second, third, or thousandth user are not significantly greater than those of making it available to the first one. Ever since the Gutenberg revolution, the technical advances that have lowered the costs of reproducing "encoded" material (text, images, sounds) also has permitted "pirates" to appropriate the contents of the first copy without bearing the expense of its development. Unchecked, this form of unfair competition could render unprofitable the investment entailed in obtaining that critical first copy.

Producers of ideas, texts, and other creative works (including graphic images and music) are subject to economic constraints, even when they do not invariably respond to variation in the incentives offered by the market. If they had no rights enabling them to derive income from the publication of their works, they might create less, and quite possibly be compelled to spend their time doing something entirely different but more lucrative. So, there is an important economic rationale for establishing intellectual property rights.

To summarize, the "property" solution, which creates rights the fruits of intellectual creations, possesses a number of definite virtues. These may be quickly adumbrated for the case of patents:

- The patent provides an obvious and recognised solution to the economic problem of the intellectual creator. By increasing the expected private returns from innovation, it acts as an incentive mechanism to private investment in knowledge production.

- Patents facilitate the market test of new invention because they allow disclosure of the related information while (in principle) protecting against imitation.

- Patents create transferable rights (by granting a license, the owner of the knowledge allows it to be exploited by other agents) and, therefore, it can help to structure a complex transaction that also concerns unpatented knowledge.

- Patents are a means to signal and evaluate the future value of the technological effort of the companies that own them (which is particularly useful in the cases of new or young companies for which other classes of "intangibles" cannot be used for proper evaluation).

- This way of providing market incentives for certain kinds of creative effort leaves the valuation of the intellectual production to be determined *ex post*, by the willingness of users to pay; it thereby avoids having society try to place a value on the creative work *ex ante* – as would be required under alternative incentive schemes, such as offering prospective authors and inventors prizes, or awarding individual procurement contracts for specified works.

But, establishing a monopoly right to exploit that "first copy" (the idea protected by the patent or the expressive material protected by copyright), alas, turns out not to be a perfect one. The monopolist

will raise the price of every copy above the negligible costs of its reproduction, and, as a result, there will be some potential users of the information good who will be excluded from enjoying it. The latter represents a waste of resources, referred to by economists as the "deadweight burden of monopoly": some people's desires will remain unsatisfied even though they could have been fulfilled at virtually no additional cost.

This is but one of the things that are likely to go awry in the case of patent protection, as may be seen from the list of "vices" that is appended to the "virtues" of patent, for, as is quite well known, the first to invent and first to file basis for awarding patents creates incentives for duplicative "races" that result in socially excessive R&D expenditures. Similarly, patents may be sought and used strategically as tools to raise rivals costs by confronting them with the threat, if not the actuality of infringement suits. A corresponding catalogue of "virtues" and "vices" can be given in the instance of copyright (as in the Text Box that follows).

Not surprisingly, then, the subject of intellectual property policies has proved troublesome for the economics profession, as it presents numerous situations in which the effort to limit unfair competition and provide adequate "market incentives" for innovation demonstrably may result in a socially inefficient resource allocation. Human institutions, however, rarely are perfect. From both the viewpoints of legal theory and economic analysis there is therefore much to be said for regarding patent and copyright institutions as remarkably ingenious social contrivances, whereby protection of the discoverer's or inventor's exclusive right to exploit new knowledge commercially is exchanged for the disclosure of information that creates a public good; and, moreover, a public good that may be drawn upon to produce

Economic Virtues and Vices of Copyright Protection

Analytical justification*:* Copyright protection addresses the problem of high fixed (first copy) cost and low marginal cost. In conventional applications where text and images were embodied in physical media, registration secured disclosure of original expressive works.

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)

additional discoveries and inventions.[8] All of which, moreover, is managed by leaving the economic value of the right to be determined by the workings of the market, and thereby removing it from the realm of political discretion.

Yet, it ought not to be supposed that the actual provisions of the laws affecting intellectual property rights fully honor this social bargain. True, no patent is valid that does not describe the invention in "clear, precise, and exact terms," thereby disclosing sufficient information to enable second-comers to practice the invention without "undue experimentation." American patent law is unusual in going farther than this, in requiring the patent applicants to disclose the best mode in which they contemplate implementing their invention. But, in practice these provisions often prove insufficient to overcome the effects of the economic incentives that patentees usually have to withhold some pertinent information, either for their private use or as a basis to extract additional rents for the transfer of know-how that is complementary to that disclosed by the patent.

Delays in the release of information add to the academic research community's concerns over the way that the workings of the patent system restrict access to new scientific and technological findings. U.S. patent law follows the principle that priority in invention, rather than being first to file a patent application is what matters; it therefore allows applicants a one-year grace period after publication. But most foreign systems award patents on a "first to file" basis, which means that even American researchers are induced – by their own or their supporting organization's commercial goals – to delay publication of their findings and inventions until they have prepared patent applications to secure rights in other countries. During the two decades following the passage of the 1980 Bayh-Dole Act, which authorized universities in the U.S. to seek patents on innovations arising from federally funded research projects, there has been more-or-less continuous modification of institutional rules in the direction of lengthening the permissible duration of delays placed on the publication of research findings for purposes of allowing the filing of patent applications.[9]

From the standpoint of academic researchers the greatest deficiency of the statutory disclosure requirements imposed by patent laws is simply that little scientific or technical data may be divulged in meeting this stipulation, so that the patent itself is of only limited interest and serves mainly as a notice that the patentees may be willing to supply more useful information, for some fee. Moreover, researchers' ability to make use of such information as the patent does divulge is by no means assured until the end of its life; the patent not only excludes others from selling the invention, but also prohibits them from making and using it. That the use of an invention for purposes of research, and hence in generating further discoveries and innovations, ought not be proscribed has long been recognized by patent case law in the U.S: researchers have been allowed to defend themselves from infringement suits on grounds of "experimental use" – so long as the infringer is able to show that no commercial benefit was derived thereby.[10]

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[8] For the legal and economic interpretations, respectively, see, e.g., Eisenberg (1989), and Dasgupta and David (1987, 1994), David (1994).

[9] The effects of the Bayh-Dole legislation (U.S.C. §§200-211: 291-307) on university patenting activity are reviewed by Mowery and Nelson (1998); Cohen, Florida and Goe (1996) report findings from a survey of U.S. university-industry research centers on the distribution of permitted restraints on publication to allow for the filing of patent applications, and the significance of these delays and other restrictions is discussed by David (1995).

[10] Dam (1999: pp. 7-8) points out that because the case law has tended to reject the "experimental use" defense against infringement suits whenever the researcher might profit, this exception to patent protection is less likely to prove beneficial for academic researchers in fields like biomedical sciences, where even publicly-funded "basic" research may yield short-term economic payoffs. Given the case law precedents in the U.S., the drive on the part of university administrators to exploit patent rights under the provisions of the 1980 Bahy-Dole Act may thus be seen as contributing

The same situation does not arise with conventional copyright protection, since what is being protected is the published form in which ideas have been expressed; only that which is fully disclosed can qualify the author for legal protection against infringers. Inasmuch as it is difficult, if not impossible to establish that unauthorized copies were made of a text which had not been made public in some way, authors seeking legal protection for their work have every incentive to hasten its disclosure. Moreover, in recognition of the cultural and scientific benefits of exegetical and critical writings, and further research based upon published information and data – not to mention the interests of authors in having such usage made on the basis of accurate representations of their work – statutory exceptions traditionally are provided to permit "fair use" infringements of copyrighted material. Largely for these reasons, this form of intellectual property protection historically has not raised serious objections on the grounds of impeding rapid access to new scientific or technological data and information. But, the situation has changed.

Forces behind the Recent "Policy Push" for a Stronger Global IPR Regime

The economic prominence of intellectual property, and concerns to strengthen the legal protections afforded patents, copyrights and trademarks, have been rising in recent years. The value of intellectual property is increasing as a share of average total firm value; the number of patent applications is growing at double-digit rates in the major patent offices; and licensing and cross-licensing are being employed with greater frequency than ever, particularly so in high-technology industries.

The greater intensity of innovation, characteristic of the knowledge-based economy, and the increase in the propensity to patent (that is, the elevation of the ratio number of patents/number of innovations or number of patents per real R&D spending), which indicates the emergence of new research and innovation management techniques, are the main factors of this quantitative evolution.[11] 147,000 U.S. utility patents were granted in 1998, corresponding to an increase of 32% compared to 1997. Over the past 10 years both patent applications and patent grants have increased at a rate of about six per cent per annum, compared to about one per cent per annum in the preceding forty years.

There is a qualitative aspect to the growth of patenting as well. Patents are being registered on new types of objects such as software (17,000 patents last year, compared to 1,600 in 1992), genetic creations and devices for electronic trade over the Internet, and by new actors (universities, researchers in the public sector). This general trend is also reflected in the increase in exclusivity rights over instruments, research materials and databases. While all of this may be seen as contributing to a dramatic expansion of "the knowledge market,"[12] the proliferation of exclusive rights on whole areas of intellectual creation, equally, represents an unpredecentedly large incursion upon the public domain of scientific and technical data and information..

Many factors explain this trend. A first factor is simply that patent is becoming an intangible asset of increasing importance: for new and/or small companies because this is sometimes the only reliable way to signal their value to the market, and more broadly, for any firm involved in innovation-based competition. A second factor is the increasing value of strategic use of patents as bargaining chips: with

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indirectly as well as directly to creating more formidable barriers to the ability of academic researchers to rapidly access new research tools and results.

[11] See, Sam Kortum and Josh Lerner, "Stronger Protection or Technological Revolution: What Is Behind the Recent Surge in Patenting?," Carnegie-Rochester Conference Series on Public Policy, 48, 1998: pp. 247-304.

[12] See Arora et al., 1999.

the current (or expected) strengthening of national and regional legal systems of intellectual property, the expected benefits of amassing portfolios of legal rights to exclude began to outweigh their costs.[13]

The third factor deals with changes in patenting policy in the US and Europe. Patenting policy decided by the patent offices and courts deals obviously with the interpretation of the three basic patentability criteria. They always played a role of regulation, blocking or slowing down private appropriation in certain fields. Today, pro-patenting policies of patent offices mean that patentability criteria have gradually been eased and extended to new subject matter areas. Many research results become patentable, as a result of both legal (court) and patent office decisions. The increasing ability to patent fundamental knowledge, research tools and data bases is part and parcel of a broader movement towards strengthening IPRs.

Other important factors relate to changes at the institutional level:

- Powerful commitments to basic research by private firms in certain sectors (for instance, the case in the genomics area where we can observe the emergence of a new generation of firms which are highly specialised in fundamental research and are, therefore, in direct competition with the public research institutions).

- Changes in the behavior of universities and public institutes have contributed significantly to increased patenting in the U.S., particularly in the biotechnology and medical devices fields; more generally universities have become more and more oriented towards exploiting the intellectual property system as a means of capturing revenue [Henderson et al. 1998], and demonstrating a commitment to the promotion of economic development in their regions [Feller 1997].

- Privatization of some of the activities of governmental civilian agencies which become major players in the contractual research market [Jaffe and Lerner 1999].

These trends do not necessarily lead to an excess of privatization of knowledge. In many cases the establishment of intellectual property rights strengthens private incentives, allows the commitment of substantial private resources, and thereby improves the conditions of commercialization of inventions. Moreover, the establishment of private rights does not totally prevent the diffusion of knowledge, even if it does limit it. Finally, a large proportion of private knowledge is disseminated outside the market system, either within consortia or by means of networks of trading and sharing of knowledge, the foundation of the unintentional spillovers discussed by several authors [e.g., von Hippel 1988, and David 2001b].

Nevertheless, there is some concern when all these developments show a general shift from one view to another of the role of IPRs [Steinmueller 2001]: traditionally, IPRs are considered as one of the incentive structures society employs to elicit innovative effort. They co-exist with other incentive structures, each of which has costs and benefits as well as a degree of complementarity. The new view is that IPRs are the only means to commodify the intangible capital represented by knowledge and should therefore be a common currency or 'ruler' for measuring the output of activities devoted to knowledge generation and the basis for markets in knowledge exchange.

The restructuring of the legal regimes relating to patents and copyrights, and the adjustments of behavior to the new incentives created by those institutional innovations are likely to impact the

[13] See Bronwyn H. Hall and Rosemarie Ham Ziedonis, "The patent paradox revisited: an emprical study of patenting in the U.S. seminconductor industry, 1979-1995," RAND Journal of Economics, 32(1), Spring 2001: pp. 101-128, for the defensive use of patent portfolios in an industry that prior to the 1980's has been characterised by low propensity to patent.

organization and conduct of scientific research and publishing. Indeed, they seem bound to figure among the more prominent unexpected consequences of the very same digital infrastructure technologies that were created by publicly sponsored scientists and engineers. Unfortunately, at least some of these repercussions now appear to be detrimental to the long-term vitality of the practice of "open" science in the world's academic research communities. Such an untoward effect will not follow from the technology itself. It comes, instead, from the lack of appropriate concern for maintaining a healthy balance between the domain of publicly supported knowledge production and exchanges, and the sphere in which flourish private, proprietary R&D and profitable businesses based upon information goods.

One source of difficulty in preserving such balance is quite immediately apparent. An attractive short-run strategy of business development entails utilizing enhanced information processing and telecommunications in conjunction with the assertion of private property rights over the mass of publicly provided data and information products. Rather than having to produce wholly new content for distribution via the new and more effective technical facilities, an obvious first line of enterprise is to make use of what comes freely and most readily to hand. Ever since the introduction of printing with moveable type, the history of new publication and broadcast media has shown how automatic it is for entrepreneurs to seek first to draw upon content that was already available in the public domain.

Hence, one can expect that this approach will continue to be tried, exploiting larger and larger portions of the body of codified scientific knowledge and observational data that has been built up under public patronage and maintained as a common, readily accessible research resource. Sometimes the commercialization of public databases makes good economic sense: because private firms may have technical or marketing capabilities that would add value for a variety of end users of publicly generated data, whereas existing government agencies or NGOs lack that competence. Such was shown to be the case in regard to the distribution and packaging by commercial weather information services of data gathered by the U.S. National Oceanic and Atmospheric Administration (NOAA).[14]

But, the possibility of seriously adverse consequences elsewhere in the national research system, from ill-designed policies and programs to promote proprietary exploitation of public knowledge resources, also needs to be recognized. Consider what ensued in those circumstances from the Reagan Administration's sponsorship of the Land-Remote Sensing Commercialization Act (1984), under which the responsibility for the operations of the Landsat system of remote sensing satellites was transferred from NOAA management, and a monopoly on Landsat images was awarded in 1985 to the Earth Observation Satellite (EOSAT) Company, a joint venture of Hughes and RCA. The price of Landsat images immediately rose 10-fold, from $400 per image to $4000. This permitted EOSAT to attract profitable business from commercial customers and the federal government, although virtually none from academic and independent researchers. Indeed, the impact of the privatization of Landsat operations upon basic research being conducted by university groups around the world was quite devastating, as, they suddenly went from being "data rich" into a condition not of actual "data poverty" so much as one of data "non-entitlement."[15]

The EOSAT Co. secured its monopoly position in the market for satellite images by virtue of being given physical control over the source of (Landsat) images. Yet it is equally possible to imagine that a similarly damaging outcome for academic researchers would follow from the exercise of the market power that a commercial provider of a scientific database might gain under intellectual property

[14] See National Research Council (1997), pp. 116-124, for material underlying this and the following discussion.

[15] The introduction here of the term "non-entitlement" is a deliberate allusion to Amartya Sen's observation that people starved in the Indian famine of 1918 not because the harvest was inadequate to feed them, but because the rise in grain prices had deprived them of "entitlement" to the food that actually was available.

protection; especially under a legal regime that granted indefinitely renewable copyright protection to the database contents, whether or not the data was otherwise copyrightable.[16]

The recent extension of copyright to software has itself permitted a breach of the disclosure principle that parallels the one already noted in regard to patents. Under American copyright law (in order to qualify to pursue infringers for damages) it is sufficient to register only some sample extracts of a computer program's "text," rather than the entire body of code. Moreover, there is no requirement whatsoever to disclose the underlying "source code"; copyright protection can be obtained on the basis of a disclosure of just the machine language instructions, which, even were they to be divulged in their entirety would be difficult and costly to interpret and re-utilize without access to the source code. While this practice surely can be seen to violate the principle that no burden of "undue experimentation" should be placed upon second comers, the latter requirement is one that holds only in the case of patent law. It never was contemplated that one might be able to register a text for full copyright protection without practically disclosing its contents to interested readers.

A further, more generally disconcerting set of developments may prove quite destructive to the effectiveness of traditional safeguards against "fair use" exemptions for research (and educational) purposes – even where such provisions continue to be made. This threat has emerged only recently in the form of digital technologies that limit "on line" copying of electronic information. Advanced encryption systems now underpin many computing and communications security services, and permit a wide variety of security objectives to be achieved by establishing discretionary control over access to encrypted data, along with assurance for both users and service provider of message authentication and data integrity, as well as privacy and confidentiality goals. There are other techniques for marking and monitoring the use of distributed digital information, such as "water marking," which attaches a signal to digital data that can be detected or extracted later to make documentable assertions about its provenance, authenticity, or ownership; "fingerprinting" embeds a mark in each copy that uniquely identifies the authorized recipient.

"Self help" or "copyright management" systems that make use of encryption or prevent unauthorized copying of "cleartext" allow copyright holders to enforce their legal claim to capture economic value from users of the protected material, and, moreover enable selective access to elements of content that makes it more feasible for the vendor to engage in price discrimination. Marking and monitoring techniques, in contrast, do not allow direct enforcement of copyrights, but can be used to deter unauthorized copying and distribution of information by facilitating tracking of errant data to the original recipients who were responsible for its improper use.

These advances in digital technology have a direct economic effect that is efficiency enhancing, insofar as they reduce the costs of enforcing a statutory property right and thereby securing whatever societal benefits copyright legislation is designed to promote. Yet, in the currently prevailing enthusiasm for stronger intellectual property protection, the American drafters of the 1998 Digital Millennium Copyright Act included a provision that prohibits the circumvention of "any technological measure that effectively controls access" to a copyrighted work, and outlawed the manufacture, importation or public distribution of any technology primarily produced for the purpose of such circumvention.[17] The problem posed by this statutory reinforcement for applications of novel self-help technologies is simply that it may render impossible the exercise "fair use" of copyrighted material by researchers and educators, leaving the provision of information access for such purposes as a matter for the discretion of copyright holders.

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[16] It will be seen (from the discussion below) that such also may be the import of the European Commission's Directive on the Legal Protection of Databases, issued on March 11 1996.

[17] See Digital Millennium Copyright Act (1998), United States Code, 17, §1201; also, Dam (1998) for discussion of the policy issues raised by self-help systems.

This, however, is not the only serious assault upon the traditional means of permitting publicly supported open science communities to pursue their work untrammeled by the protections afforded to copyright owners. As attractive as the prospect of more powerful "self help" technologies may appear to be in curtailing "digital piracy," such remedies would create a threat to the achievement of a reasonably regime for the allocation of scientific and technological information goods while providing protection for private investments in information goods. One way in which it is feasible to approximate the efficient workings of a system of discriminatory pricing for data and information is to allow educators, scholars and researchers to invoke "fair use" exemptions from the requirements for licensing material that is copyrighted or otherwise legally protected by statute. In effect, this approach would set differentially lower prices for the use of information goods in producing and distributing knowledge – indeed, prices that approximate the negligibly small marginal costs of digital reproduction and transmission.

But, so far we have considered only the most straightforward and obvious of the potentially adverse consequences of turning over parts of the public knowledge domain to information monopolists. The staking out of property rights to scientific knowledge has potentially serious and subtler implications for the circulation of information and its use in research. These may be grouped, for the sake of convenience, under the general heading of "transaction costs increases." Firstly, it is possible that IPR-related transaction costs may increase so much that the result can be the blockage of knowledge exploitation and accumulation. Policy makers and academics alike have focused especially on the tragedy of the anticommons in biotechnology and microprocessors the potentially deleterious effect of strong IP protection for databases on academic science, and the extension of patentability to new subject such as patents, and more recently business methods.[18]

Secondly, efforts and costs devoted to sorting out conflicting and overlapping claims to IPR will increase as will uncertainty about the nature and extent of legal liability in using knowledge inputs. Again policy makers and academics are concerned with the increase of litigation costs, including indirect costs, which may distort the innovative behavior of small companies.[19] As put well by John Barton (2000), there is a problem when "the number of intellectual property lawyers is growing faster than the amount of research." And this is what happens in the U.S. while similar trends in Europe show that this is no longer a purely American problem.

ICTs, "Weightless" Goods and Services, and Databases in the New Economy

The 20th century witnessed a transition to "knowledge-driven" productivity gains and economic growth in the industrially advanced economies, at process that spread within a widening circle among the late-comers to industrialisation. All economic activity is, and always has been knowledge-based , in the sense that the state of the arts in production, the conventions of commerce, and the norms of consumption all entail possession of information and cognitive skills. In the knowledge-driven economy, by contrast, the continuous search for new, reliable knowledge and the generation and absorbing of new information are centrally responsible for structural change and material progress, and the focus of attention in the search for improved efficiency moved from perfecting the management of routine to sustaining the capacity for problem-identification and –solution.

Accordingly, and increasing share of society's domestic resources comes to be devoted to activities of the latter sort, in whose course which heterogeneous intangible knowledge- assets are formed and recombined to generate further knowledge-assets. Recent decades have seen a significant acceleration

[18] On these points, see Heller and Eisenberg [1998], Hall and Ziedonis [2001]; David [2000]; and Samuelson [1993, 1999], and Cockburn [2001], respectively.

[19] See, e.g., Lerner [1995].

in the pace of this historical transition. This developmental surge has been quite evidently associated with the dramatic advances in ICT, especially with the progress of digital computing and its convergence with telecommunications. The cluster of innovations – very large integrated circuits on silicon wafter, digital switches, electro-optical networks, and computer operating systems and applications – that has made possible the phenomenon of the Internet, can be conceptualized as a having provided a new and potent general purpose technology (GPT). This is a tool set that may be utilized in many way; combining with, transforming, and thereby enhancing the productivity and profitablity of other, pre-existing technologies and organizational modes, the digital GPT cluster is not displacing "the old economy" but instead manifesting its potential for "renewal."

A central feature common to the multiplicity of diverse processes of economic renewal that presently are underway is their intensified dependence upon the generation, capture, processing, transmission, storage and retrieval of information. The spectacularly declining costs of performing those activities promotes this intensification, and induces the search for still newer uses toward the accumulating bodies of information can be put in order to form the capabilities that we refer to as "knowledge" – which included the capacity to find – or impose - order (information) in the myriad streams of data that now can be captured and subjected to systematic analysis. The collection of data and the preservation of information extracted from them hardly are new human activities. But the great reduction in the technologically mandated costs, and the enhanced accuracy and scale upon which this can now be done challenges the capacities of individual human beings to attend to, and focus upon the signals that are likely to prove significant.

It is for this reason, as well as the greatly increased technical ease of data capture and manipulation, that distributed databases and the tools to work with them have grown increasingly prominent on the landscape of the digitally "renewed economy." The knowledge-driven society is coming to rely more heavily upon, and find new and more productive uses for the rather mundane entities that we call "databases." These objects are in a sense paradigmatic of the enhanced role, and social value that "information assets" of all sorts are coming to acquire in modern, digital economy.

Of course, scientific and scholarly inquiry has long created collections of objects, and observations, as a means of preserving materials that could form the basis of later study and forming the necessary support for the collective memory that allows the cumulative advancement of knowledge. In former times scientific databases were comparatively small (10 kilobytes), and feasible for individuals and small groups of researchers to compile, annotate and maintain by labor intensive methods; they often were published as typeset tables or simple, on-line documents. Recently, however, the size and complexity of scientific databases has growth enormously, and with that the potentialities of exploiting that data also have mounted. The necessary activities are absorbing increasing resources from publicly funded research programs in science and engineering, and there has been a commensurate expansion of in the pressure upon researchers to find ways of extracting revenues from these "assets," so as to defray the costs of creating and maintaining them. In some degree, that pressure reflects the perception that the commercial database business can be a lucrative one.

Thus, it is pertinent to notice that the development and "on line" databases have been proliferating in the world of business as well, and for many of the same reasons. Yet, the rapid growth of the commercial database industry in the U.S. during the 1990's, summarised by the statistics in the following Table, might be seen as presenting something of a puzzle to those who regard the necessity of stronger protection for intellectual property rights in the "new economy environment" to be a self-evident proposition. That is because the 1991 decision of the U.S. Supreme Court (in the case of *Feist Publications v. Rural Telephone Service Co.*) removed the remaining shreds of legitimacy draped around the argument that the producer of a database was entitled to the protections of copyright law on the basis

of the sheer "sweat of the brow" effort invested in the activity of compilation, regardless of whether such investment had involved a significantly original, creative achievement.[20]

Performance of US Database Industry post *Feist v. Rural Telephone* (1991)

Performance indicators	1991	1997	% change
Number of databases	7,637	10,338	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.

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 U.S. therefore have been found liable for copyright infringement since 1991. Industry proponents of *sui generis* legislative protection voiced alarm that comprehensive electronically stored databases, being works of especially "low authorship" and containing material that was in the public domain, would not meet the standard set by copyright law; that there was a compelling need in this case – as elsewhere – to modify existing IPR institutions to protect incentives for productive investments in this form of information asset from being undermined by "electronic piracy" in the new technological environment that the convergence of digital computing and advanced telecommunications had created.

Just how limited was the lost "sweat of the brow" protection for database producers could not be so readily perceived by observers who were not steeped in the intricacies of the U.S. courts' treatment of copyright infringement claims. Nor was it evident to inexpert participants in the debates over the significance of the *Feist* ruling that most of the databases of substantial commercial valuable (i.e., those really worth "pirating') 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. U.S. 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. These points were still less discernable to spectators in Europe, among them the members of the European Commission's High-Level Expert Group who, at just that point in time, were considering policies to promote the development of "the Information Society."[21]

[20] The practical importance of the "sweat of the brow" argument for the legal protection of database investors in the US has tended to be exaggerated. Legal opinion divided on the question, but, as Maurer and Scotchmer (1999, n.3) have noted, courts in New York and California -- the two main jurisdictions where intellectual property litigation traditionally occurred -- did not accept this argument for extending copyright to databases. 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 U.S. therefore have been found liable for copyright infringement since 1991. See Stephen M. Maurer and Suzanne Scotchmer, "Database protection: Is it broken and should we fix it?" *Science* 284 (14 May) 1999: pp. 1129-1130.

[21] The background of the EC Directive is discussed in P. A. David, "A Tragedy of the Public Knowledge 'Commons'?--Global Science, Intellectual Property and the Digital Technology Boomerang," Forthcoming in *Research Policy*, Special Issue on IPR Protections' Impact on Scientific Research, edited by P. A. David and B. H. Hall. (Available on:<http:siepr.stanford.edu/wpapers/index.html>).

Yet, had they looked more closely at the prevailing business practices, the High-Level Group would have discovered that a wide variety of other appropriation devices was available and was being successfully deployed by U.S. database businesses.[22] In the case of the so-called "full text" databases, which often consist entirely of copyrighted documents, the contents do not lose their protected status by virtue of having been incorporated into a database. Another appropriation device available under existing law is the use of copyrighted enhancements: databases frequently are sold in a package along with advanced software. Because software is copyrightable (and in some instances patentable), would-be database copiers must either try to market a version of the material that is likely to be less useful, or make their own investment in developing search tools to package with the copied contents.

Furthermore, technical database firms in the U.S. were availing themselves of a variety of "self help" protections against free-riding. Custom and semi-custom databases prepared for a small number of users provide virtually automatic protection against third parties, and, more generally, contracts between the owners of such databases and their customers which limit the latter's right to use and/or disclose the contents to third parties are enforceable as trade secrets, even where the underlying information and data cannot qualify for statutory protection.

Where information was distributed to larger numbers of customers, the industry availed itself of the use of "shrinkwrap" and "clickwrap" licences, search-only and password protected websites, and the frequent updating of contents, editing and enhancements of search facilities – all of which are especially valuable to researchers in rapidly changing branches of science. Besides these means, Stephen Maurer's (1999) survey of industry practice found that "a significant number of products are sold without any protection at all, sometimes for comparatively high prices." The explanation offered is that large vendors can afford to circulate catalogues that enable them to reach a small number of customers who are prepared to pay high prices for comparatively obscure titles, whereas the smaller would-be copiers cannot afford the expense of trying to bring their wares to the attention of those same purchasers.

Thus, there was little if any substance to the rationale that was produced by the EC's High-Level Expert Group in their 1992 draft Directive, which called upon the Member States of the EU to implement statutory protections for intellectual property in the form of databases: their argument was that such protection was needed to "level the playing field" so that European database creators could compete on less disadvantageous terms with their American counterparts.

The EU's *Sui Generis* Property Right in Databases and Its Implications

A new and quite unexpected direct threat to the academic research enterprise in science and engineering thus emerged in mid-1990's, as a result of the extension of *sui generis* copyright protection to databases, even to databases containing non-copyrightable material. This institutional innovation crystallized in the European Union Directive on the Legal Protection of Databases (issued March 11, 1996). It enjoined member states to create a new broadly comprehensive type of intellectual property that was free from a number of the important and long-standing limitations and exceptions traditionally provided by copyright law, in order to safeguard access to information used in socially beneficial, knowledge-creating activities such as research and teaching. The EU Database Directive applies equally

[22] See Stephen M. Maurer, "Raw Knowledge: Protecting Technical Databases for Science and Industry." Report Prepared for the NRC Workshop on Promoting Access to Scientific and Technical Data for the Public Interest, (1999): pp. 19-21.

to non-electronic and electronic databases, even though, as will be seen, it originated as a strategic "industrial policy" response to the commercial development of on-line (electronic) databases in America.

Further, as a device to secure international acceptance of the new approach initiated by this directive (which remains binding upon the member states of the European Union, in the sense of requiring implementation in each of their national statutes) reciprocity provisions were included. The latter in effect threatened the commercial creators of databases who were nationals of foreign states outside the EU with retaliatory infringement of copyright material in their products, unless their respective governments became signatories to a World Intellectual Property Organization (WIPO) draft convention on databases which had been framed to embody the essential provisions of the *sui generis* copyright protection established under the1996 EU Directive.[23]

The European Commission's strategy succeeded in setting in motion an Administration-initiated legislative response in the U.S. Congress, which has now led to two competing draft statutes being actively debated. The response began in May 1996 with the introduction at the behest of the U.S. Patent and Trademark Office of House of Representatives of a bill, H.R. 3531, short-titled the "Database Investment and Intellectual Property Antipiracy Act of 1996." This first and ill-considered rush to legislate soon encountered opposition from the U.S. academic research community and non-commercial publishers of scientific information. But although that attempt proved unavailing, the legislative genie has been let out of the bottle, with the result that the 104th Congress presently has before it two further pieces of proposed legislation. The first of these is "The Collections of Information Antipiracy Act," H.R. 345, which was introduced in January 1999 and represents a re-incarnation of the quite pernicious approach taken in the original Administration-inspired legislative proposal in 1996. A second bill, "The Consumer and Investors Access to Information Act," H.R. 1858, was introduced in May 1999, and contains provisions protecting access to database information that are rather more responsive to the objections raised during 1997 against H.R. 3531. This too failed to gain support in the Senate, but its proponents have promised to try once again in the new session of Congress.

A rapid review of the main features of the EC's Database Directive of 1996 highlights the following problematic points:[24]

- The Directive's *sui generis* approach departs from the long established principles of intellectual property law by removing the distinction between protection of expression and protection of ideas, a distinction that is central in US copyright law and was embodied in the TRIPS agreement adopted by the WTO.

- Compilers of databases in the EU will now be able to assert ownership and demand payment for licensing the use of content, which already is in the public domain, including material that otherwise could not be copyright-protected. In complying with the Directive, member states will not be providing any specific incentives for the generation of new database content (such as scientific data and information, for example), as distinguished from new compilations. Nor can it be thought that copyrights in databases are being granted as part of a social bargain, in exchange for the public disclosure of material that hitherto was not revealed.

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[23] The 1996 draft was entitled: "Basic Proposal for the Substantive Provisions of the Treaty on Intellectual Property in Respect of Databases...", WIPO Doc. CRNR/DC, Geneva, August 30. It has been pointed out that in this regard, as well as in others, the EU Directive called for a departure from the principle of administering commercial laws on a "national treatment" basis, under which a country's domestic laws (whether for intellectual property production, or unfair business practices) should treat foreign nationals like one of the country's citizens. The principle of national treatment is embodied in Article 3 of the TRIPs Agreement, as well as more generally in the Paris Convention (on patents and trademark protection) and the Berne Convention (on copyright protection). Objections to this departure were recorded in the testimony of the General Counsel of the U.S. Department of Commerce (Andrew J. Pincus), in the 106th Congress House Hearings on H.R. 1858 (1999): section F.

[24] The following draws upon the documented legal analysis in National Research Council (1997), pp. 148-153.

- A second distinction fundamental in copyright law, that between original expressive matter and pre-existing expressive matter, has been discarded by language of the Directive, because the latter fails to attach any legal significance to the difference between expressive matter that already exists in the public domain, and matter that is original and newly disclosed. Domestic laws and national courts that reaffirm this omission in effect will allow a database maker to qualify for renewal of the 15-year term of exclusive rights over the database as a whole – by virtue of having made a "significant investment" in updates, additions, revisions.[25]

- Strict limitations upon re-use of database contents are imposed by the Directive, requiring third party regeneration or payment for licenses to extract such material. This would inhibit integration and recombination of existing scientific database contents with new material to provide more useful, specialized research resources.

- But regardless of whether or not it is possible in theory to regenerate the raw contents of a database from publicly available sources, under the terms of the Directive, investors in database production can always deny third parties the right to use pre-existing data in value-added applications, even when the third parties are willing to pay royalties on licenses for such use. It would therefore be possible for an initial database producer simply to block subsequent creation of new, special-purpose databases which reproduced parts of existing compilations, wherever the regeneration of such data *de novo* was infeasible or terribly costly (as in the case of years of remote-sensing satellite observations, or data-tracks from high energy particle collision detectors, or multi-year bibliographic compilations of scientific publications and citations thereto).

- Where a database maker also held the exclusive rights to license previously copyright-protected publications, it would be entirely proper under the terms of the Directive to refuse third parties licenses in that material, while incorporating it within a database protected under the terms of the EC Directive. There are no compulsory licensing provisions under the Berne Convention on copyrights, and these are likewise excluded under the TRIPS Agreement. By following suit and excluding conditions for compulsory licensing, as well as omitting to provide remedies for abuse of the legal protections newly accorded to database investors, the Directive opens the door for the construction of indefinitely renewable monopolies in both non-re-generatable and non-re-generatable scientific data.

- The Directive abandons the principle of "fair use" for research, as distinct from extraction and use of data for purposes of "illustration in teaching or research." How "illustrative use" is to be interpreted remains ill defined, pending some infringement litigation that would provide opportunity for a court ruling in the matter. But the current consensus among IPR scholars is that "illustration" falls far short of the normal scope of research use of copyrighted material.

The absence of fair use exclusions for research (and research training) creates the prospect of a two-way squeeze on public sector funded research programs, as the costs of obtaining commercially supplied data are likely to rise. The 10-fold rise in the unit prices of remote-sensing satellite images that immediately followed the privatization of LANSAT satellite operations in 1985, and its withering effects upon university-based research projects, might well be recalled in this connection. Continuing pressures

[25] See EC Directive on Databases, note 52, articles 7(1), providing an initial 15-year term from the date of completion; 7(2) extending protection for an additional 15 years if the database "is made available to the public in whatever manner" before the initial term expires; 7(3) allowing 15-year renewals for "[a]ny substantial change, evaluated qualitatively or quantitatively, to the contents of a database…from the accumulation of successive additions, deletions or alterations, which …result in …a substantial new investment." Under U.S copyright only the additions and revisions themselves – which would be considered as "derivative work" from the prior original expressive matter – would be entitled to fresh legal protection.

for cuts in government budgets, and the priority that tends to be accorded to near-term applications-oriented research vis-à-vis exploratory science, is likely to encourage derogation to commercial database generators of the function of compiling, updating and publishing databases that remain of continuing relevance for basic public sector research. There is a two-fold risk in this situation. One is the threat to data quality in the separating of the database creation and maintenance from the scientific expertise of the research community that creates and uses the data; the other is the resulting squeeze on public research resources, as already restrictive appropriations would have to be spent on purchasing data and database licenses.

When considering the benefits to society of enabling the appropriation of the value of this facility (and ones like it in other research fields -- say, in developing new genetic diagnostic kits, or new drug therapies -- the question to be asked is what effect doing so will have on the probability of valuable discoveries both in the near term and over the longer run. Seeking to apply the rights granted by the EC's Database Directive and restructure the "information space" so as to readily extract licensing fees from users, would have the predictable effect of curtailing searches that were not thought to have a high expectation of quickly finding something with high "applications value." In other words, the probabilities of unexpected discoveries would be further reduced by the economically restricted utilization of the facility. Targeted searches may be quite affordable, but wholesale extraction of the data-spaces' contents to permit exploratory search activities is especially likely to be curtailed.

The adverse influences of the consequent "lost discoveries" also are likely to ripple outwards. This is so because the development of new and more powerful search devices, and techniques of pattern recognition, statistical analysis, and so forth, are more likely to figure among the discoveries that would be made collectively through the exploratory use of facility by a larger number of searchers. Therefore, some cost of extracting economic rents from this construct today will most likely come in the form of smaller benefits (and the sacrifice of reduced applications-oriented research costs) in the future. In addition, one should consider the possibly serious inhibiting effect of setting up a "model" of IPR exploitation of such structures upon the construction of some new, presently unimagined information tools that would require the assembly (and licensing) of myriad information components from many, diverse sources.

A concrete illustration of the creative power of collaborations built to exploit enhanced digital technologies is provided by the vast, multi-dimensional "information space" that has been built up over the course of many years by the research community whose activities are coordinated today by the European Bioinformatics Institute (EBI). This "virtual library" is a dynamic collective research tool rather than a simple repository of information. The ordinary conceptualization of "a database" is too static, and, in a sense too pre-structured, to comprehend the potential for discoveries that has been created by this collective construct. Yet, as the EBI's Director has testified, this information space began to be formed long before the research communities involved gave any consideration to intellectual property right restrictions on the use of the information contents that were being linked for subsequent retrieval and analysis. The implication was clear that it would be far more difficult in today's environment to create this particular research tool.[26]

Reconsidering the Traditional Economic Rationale for Copyright Protection

The advent of technologies that have greatly reduced both the fixed and the variable the costs of reproduction and transmission of information elicited strong defensive reactions from business publishing

[26] See Statement by Graham Cameron, in *IPR Aspects of Internet Collaborations*, European Commission -- DG Research, Strata Programme Working Group Report, EUR 19456, Brussels (April) 2001.

interests that previously enjoyed a measure of protection from their possession of superior, decreasing cost production facilities. It was said that unrestricted use of plain paper photocopiers in the hands of readers threatened the profitability of conventional publishers. But, more careful economic analysis has shown that such is not necessarily the case; indeed, just the opposite might be true.

Under the traditional analysis of the social efficiency of copyright, it was held that stringent protection against unauthorized copying could social as well as private losses from underutilization of the intellectual asset, where the cost to consumers of obtaining an unauthorized copy was greater than they would be charged by a copyright holder who had a strict, enforceable monopoly. This is tantamount to the conclusion that strengthening copyright protection could enhance social welfare even without stimulating the production of new works of authorship, so long as lax restraints on copying resulted in the demand for authorized copies ("originals") being reduced greatly in relation to total consumption of the work in question.[27]

But, those arguments rested crucially on the supposition that the private cost to the consumer of obtaining a close substitute by copying an authorized "original" was greater than the copyright monopolists' marginal costs. As Liebowitz (1985) pointed out, however, the latter assumption was in many situations been invalidated by advances in copying technologies. The complementarity in production between authorized "originals" and low-cost copies could mean (under conditions in which the demand demand for copies of such works was sufficiently price elastic) that a more permissive law regarding copying -- by allowing utilization of highly efficient copying technology -- actually could increase the effective demand for "originals" as well.

Furthermore, it turns out that the best way for business to exploit the potential monopoly power conveyed by legal protections for “intellectual property” is not always that of trying to extract the maximum consumer surplus from each individual user. Even traditional “content owners” of information goods such as books, video-recordings, CD’s, software programs, and the like may be able to reap greater profits by allowing “sharing” (the *free* copying for use) of information goods among certain groups of consumers. The candidate groups would be those whose members were closely integrated socially, and whose collective willingness to pay exceeded the sum of their individual revealed demands for the commodity in question.[28]

This represents an important qualification of the widely asserted claim that digitally assisted, low marginal cost reproduction encourages “piracy” (unlicensed copying and redistribution) which must be injurious to copyright holders, and therefore warrants introduction of stronger protections against all unauthorized copying. In the context of the present discussion, therefore, it is especially appropriate to point out that spatially distributed scientific and engineering research *networks* are in a sense paradigmatic of the self-selected producer groupings whose information goods requirements might be more profitably met by publisher/vendors who permitted, or actually facilitated free (intra-group) sharing.[29]

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[27] See I.E. Novos, and M. Waldman, "The Effects of Increased Copyright Protection: An Analytical Approach," *Journal of Political Economy*, vol. 92, 1984: pp.236-246; W.R. Johnson, "The Economics of Copying," *Journal of Political Economy*, vol. 93, 1985: pp.158-174, for these two argument, respectively.

[28] See further discussion in P. A. David, “A Tragedy of the Public Knowledge ‘Commons’? (2000: pp. 19ff), referring to Yannis Bakos, Erik Brynjolfsson and Douglas Lichtman, “Shared information goods,” University of Chicago Law and Economics Working Paper No. 67 (2nd Series), February, 1999, and forerunners in this vein.

[29] Moreover, in “the knowledge society” – where collaborative generation of new ideas and practices is expected to characterized a larger and large segment of business activity, the scientific research network, conceived of as a form of “competence based club,” may become a paradigm for an economically much larger part of the market for information-goods that are research inputs.

The key condition for arguments of this sort is that allowing customers to "bundle themselves" into such consumer units permits increased aggregate sales, so long as the groups are "natural clubs" – like families, and scientific research teams – that organized themselves for some other purpose than spreading the fixed costs of acquiring access to the copyable information product. But, in actuality, the restrictions on group membership could be dispensed with in technological circumstances that restricted the ease of producing copies; where the latter were embedded in physical medium, such as a printed book, publishers could benefit from the formation of club-like organizations that aggregated individual consumer demands effective "bundles." The English book trade thus came eventually to take tolerant, and even appreciative view of the local commercial circulating libraries that arose during the 18th century to cater to the growth of demand for popular literature.[30]

It is said that economists are the sorts of scientists who like to show that things that are observed to work in practice also can work in theory. So it is reassuring that the experience of commercial circulating libraries conforms with the result of microeconomic models that demonstrated that lax restraints on copying (or free sharing) could be compatible with profitable publishing. But, more recent, and more intricate theoretical arguments have raised rather more profound challenges to the traditional rationale for copyright protection in the digital information age. In an pioneering and mathematically elegant dynamic general equilibrium analysis, Boldrin and Levine (2002) show that even in the absense of any restrictions on the re-copying of a new information good – restrictions that legal owners of copyright are permitted to impose on their customers and licensees -- competitive markets can support a socially efficient equilibrium in the production of information assets, and in the intertemporal flows of consumption utilities these yield.[31]

The underlying idea here is that although unrestricted copying eventually will drive the price of the marginal copy to zero, this doesn't happen so rapidly; even if new technology has made copying rapid and essentially costless at the margin, Boldrin and Levin point out that consumption use may degrade the reproduction rate, and the supply of copies cannot instantly undergo infinite expansion. Hence, the possessor of a "first copy," i.e., the original instance of the intellectual or cultural work, has an asset that can command a positive price under competitive conditions. Its price reflects the present value of the future flow of marginal utilities that subsequent copies will yield to impatient consumers. Thus, the notion that the infinite expansibility of information, by permitting "free-riding" on the part of consumers, would leave the producer of the first copy with nothing for her efforts, is unjustifed because the process takes time, and there is a value to reading the best seller, or the latest DNA sequence sooner, rather than later.

Still more recently, this line of analysis has been taken a very significant step farther by Danny Quah (2002) : it turns out that the ability of competitive equilibrium prices to support the socially efficient dynamic allocation – maximizing the present value of the future stream of consumers utilities – survives the complete removal of all the restrictions that copyright law (and analogous sui generis legal protections for works of "low authorship') allows possessors of "the first copy" to impose upon licensed users.[32] Whereas in the analysis of Boldrin and Levine the terms of the weaken license permits purchasers to make copies only for future consumption purposes, Quah's analysis shows that the first copy can command a positive value even when those copies can be sold in competition with the copies being

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[30] See Richard Roehl and Hal R. Varian, "Circulating Libraries and Video Rental Stores," *First Monday*, 6(5), 2000. Available from: www.firstmonday.dk/issues/issue6_5/roehl/index.html#r8.

[31] Michele Boldrin and David K. Levine, "The case against intellectual property," *American Economic Review*, 92 (May), 2002; Michele Boldrin and David K. Levine, "Perfectly competitive innovation," Staff Report 303, Federal Reserve Bank of Minneapolis, March 2002.

[32] Danny Quah, "24/7 Competitive Innovation," LSE Working Paper, April 2002. Available from: <http://econ.lse.ac.uk/staff/quah>.

supplied by the holder of the original instantiation of the information good – so long as the rate at which copies can be generated remains bounded from above.[33]

Commercial database firms in the US appear to have understood at least one facet of the economic reality that is reflected in these theoretical propositions. Copyright, or other legal protections of the content of their data bases was not necessary for them to run profitable businesses, in part because they could charge a premium to customers who wanted access to early updates of the contents, and not have to restrict them putting the information they extracted into other, equally unprotected databases.[34] To be sure, these results do not go so far as to say that the competitive market valuation of the "first copy" always would be sufficiently large to cause every possible information asset to be created. The cost of the creative effort may be too large, but, then we do not ask competitive markets for conventional commodities to provide them even when the cost of doing so exceeds what the utility maximizing consumers would be willing to pay.

Viewed from vantage point of these deepening doubts about the old rationale for legal monopolies in readily copyable and ubiquitously share-able information goods, the current rush to tighten the copyright regime and encourage strict enforcement of "anti-piracy" provisions of all kinds, may at some date in the not-so-distant future come to be perceived as having been a serious mistake. This is so not only because it will turn out to have been unnecessary for the socially efficient production and distribution of an increasingly important class of commodities in the New Economy, or because it will have consequences that were were injurious to the conduct of open science. Those will be bad enough, but policy makers are likely to suffer more obloquy if it begins to be evident that their enthusiasm for entrenching the all the old IPR institutions was antithetical to the development and exploitation of new and more profitable business opportunities. This prospect is not merely a fantasy.

Among at least some leading innovators concerned with the future trajectory of e-commerce, there is growing recognition that the conventional regime of proprietary controls over the use of information by industry may hinder to exploitation of new profit opportunities being created by digital, networked technology. Within the domain of Internet based media industries, a new landscape of what are referred to as 'peer to peer' (P2P) services has emerged, featuring shared storage, shared information and shared processing. The new P2P applications devolve significant autonomy and control to independent nodes in the network; they capitalize on under-utilized network-connected computing resources at the edge of the network; they operate as transparent end-to-end services across an Internet of uneven and temporary connections. One vision of the future sees the greater effectiveness of this comparatively unstructured and self-organized mode of producing and delivering new information to individual users as the basis for new and competitive commercial services; that these will challenge the incumbency of traditional business forms in information-intensive production and distribution activities.

Not surprisingly, therefore, spokespersons for P2P business applications have been worried by the threat that proprietary standards strategies on the part of platform vendors would create barriers to collaborative computing, in just the same way that scientists engaged in distributed Internet projects worry about IPR-created barriers to the flow of information, and the diminishing future prospects for easy

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[33] The quickening rate of copying that Quah's (2002) analysis contemplates is alluded to by the reference to "24/7-time" – the continuous, 'round the clock every day of the week' pace at which the Internet permits economic activity to run. In the limit, where copying becomes infinitely rapid, Quah finds that the intuition of the traditional economic argument that competitive markets will fail is regained. The first copy (asset price) and the price of the marginal consumption flow both go to zero.

[34] As has been pointed out US database firms also provide a variety of complementary services, including efficient and rapid search algorithms, which also contribute to the profitability of their operations in the absence of intellectual properly protection for the database contents.

voyages of exploration in "information space." Here is Esther Dyson's formulation of the threat to P2P, and a possible means of avoiding it:[35]

> "The growth of P2P services will be retarded if this world fragments into warring proprietary platforms, forcing users to make unpalatable choices and killing synergistic network effects. Some existing proposed standards fit naturally into P2P models, including simple object access protocol (SOAP) and universal discovery description and integration (UDDI)…. At some point it will make sense to have at least *de facto* standards for common P2P elements. Standards bodies [which under ANSI rules preclude adoption of proprietary specifications that are not freely licensed] provide a place for industry participants to gather, compare notes, identify shared challenges and find common ground."

At the 2001 Economic World Forum meeting in Davos, Switerzland, Richard Li, executive Chairman of Pacific Century CyberWorks, is reported to have voiced essentially the same worries:[36] "his biggest concern about the development of broadband technology was the conservatism of many content providers who were determined to retain copyright protection and unwilling to consider creative new business models.'That element is probably the missing slice -- for the time being'." Significantly enough, the emerging P2P approach to network-based computing and computer-mediated telecommunications services, and the demonstrated capacity of that non-hierarchical form of machine organization to mobilize distributed intelligence for the rapid solution of new problems, has strong elements of homomorphism with the historical functioning of "invisible colleges" in the open science domain.[37]

What has changed, of course, is the qualitative effects of the technological capacity to link "distributed intelligent resources" in a host of differentiated sub-communities at negligible cost; and to thus provide spectacularly rapid capabilities of searching the "information spaces" thereby created. What hitherto was the peculiar organizational facility for discovery and invention that the commercially unpressured pace of open scholarly inquiry afforded practitioners of "open science" may become a much more widely relevant mode of generating innovative information-goods that customers are willing to pay for.

The transformation that appears to be bringing the world of P2P network-based commerce and the world of "invisible colleges" of academic inquiry into closer alignment with regard to their working modalities is certainly an intriguing development, and one that is potentially promising for the future synergetic interactions between those two spheres of human endeavor. It stands in much greater need of concerted public policy support than the present impetus being given to the negotiation of university-industry collaborative research agreements whose IPR provisions accede to the monopoly-protecting strategies familiar to conventional R&D-intensive businesses in the chemical, pharmaceutical and electro-mechanical engineering industries.

My point in drawing attention to the parallels between the organization of open-science communities, and the information-intensive strategies emerging in the domain of cyber-commerce is simply this: policy-makers in the industrially advanced country, and those in other regions who are echoing their views may be making a serious error in pressing university- and public institute- based research groups to involve themselves in conventionally securing and "managing" proprietary rights to

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[35] Quoted from *Release 1.0, Esther Dyson's Monthly Report*, vol. 10, no.2 (22 November 2000), p. 8. Available from http://release1.edventure.com.

[36] "Industry Leaders See a New Era in the Tech Revolution," *International Herald Tribune*, 30 January 2001, pp. 1,16.

[37] See P.A. David, "Communication norms and the collective cognitive performance of "Invisible Colleges'," in *Creation and Transfer of Knowledge: Institutions and Incentives*, Eds. G. B. Navaretti et al., New York and Berlin: Physical Verlag, 1997; P.A. David, D. Foray and W. E. Steinmueller, "The research network and the 'new economics of science'," *in The Organization of Innovative Activities in Europe*, eds., A. Garmbardella and F. Malerba, Cambridge: Cambridge University Press, 1999.

the use of new knowledge. However fashionable this current policy trend may be at present, those subscribing to it may be found to have been trying to ride the wave of the past -- at the expense of building the wave of the future. In actuality, if such efforts to create "wealth from knowledge through IPR" succeeded, the result might be to have rendered more difficult their economies' eventual development of novel kinds of computer-network intensive service organizations, and the other new lines of e-business to which those would lead.

Rather than seeing "open science" communities as asserting claims that stand in the way of the exploration and exploitation of profitable business opportunities built on exclusive ownership and control of digital content, their characteristic mode of disclosure and data-sharing might well be regarded as a precursor and paradigm of future "New Economy" activities that will fully exploit the potentialities opened by the Internet. To put this thought in proper historical perspective, the ethos and mode of organization that has been associated historically with publicly supported scientific work groups (at least since the 17th century), now could be coming into its own as the basis for new forms of *commercial* activity feasible in the Digital Age. This certainly is what some observers of the open source software movement now suggest.[38] What policy-making for economic development in the 21st century ought to consider carefully, therefore, is how to avoid promoting an entrenchment of durable IPR protections regime that could fatally obstruct that evolution.

Modest Proposals: IPR Policies to Preserve the Public Knowledge Commons

What sort of intellectual property arrangements will be best suited to the social efficient exploitation of the production and consumption possibility emerging in the "weightless economy," and to the construction of the "digital information spaces" in which globally collaborative programs of discovery and invention are likely to flourish?

The policy position on copyright and copyright-like protections of intellectual property that I have advanced on previous occasions, and continue to advocate here is of the meliorist, rather than the radical variety.[39] This is not because I am not attracted by the elegance of the idea of creating a positive right to "fair use" of legally protected information, and research tools, for educational and research purposes. One might be tempted to think along such lines by the recent indications that WIPO is aware of the existence of a connection between intellectual property and human rights. The joint panel discussion organized by WIPO and the Office of United National High Commission for Human Rights, to commemorate the 50th anniversary of the Universal Declaration of Human Rights, addressed issues such as biodiversity, the production of traditional (ethnic) knowledge and innovation, the right to culture, health, non-discrimination, and scientific freedom. Another possible straw in the wind is to be seen in article 10 of the European Convention on Human Rights, which prescribes the right to freedom of speech as protecting not only the positive right to expression, but the right to receive information. Yet the

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[38] See, e.g., "The Organization and Viability of Open Source Software: A Proposal to the National Science Foundation," P. A. David (Principal Investigator), Stanford Institute for Economic Policy Research, January 22, 2001.

[39] See, e.g., P. A. David, "A Tragedy of the Public Knowledge 'Commons'? Global Science, Intellectual Property and the Digital Technology Boomerang," Department of Economics Working Paper 00-16, Stanford University, October 2000, available at http://www-econ.stanford.edu/faculty/wpapers/index.html.; P. A. David, "The Consequences for Internet-Mediated Research Collaborations of Broadening IPR Protections," *IPR Aspects of Internet Collaborations,* EC (DG-Research) Workshop Report, April 2001. Available at: http://europa.eu.int/comm/research/area/ipr_en.html.

involvement of human rights counts in intellectual property law is likely to be a distant and incremental evolution, if it happens at all. It therefore seems expedient to attend to less far-reaching means of improving the present state of affairs.

Developed and developing economies alike have a shared interest in halting, and, if possible reversing the trend toward the further strengthening and extension of property rights regime to every conceiveable form of "information." My convictions in this regard have crystallised as a response to the prospective implications of European Union's database legislation, the proposals for similar *sui generis* protections that were surfaced in the US Congress, and the likelihood that the European Commission soon will follow the US in introducing new criminal law sanctions to reinforce the effectiveness of digital "self help" technologies such as watermarking and encryption. These institutional changes appear to me as last-ditch efforts to entrench an approach to intellectual property rights that is being rendered increasingly obsolete by the technological developments that are driving "the New Economy." Yet, worse than exemplifying ingenious adaptations to preserve the workability of an old legal regime, the continuation of this trend may seriously curtail the benefits developed and developing societies alike are able to derive from vastly expanded access to scientific, technological and cultural knowledge.

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 the scope of 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" that enable copyright owners to more perfectly control the dissemination of digital content (whether that is 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 acomplis* -- 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 previously, the U.S. 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,[40] it remains quite conceivable

[40] 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 (U.S. Code, 17, §1201) would make it illegal even to devise and distribute

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 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.[41] 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). 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, it may be argued that 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 foregoing 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 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, others European states, such as the Netherlands as well as Greece, Ireland, Italy, Portugal, 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 most unlikely 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 Roman 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 U.S. 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

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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 them that what the would-be protectors of technological innovation most frequency fail to grasp is that information is an input in the process of generating new knowledge.

[41] See Reichman (1998) on the interpretation of the enforcement articles included in Part III of the TRIPS Agreement, and the survey of implementation issues in Keely (2000).

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.

The important broad principle to be established is a simple one: whatever are the legal rights that societies construct regarding "intellectual property," whether under international patent and copyright regimes or by *sui generis* protections (inadvisable as these may be, on other grounds), the licensing terms available to "owners" should never be allowed to create inefficient artificial impediments to the intensive utilization of the contents of virtual archives and information tools. As I have suggested, this principle may be just as important for the future of new commercial ventures based upon computer-mediated telecommunications as it is for the health of fundamental, exploratory inquiries organized under the auspices of non-profit institutions. As has been noticed It also should be more widely recognized that such a principle is not necessarily deterimental to profitable enterprise in information-goods markets

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. As 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 thrust of the policy advocated here is thus quite 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. The implication is that the fixed costs should be covered by lump sum subscription charges, which would be waived in the case of researchers engaged in constructing and maintaining these databases under the auspices of publicly supported projects.

A fully consistent, albeit still bolder, recommendation would have the same provisions apply more broadly. They could be extended to all the users of such data and information resources who agreed to distribute the data they generated on the same basis as that on which they had been able to access the data used in creating it. That universal application of the so-called "Copyleft" principle in the GNU General Public License leaves open the possibility to commercial ventures of licensing and direct marketing of ancillary and complementary goods and services. By such means the firms might coup the

fixed costs of the contribution to the "information infrastructures" that they would participate with publicly sponsored researchers in helping to create.

Further, and still more far-reaching reforms affecting patents on research tools follow from this approach. The first would institute a public policy of "patent buy-outs," under which public tax revenues would be used to purchase the rights to this class of inventions, and place them in the public domain. A possible device to prevent confiscation of valuable patents at arbitary low compensation, or the award of an inappropriately high "prize" to the patentee, would take the form of the following provision: such inventions would be made legally subject to compulsory licensing at a "reasonable" royalty rate, and the (regulated) rights to the revenue stream would then be publicly auctioned, with the government standing ready to acquire the rights for the public domain by default if a pre-announced "reservation" price was attained by a private purchaser.

It is true that there are some well known circumstances where significant patent protection might be warranted by the high fixed costs that public regulatory policies impose upon the private developers of innovative commodities that are readily "reverse engineered" and cheaply copied -- e.g., by the extensive field testing requirements for pharmaceutical products and medical devices. But, these represent the exception rather than the rule, and the end products themselves typically do not have the essential 'public goods' properties associated with information-good and information-tools. Rather, it is the product safety-testing information regarding new pharmaceuticals, and other complex and potentially dangerous products that actually constitute the "public goods." Yet, even here it should be pointed out that a convincing economic case has still to be made for using legally constructed monopolies to solve the resulting appropriability problem, rather than, say, public procurement contracts for safety-testing,.[42]

Conclusion

The American poet Robert Frost's ode to individualism celebrates the stone fences that distinguish the rural landscape of upland New England: "good fences make good neighbors." Perhaps it is so, where the resource involved is land, onto which the livestock from neighboring farms otherwise may wander to graze and thereby destroy the provender of the animals already pastured there. But is it so, too, when one scientist pores over the data gathered by another? Simple consideration of the "public goods" nature of information tells us that such is not the case.

Information is not like forage, depleted by use for consumption. Data-sets are not subject to being "over-grazed" but, instead, are likely to be enriched and rendered more accurate, and more fully documented the more that researchers are allowed to comb through them. It is by means of wide and complete disclosure, and the skeptical efforts to replicate novel research findings, that scientific communities collectively build bodies of "reliable knowledge." Thus, there is good reason for hesitating to embrace "private property rights" as a universal panacea, for that is a system of resource allocation that has been found to work well in the domain of conventional commodities that are exhausted in the process of use and cannot be simultaneously enjoyed by many.

By contrast, in the realm of knowledge, information and scientific data, an overly literal application of the metaphor of "property," one that emphasizes the desirability of socially enforced rights to exclude trespassers and to alienate "commodities" by means of exchange, may lead towards perverse

[42] Purely fiscal arguments would have to show the existence of socially more productive alternative uses of the claims on resources used (or with-held by their owners) as a consequence of the state's reliance on general tax revenues to provide product- and process-safety information upon which to base its regulatory decisions. It might be noticed that there already is a specific (and hidden) form of state subsidization of private investment in field trials of drugs and medical devises: in the UK, for example, the hospital and clincal facilities of the National Health Service are placed as the disposal of the researchers who conduct those trials on behalf of the commercial developers of the innovations.

economic policies in the field of scientific and technological research. By its very nature, the alternative to proprietary research -- the pursuit of "open science" -- requires patronage from external sources of grant and contract funding, or from those who are personally engaged, and often from both.

The central problems facing researchers in the developing countries are rooted in a lack of adequate material resources to pursue their work in the effective, open mode of cooperation with scientists throughout the world. Thus, it is tempting for them to think of embracing proprietary research as the solution to the income constraints under which they presently labor. The same thought will occur quite naturally to those who wish to help these less advantaged colleagues. After all, this course of "self-help" in meeting the rising costs of modern scientific research demonstrably has proved attractive to the administrators of many far better endowed universities and public institutes in the industrially advanced regions – and also to individual researchers who see in it a means of further advancing both their work and their material standard of living.

In the developed countries this course has provided, at best only a small margin of incremental research support, averaging 8-10 per cent among research universities in the US. Yet, in some fields, and particularly in the life sciences, where the share of funding from industrial sources approaches 25 per cent at the leading institutions, the commercialization movement is perceptibly encroaching upon the culture of academic research and challenging the ethos of collaborative, open science. Consequently, we must worry that applying the same "remedy" to mend the economic disabilities of open science in the developing countries would have more profound transforming effects, and might in the end result in further isolating researchers there from the remaining sources of cooperative exchange with publicly supported colleagues and institutions elsewhere. Yes, in the private property rights system we have a readily prescribed and potentially potent "cure" for the condition of impoverished open science. Unfortunately, it is one in which the patients die. We really do need to think of something better.