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Introduction: Intellectual Property and Diverse Rights of Ownership in Science

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Issues surrounding intellectual ownership in science are growing more complex, due in part to the emergence of new claimants to scientific property. In many cases, an overlap of proprietary interests on the part of universities, business, and government in scientific research has created ambiguity and conflict. This has restricted the communication of scientific ideas. Given the complexity in the norms prescribing scientific property rights, such conflict is bound to continue.

Ownership of intellectual property in science has historically been consequential, uncertain, and contentious. This has been so in some measure since the emergence of modern science in the seventeenth century. In more recent times, science has become increasingly interdigitated with other social institutions, bringing with it new questions about intellectual property in the domain of sci-

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ence. These questions have been accompanied by efforts both to redefine rights of ownership and to extend them to new claimants, generating conflict, in the process, about the rights and responsibilities of property owners and the extent to which they are observed in practice.[1] These articles take up a variety of such conflicts but all address the same fundamental questions: Who has rights of ownership in science, under what circumstances, and how free are they to convey the "owned" intellectual property to others? [Editor's note: the four articles discussed in this introduction appeared in *Science, Technology, & Human Values* 13(1 & 2):17-63, Winter & Spring 1988), in a theme section on "Changing Notions of Ownership in Science."]

Legally, according to standard sources such as *Black's Law Dictionary*, ownership refers to a collection of exclusive rights to use and enjoy property, including the right to transmit it to others. In further legal terms, ownership involves rights to possess and dispose; owners may "even...spoil or destroy" property, unless legally restrained from doing so. The essence of ownership is the right to control (Black 1979, pp. 996, 997). In defining ownership, *Black's* says nothing about the responsibilities that go with it, but the definitions of property and liability do. In the mores of science, as in the law, ownership of intellectual property involves both rights and responsibilities—a point worth underscoring here and one to which I return shortly.

But the mores of science are quite different from the law when it comes to other salient features of intellectual property for "science is public, not private knowledge" (Merton [1938] 1970, p. 219).[2] Scientific ideas or findings that are kept secret are not accorded the status of intellectual property and cannot be claimed by their originators.[3] Scientists must publish their work in order for it to become their own. Property rights in science, therefore, have a peculiarly paradoxical character (Merton [1942] 1973, pp. 273-75). The only way scientists can be sure of being credited with the originality esteemed by their peers is to give their work away, by conveying it to the scientific community.

Property rights in science thus become "severely limited." Once scientists publish their work, "they no longer have exclusive rights of access to it." With publication, traditional rights to retain, deny access, or control transmission and disposal are forfeited. Scientists' rights become "whittled down to just this one: the recognition by others of the scientist's distinctive part in having brought the result into being" (Merton [1957] 1973, pp. 294-95). "The scientists' claim to 'his' intellectual 'property' is confined to that of recognition and esteem" (Merton [1942] 1973, p. 273).

In effect, access to the intellectual property is transferred from scientist-contributors to the community. In its turn, the scientific community is obliged to credit their contributors, to acknowledge the intellectual property as theirs. As a consequence, individual scientists and the community alike have personal interest as well as public interest in the free communication of ideas and findings. In all these varied respects, property in science differs from property in technology.

In principle, these historically evolving norms seem unproblematic. In practice, most scientists have long been concerned with protecting their property rights and ensuring the proper allocation of credit. They know that the reward system in which publication is exchanged for credit works imperfectly. It was not uncommon for seventeenth-century scientists to worry that their work would be stolen (plagiarized) before it got into print. Indeed, the prolific Robert Boyle was chronically anxious about what he called "philosophical robbery,"[4] anxious enough to deposit sealed and dated accounts of his discoveries with the Royal Society. Boyle was not alone. This common practice assured there being a record of discoveries and their discoverers, independent of publication. The French did the same, depositing what they called *pli cachete* (or sealed folded messages) with the French Academy. This ancient practice does not greatly differ from the newly devised procedure, based on graph theory, that allows mathematicians who discover a full proof to announce its existence without revealing its details before publication (Kolata 1986, pp. 938-39).

Anxieties about receiving appropriate credit derive, in part, from the fact that scientists, unlike other property owners, cannot know whether they will receive due credit upon making the work public. They must take the risk of making their work known without assurance of future credit or payment. In contrast, legal owners of other types of property generally know before the fact of conveyance whether compensation will be forthcoming; if this is unsatisfactory to them, they can withdraw their property from the market.

It is not surprising that a variety of devices, particularly the various ordering of authors' names on papers, have been fashioned to signal the proper allocation of credit upon publication. (On name-ordering of authors, see Zuckerman 1968.) Yet there is ample evidence that many scientists continue to worry about authorship and having their work accredited to them. The *quid* is not always there for the *quo*. The institutionalization of a *quid pro quo* involves severe penalties for plagiarism and positive demands for the practice of acknowledging sources of ideas, data, and findings through citation or referencing.

Moreover, as these articles indicate, issues of ownership of intellectual property not only provoke anxiety in scientists, they also produce conflict between claimants, all of whom consider their rights to be legitimate. Vivian Weil, Illinois Institute of Technology, Chicago, for example, observes that governmental controls on the communications of scientific and technical information involve the collision of basic First Amendment issues and government's rights to limit access, where that is deemed in the national interest. In practice, governmental agencies have at times overclassified such information ostensibly to protect national security or national economic competitiveness and have also leaked such information when *that* was thought useful. In their analysis of dual mission agencies such as the National Centers for Disease Control, Robert Boruch, Northwestern University, Evanston, Illinois, and Valerie George, Cleveland State University, Ohio, note that these are required to collect information for research purposes *and* to use that information for law enforcement, this producing an organizational recipe for generating both conflicting claims to the ownership of data and great uneasiness among researchers about protecting the confidentiality and the validity of data. Stephen J. Ceci, Cornell University, Ithaca, New York, takes up the question of mandatory data-sharing, the rights of the scientific community to evidence collected with public funding. This involves conflicting views first about scientists' obligations to share their data when these were collected from subjects promised anonymity. Second, it involves conflicting views about scientists' obligations to allow others to examine and use their data, before they have been fully exploited by the original investigators.

In another article, Daryl E. Chubin, Office of Technology Assessment, Washington, DC, examines the intriguing case of Stewart and Feder, two authors who were barred, at least temporarily, from publishing a paper reporting alleged misconduct of scientists by the threat of libel suits against them and against the journals that published their paper.

Some of these conflicts are old; some relatively new. The contradictions between open communication and the preservation of national security and national proprietary interests are, of course, as old as modern science itself.[5] For obvious reasons, these conflicts are found far more often in recent times. It may be that the U.S. government has recently become particularly intent on using legislation, designed originally for other purposes, to control the flow of scientific information. As an example, Weil notes that the Export Control Act has recently been invoked by the Reagan administration to force scientists to withdraw their papers from one scientific meeting and to prevent the participation of East European scientists in another. Such practices may be new in detail but it is scarcely surprising to find government and industry pressing for secrecy rather than open communication. Similarly, there is nothing surprising about some scientists being reluctant to share their data or research procedures in order to protect their subjects or their priority. The normative and reward systems of science make for such reluctance.

Far less familiar are other types of conflict dealt with in these articles. In particular, there is the collision in dual mission agencies between law enforcement and research interests, described by Boruch and George, and the collision between protection from defamation of character and free communication of pertinent scientific evidence, described by Chubin. But not entirely so. It will be recalled that Napoleon was not above making census taking a "dual mission" enterprise, by using the census to identify recalcitrant taxpayers. Some Frenchmen disappeared, of course, just before the census takers arrived, thus managing to outwit the tax collector *and* to undermine the validity of official population counts.

These four articles also call attention to the emergence of new claimants to scientific property. A rapidly growing number of universities now have a proprietary interest in the scientific contributions of their faculty members, and new university-industry relations have emerged that make the ownership of intellectual property increasingly complex.[6] These arrangements, designed to provide financial support for university research as well as large financial rewards for scientists—by Hoechst, for example, at Harvard or, in a different mode, by Whitehead at MIT—set the stage, when not carefully specified in advance, for claims being made by industrial firms to the ownership of research by academics doing their work in university laboratories.

This is evidently a time of exceedingly rapid and possibly fundamental change in the social organization of scientific research and in the normative structure of science. A recent study by Blumenthal and colleagues (1986a) indicates that industrial firms support as much as one-fourth of biotechnology research in institutions of higher education in the United States. A second study also shows that the scale of university faculty-industry collaborations in the life sciences is far larger than had been thought (Blumenthal et al. 1986b). Of university scientists in departments relevant to biotechnology in research universities, 23% had industry support of some kind.[7] As Blumenthal et al. point out, however, theirs is not a random sample of faculty members because they only surveyed scientists affiliated with the 40 most research-intensive universities. Still, this estimate may not be far off because faculty members in schools of medicine and agriculture were excluded. Both groups are even more likely to have support than the faculty in biotechnology departments actually surveyed.

It is clear that a sizable fraction of university scientists are involved in such collaborations and are thus exposed to new restraints on ownership and communication on a scale previously unknown. A fourth of those receiving industrial support reported having conducted research at their universities resulting in findings that could not be published without the sponsors' consent and that became the sponsors' property. And almost one-half (44%) of the scientists with such support were persuaded that these university-industry collaborations undermine intellectual cooperation and exchange (Blumenthal et al. 1986b, p. 1364). Given that these scientists all had industrial support, this opinion can scarcely be interpreted as sour grapes. The importance of all this is plain. The communication of scientific contributions by academic scientists is apparently becoming less open than it was. And, in many instances, it is defined as legitimate that industry lay claim to the ownership of research carried forward in universities as well as in industrial laboratories.

The tensions generated by collaborative efforts between industry and academic scientists to find the gene producing cystic fibrosis provide a prototypal case (Roberts 1988). Of considerable scientific interest, this research also has sizable technological and financial implications—the entrepreneurial firm involved has already invested $10 million and, if successful, will make many times as much in return. The case shows the unsettled character of such collaborations and ambiguity in the rights and obligations of industrial and academic scientists engaged in them. One issue concerns the timely reporting of research results. The academic scientists responsible for the results are said to believe that their chances for credit for the work were undermined because data were withheld to protect proprietary rights. Their industrial collaborators insist that the evidence was not withheld. Rather, they believed the data were not reliable and held off reporting results in order to avoid making a mistake (Roberts 1988, p. 143). Other issues concern obligations for full disclosure between industrial and academic collaborators and the freedom of academic scientists to pursue research directions not approved by the firm. Opinions differed on both matters. The academics are reported to have felt that they were not given full information by the firm. As a consequence, they went ahead on research they had been told not to do but that they thought necessary to establish their priority. Their industrial collaborators were not pleased. For them, accusations of excessive secrecy by their collaborators and other researchers in the field were unjustified. The case also shows how conflicts between industrial and academic collaborators are fueled by competition with other investigators. They are also fueled by participants' differing perceptions and normative expectations related perhaps to the kinds of scientists self-selected for work in industry and academia. Industry-academy associations, therefore, do not occur within a social and normative vacuum and have to be seen in the context of the research communities in which they occur.

Finally, in this inventory of disputes involving new claimants to scientific property, one must add the human (and in some cases, through proxies, other animal) subjects of research. Human subjects now claim a right to control the dissemination of data gathered about them or at least to assure themselves that certain information will not be communicated and that their identities will remain confidential. These questions have been addressed mainly in the context of evolving rules for the protection of human subjects, thus obscuring their implications for the ownership of intellectual property. Nevertheless, these questions do have such implications. This is especially the case when research subjects claim an interest, as a small number have, in the financial benefits of the research in which they have played their distinctive part.

In the main, then, the cases involving new definitions of scientific property that are examined in these four articles constitute a subset of a larger universe of cases involving new claimants to scientific property. These also exhibit the present ambiguities of the evolving rights of ownership in science.

Why have these disputes emerged now? Of course, not all of them have. Some are far from new. But those that are have resulted mainly from the pragmatic success of science-based technology and its growing significance for different segments of society. This means that many outside the domain of science narrowly defined—those in university administration, industry, and government (especially the military)—have increasing reason to stake claims to scientific property and to seek the control of access to it. The economic sources of such claims become increasingly evident. Much of this science requires enormous investment. The more expensive science becomes, the more it is held accountable to those who foot the bill for it, whether these are industry, the military, or other government agencies.

Finally, we come to the intriguing case examined by Chubin. As Chubin reports, the Stewart and Feder episode was no ordinary case of two scientists submitting a paper for publication.[8] Rather, the manuscript encountered a special kind of difficulty in getting published. Only after long delays, elaborate refereeing, and, most important, despite the threat of libel suits against the authors and the journal, was it finally published in *Nature*, with an accompanying piece by Eugene Braunwald (1987), one of those accused of misconduct by Stewart and Feder and one who had retained libel lawyers to try to prevent publication. Rather than poorly defined norms of scientific property, this case illustrates, in emblematic fashion, a contest between two sets of well-defined rights. First Amendment rights of free speech and free publication in science collide with the rights of individuals to protect themselves against defamation. Stewart and Feder and the journals, *Nature* and *Cell* (where the paper was also submitted), clearly have the right to publish. Braunwald and Kloner, both of whom objected to the paper being published, clearly have the right to sue for defamation.[9] Chubin correctly calls attention to the novelty of libel lawyers getting involved in questions involving scientific communication and to the potential threats to the free communication of science signaled by such involvement. How are such conflicts between apparently legitimate sets of rights to be adjudicated? How can justifiable whistle-blowing—which itself involves a clash between norms of science and the norm of personal loyalty—be encouraged while still protecting the rights of those accused of misconduct? And finally, does such use of libel laws constitute an illegitimate attempt to control the free flow of scientific communication? These are far from easy questions. They testify that something new is rapidly emerging in the interface between science and law.

For this reader, the four articles, for all their differences, communicate a reasonably coherent set of messages:

—First, all deal with contemporary cases of efforts to modify traditional concepts of scientific ownership, some requiring more public disclosure and some, less.

—Second, in the process of change, a new set of claimants to the control of scientific property has emerged, with each claimant asserting legitimacy based on having an "interest" in the research by having variously invested in it.

—Third, these developments largely derive from scientific research, especially in biology, that has become increasingly consequential and thus of increasing and varied interest to universities, industry, and government. If science and especially science-based technology mattered less in their pragmatic consequences, there would be fewer claimants wanting to control their products.

—Fourth, the norms prescribing scientific property rights appear increasingly complex and ambiguous. Ceci's informal surveys of academic and other scientists indicate how problematic these matters are. On the one hand, the surveys show that the ideal of free communication is widely endorsed and widely, not universally, followed; on the other hand, scientists report a conspicuous lack of success in getting colleagues to share their data.

—Fifth, we should expect disputes about scientific property to become increasingly frequent and to involve a greater variety of participants. Nor do these disputes only involve efforts to restrict communication; there will certainly be efforts as well to enlarge access to information.

Ironically, the pragmatic success of science is limiting rather than extending its autonomy. Science has become involved with a variety of partners, each of them claiming ownership rights to its intellectual property. Traditional notions of scientific property grew up in a time when much of science was pragmatically less consequential and, therefore, comparatively more insulated from its social contexts. That insulation is rapidly diminishing. Conflicts over the ownership of intellectual property in science mirror the changing institutional and cognitive place of science in society and culture. These conflicts are bound to continue in the foreseeable future.

NOTES

1. For a review of the nature of disputes over intellectual property in science and their likely consequences, see Nelkin (1984).

2. John Ziman (1968, 1978) does much with the public aspect of scientific knowledge in his essays dealing with the social dimensions of science, most particularly the *consensibility* of the contents of science and the *consensuality* of the scientific community (1978, p. 6).

3. The institutionally reinforced quest for recognized originality leads, on occasion, to "races for priority," which, at the margins, become pathogenic, leading at times to such deviant behaviors as the concocting of fraudulent data and the theft of ideas, that is, plagiarism (Merton [1957] 1973, pp. 93-296).

4. See Zuckerman and Merton (1971, pp. 69-71) on the institutionalization of the scientific journal as a means of protecting scientists' property rights from plagiarism.

5. On the relations between science and military uses in the seventeenth century, see Boris Hessen's landmark analysis of the "social and economic roots of Newton's *Principia*" ([1931] 1971) and Robert Merton (1935).

6. Such arrangements now extend to academic scientists becoming entrepreneurs, forming firms, and then making agreements with their universities. On "entrepreneurial scientists" and "entrepreneurial universities," see Etzkowitz (1983, 1988).

7. This is a higher proportion than among other life-science faculty members, where 17% have such support, but far lower than among chemists and engineers, where 43% do (Blumenthal et al. 1986b, p. 1362).

8. As is well known, the paper by Stewart and Feder (1987) analyzes errors and, in the authors' view, other kinds of scientific misconduct as they appear in publications coauthored by John Darsee, an admitted fabricator of data.

9. Chubin notes that older, powerful scientists involved in cases of fraud have paid far less in terms of their careers than their junior collaborators. The reasons for this difference seem to derive from the seniors' greater power and resources, and also from their not being, in most of the reported cases, themselves guilty of fraud. In these cases, they stand accused of negligence, itself a significant violation of normative standards but not judged as serious as actual fraud.

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