

Research, Ownership, Misconduct—Readers Respond

Robert B. Laughlin's gross extrapolation (PHYSICS TODAY, December 2002, page 10) from a single incident at Bell Labs—the first in its 77-year history—to an indictment of the whole of industry research is wrong on every plane.

The assertion that scientific misconduct in industry research is not only more frequent than in publicly funded research but indeed common is unsubstantiated by the essay. In fact, that comment is directly at odds with the results of investigations by those agencies that oversee federally funded research. The Office of Research Integrity, which oversees research sponsored by the National Institutes of Health, the Food and Drug Administration, the Centers for Disease Control and Prevention, and related agencies, has gathered some revealing statistics from annual reports on possible research misconduct during the six-year period 1991–96. Universities, both public and private, constitute 26.5% of those entities that answer to ORI, yet they account for 68% of the institutions at which misconduct was found. Small businesses, on the other hand, make up 43% of those institutions that answer to ORI but only 4.9% of the misconduct findings. The office of NSF's inspector general publishes a semiannual report of shenanigans by its grantees. According to the reports of the past few years, almost all misconduct findings were in universities—though it should be noted that most NSF grants go to university research.

I'd like to see the statistics for grant falsifications for all federally sponsored research. I strongly suspect they too would refute Laughlin's thesis. The "inherent truthfulness" of university research doesn't explain why the overwhelming majority of research misconduct findings

occur at universities and not in industry labs. In light of the facts, is Laughlin willing to admit that some fraction of the university-style research portfolio that he is so proud of is "simply lies" as he callously characterized industry research?

I've worked in both environments, and the pressure to fudge both data and dollars is as easy to understand in an academic environment as in an industrial one. "Publish or perish," the law of the land in academia, translates to "patent or perish" in industry. But a private company faces a much more punishing feedback mechanism—namely, bankruptcy—to ensure accountability than any public enterprise. When a private company gets caught defrauding the taxpayers, there are unanimous calls for retribution. But such brutal accountability is hard to find in the public sphere. A tenured professor can be convicted and imprisoned for falsifying grants, get out of jail, and return to his or her old job. Does anyone expect Jan Hendrik Schön to ever work at Bell Labs again?

The notion that the products of industry research remain cloaked in secrecy is false. They are usually submitted for public scrutiny in the form of a patent application. Every such application includes a full disclosure of the technology involved and any discoveries that led to it. Anyone can read it, learn from it, and build upon that knowledge. Trade secrets are a rarity in industry because they are so hard to keep. Most industry leaders recognize the importance of open lines of inquiry and only clamp down when they are close to something patentable.

The idea that secrecy breeds impropriety is absurd. A secret that is untrue is a worthless secret. And a patent based on such information isn't worth the paper it's printed on. The "rotteness" of any fraudulent research in industry does not "take an extremely long time to reveal itself"—investors tend to be an impatient and shortsighted lot. Even if the work should somehow lead to production, products that don't work don't sell terribly well. And it is not at all clear how a company's shoddy research might "clog the pipeline of innovation," especially if that research is

being done in secret. Did all semiconductor research grind to a halt when Bell Labs thought it had a transistor without avalanche breakdown? Schön and company published their phony results and others tried and failed to reproduce them. It remains for Laughlin to prove that the whole corrective process took longer at Bell Labs than it would have in a university lab. Remember, Stanley Pons and Martin Fleischmann "discovered" cold fusion in a university lab.

The "fiery independence" of university researchers receives praise from Laughlin, but few individuals possess the fiery independence of an entrepreneur. Revenues from patents offer universities some genuine independence by relieving them of at least some fundraising burden.

The claim that science is driven by selfless altruism is nonsense. We do it because it's fun—a distinctly selfish motivation. And never discount the value of simple greed. Greed is a terrific source of motivation, and far more reliable than altruism.

Bottom line: The decision to do something dishonest is a personal one and is more indicative of a character flaw than the avarice or altruism of one's employer. Honest, productive research can thrive in either industry or university environments. There are good arguments for supporting university research. Laughlin's isn't one of them.

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The Reference Frame column by Robert Laughlin raises very interesting issues concerning the economic inducements to commit fraud in science and technology. It is always a pleasure to find physics writers sensitive to the industrial world, not just the university one.

It was striking, however, to observe how fixated Laughlin was on his peculiar idea of "property." I counted at least nine times he used the word, with uniformly negative connotations. For Laughlin, at least as far as the sciences are concerned, property is the root of all evil. It would appear that he has little or no industrial experience himself, or else learned little from what experience he had.

Letters and opinions are encouraged and should be sent to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842 or by e-mail to ptletter@aip.org (using your surname as "Subject"). Please include your affiliation, mailing address, and daytime phone number. We reserve the right to edit submissions.

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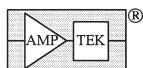


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Ironically, he has things exactly backward. In government and university occupations, researchers who commit fraud are putting just what at risk, personally? Perhaps their reputation, if they are caught. Perhaps their job, if the sin is egregious. Susceptible to fashions, the government and university sectors have a strong incentive to protect researchers and their work and to overlook little flaws that may tend to advance common interests. And with little or no need to produce a commercial product, university and government researchers are subject to no mechanism for independent test of value, other than the so-called peer review of other soldiers in the same army. If and when somebody is exposed doctoring data, still nobody really loses. The researcher is "promoted sideways" (found another job in another lab or agency), a polite retraction is issued by the sponsors or department head, and the money keeps flowing. In last year's most newsworthy revelations of physics fraud, not one of the coauthors of the perpetrator's papers admitted even secondary responsibility ("I just assumed he was providing good data," they whined), let alone suffered the slightest financial or career setback. Except for one man, the fraud was free.

In industry, by contrast and as Laughlin correctly noticed, the stakes are much higher. Industrial research, far from being insulated from self-correcting (market) forces, experiences the strongest possible discipline daily. Consider where the high stakes of investment costs and the potential value of intellectual property really lead: not to fraud but to truth. Senior people in high-tech companies who pursue fraud do not just lose their reputations, they lose their homes, their fortunes, their livelihoods, and sometimes even their families under the stress.

Just as a successful discovery or development can make you rich, a false one can ruin you. Entrepreneurs bet everything they own on the value of their ideas, discoveries, developments, products. They have little time to waste on data or ideas they know to be false or worthless, because they literally cannot afford failure or wasted effort. They are paying for the work themselves. Naturally, ideas, discoveries, and developments result in intellectual property, sometimes of the very highest value. But the property has value only to the extent it is valued by others. Once a

private enterprise brings a new discovery or product to the market, consumers will test the work immediately and without pity. If it is without merit, or if its value is significantly less than the developers claimed, customers and competitors quickly crush the developers with rejection. That market scenario contains very little room for fraud and the greatest penalties when fraud is exposed. I would suggest that somebody enroll Laughlin in Economics 101.

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I could not disagree more with Robert Laughlin's analysis of recent fraud in experimental physics and the cure for what ails the profession. For science to be "relevant," it must produce something—which may be beauty or insight or patent royalties—that has real value to someone. Our best response to economic pressure is to create things with real value.

Laughlin claims that we scientists have an "obsession with fundamentals and truth" but that present economic "pressure can turn otherwise excellent and honest scientists into willing deceivers." Scientists as a group have moral frailties similar to other professional groups, but most of us understand two basic parameters. First, science is based on repeatable experiments and calculations, so it will not advance one's career to publish results that others will not repeat. And second, products and processes based on faulty parameters and theories do not work well. So truth is valuable in science because it enhances the value of intellectual property. A sane scientist would not assert a false answer to a question that has economic importance, but might be tempted to assert a self-serving falsehood that is "academic." Major hard-science frauds are generally committed by people who think that they know what the "right result" is and are frustrated in their attempts to get that result honestly.

To suppress fraud in physics, we can test our students for fraud in labs and assigned problems and punish where it is found. An instructor can set up a lab class to expect a fallacious result and then give a zero score to those who report it and praise those who report properly. Students often are given the correct answers before they begin to work assigned problems, especially those

in which issues of sign or factors of 2 are tricky. The instructor can check that the student obtained the correct sign or factor at the correct point, rather than changed it at some arbitrary step, and thus grade accordingly. Substantial partial credit should be given for a calculation presented honestly with the wrong sign or factor and a 0 for the correct answer presented dishonestly. In addition to teaching our students physics, it is also valuable to teach them to correct those misunderstandings about what is proven and what is speculated that arise from different personality types.

Laughlin asserts that the recent frauds at Bell Labs "are noteworthy only because of Bell's special stature in American science and its reputation, both partly attributable to Bell's having been shielded from [economic] pressures by the old AT&T monopoly." I assert that it is noteworthy that, despite its immediate economic stress, the present Bell Labs did the right thing. That benefits Bell's long-term economic interest.

The private companies that hire Oregon State University students report that OSU's most important lesson is ethics.

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The frightening trend of industrializing our universities is, I believe, the single greatest threat to the integrity of higher education in this country (and probably all countries). The topic was hotly debated 30 or 40 years ago, but as the money has flowed, the concern seems to have waned. To better tap industrial largess and to appease state legislatures, university administrations have turned to the business model, which, as Laughlin so eloquently wrote, "is such a terrible idea."

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So pervasive are the contradictions in Robert Laughlin's disingenuous view of research in industrial laboratories that it is not easy to know where to begin the counterargument.

Having spent many years as a researcher and manager in an industrial laboratory, I came to understand that companies investing in basic research do not think of it as "charity

or part of an advertising budget." For a century, corporation-funded basic research has been a prolific driver of the technical revolution on which the world's economy is increasingly built, human health improved, and national security enhanced. Without these impacts, it would be hard to justify the large investments, by both government and industry, in both basic and applied science. And contrary to Laughlin's assertion, basic research continues to flourish in corporate laboratories where it is embedded in a balanced

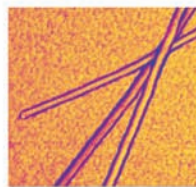
research portfolio and is highly valued by its corporate investor.

I discount Laughlin's assertion that "research linked to property has a built-in conflict of interest toward the truth" as being even less credible than it would be if "personal success and recognition" were substituted for "property." True, research is linked to property; something of economic value is created. However, it is patently false and contrary to experience that "intellectual property—knowledge that one can sell— . . . must be kept secret." Were it so, it

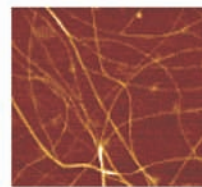
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would be hard to understand how the top industrial laboratories developed their reputations as generators of knowledge.

Patents are often used by both industry and universities to obtain a fair return on the commercial use by others of their knowledge and invention. The patent ensures that the knowledge is not kept secret but is freely shared. It is only the commercial exploitation of that knowledge that raises the subject of royalties. Thus it seems naive and a barrier to clear thinking to believe that “we

must choose between creating knowledge and creating property.” Whenever we create knowledge, we create property; the issues are about what is done with that knowledge. And let us look to the individual and to our broader values as we seek to understand the fortunately rare cases of scientific dishonesty. It is simplistic, and contrary to the evidence, to attribute the problem to the corrupting influence of industry and the contrasting purity of the academic environment.

I am not sure what message Laughlin sends his students. Is it

that doing basic science in an industrial setting is not possible? Is it that, in the creation of knowledge, researchers should avoid having knowledge become useful property out of fear that they might turn into “willing deceivers”? I hope his students will see a more realistic and balanced picture of the opportunities in the world to which they have committed their careers.

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According to Robert Laughlin, “making universities over into businesses may generate more patents,” but it “also corrupts scientific traditions” and leads to mediocrity and dishonesty. His suggestion that physicists “take the high ground and turn [themselves] into the gold standard of truth” is a laudable one. I hope he can convince his physics colleagues at Stanford University.

Rebecca Lowen has pointed out that, at the start of Stanford’s rise to national prominence in the 1950s, “the physics department was the last, rather than the first, university department to permit faculty members to be hired with government rather than university funds.”¹ If the department takes Laughlin’s suggestion, the physicists can now be the first, rather than the last, to turn down private money that might distort their dedication to scientific truth. In doing so, however, they will be swimming upstream against both past and current trends at Stanford. For example, a \$225 million award to Stanford from a group of international energy companies—ExxonMobil Corp, General Electric Co, and the German company E.ON—was recently announced. This money will fund a 10-year project, to be directed by a professor in petroleum engineering, to study climate change and energy.²

Although most physicists would probably agree with Laughlin that “economics is not fundamentally what science is about,” economic considerations nevertheless play a major role in research planning and funding decisions. Laughlin thinks the scientist ultimately faces a choice “between creating knowledge and creating property.” To him the choice is clear because “only one is science.” But the processes by which knowledge and products are created are so interrelated and interdependent that separating science and technology is neither possible nor desirable.

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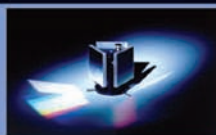
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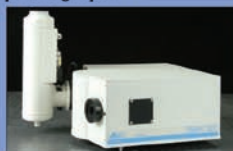
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1. R. Lowen, *Creating the Cold War University: The Transformation of Stanford*, U. of California Press, Berkeley, (1997), p. 10.
2. A. Lawler, *Science* **298**, 1537 (2002).

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Robert Laughlin's article is incisive and well worth reading. The conflict of interest he described exists in other institutions too. It isn't only high-status scientists who may find themselves making inappropriate choices. A customer support engineer may have to choose between revealing valuable technical secrets to help the customer and revealing aspects of company policy that management would prefer to keep hidden. For example, it might be in the customer's interest to say, "Don't buy that product; it has problems, and we are bringing out a better model next month." But that would be disastrous for the company, because it would leave a pile of unsold merchandise in the warehouse.

Scientists sometimes exaggerate the difference between research work and jobs in other fields. They think they alone are devoted to finding the truth and that they represent some kind of "gold standard" in truth-seeking. Actually, a farmer or programmer must also learn the truth. An airplane pilot or factory worker who ignores the truth may be killed in an accident. As Rudyard Kipling wrote in "The Secret of the Machines,"

But, remember, please, the Law
by which we live,
We are not built to
comprehend a lie,
We can neither love nor pity
nor forgive.
If you make a slip in handling
us you die!

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Laughlin replies: Rather than respond to these letters individually, I will take the long view and point out that, together, they say some important things about the discipline. The sentiments expressed largely match those sent to me privately, except that my mail is more positive. Judging from anecdotal evidence, I think the positive mix more accurately reflects the sentiment among physicists generally, but that is hard

to quantify. However, even with the balance in this group of letters, it is clear that there is a terrible schism among professional physicists over the whole question of scientific ownership, and there are profoundly different perceptions of exactly the same facts. Reading some of the criticism, I am reminded of the scene in Mel Brooks's movie *Young Frankenstein*, in which Dr. Frankenstein asks Igor how he lives with his hump and Igor answers, "What hump?"

A design problem in writing a short piece is that insufficient space to say things defensibly inevitably

generates misunderstandings. For example, I took enormous care not to impugn property but somehow managed to get labeled as anti-property anyway. So let me set the record straight by stating that I strongly support technological property and the engineering activity that generates it. I would love to be an engineer, but it is too late. I am in my fifties and—worse—am trained as a theorist. I also agree that de facto property in universities is exactly the same as private property, and that dumping on industry just because it is private is the most despicable hypocrisy.

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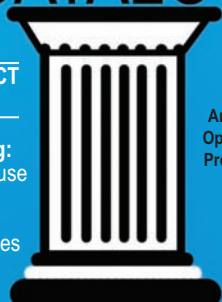
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My point was not that property is bad but that property is owned, and that its ownership has implications. In light of the difficulty the more irritated respondents had in acknowledging this fact, I find myself wondering just who needs a refresher course in economics. To get at the matter of deception, I had to speak in vague abstractions for the obvious reason that specifics are grounds for lawsuits. Those of you who have never seen any corruption should just dismiss what I say. Those of you who have seen corruption know what I mean.

I cannot resist the temptation to respond to a few specific points, although they are peripheral to the central, important matter of the controversy itself. The business page of the *New York Times* of 28 February 2003 reports that Microsoft Corp has given the government of China access to the source code for Windows®. Windows is an immediate and easily understandable counterexample to the assertion that full disclosure is good for technological business. As everyone knows, the reason Microsoft does not simply make the source code open to the world is because the company would be swiftly destroyed if it did. The notorious proprietary nature of that code is the basis of its entire business. I know many other instances of the importance of technological secrecy—for example, my colleague Bill Little's decision not to patent certain aspects of his Joule-Thompson refrigerator technology because it would have been an invitation for theft. As to the benign effects of secrecy, the Enron and WorldCom scandals were facilitated by secrecy, not by the inherently corrupt nature of business. True, the folks involved were not scientists, but it is not true that scientists are orders of magnitude more honest than everyone else. The integrity of science comes only from its openness and its ethic of "trust but verify," to paraphrase Ronald Reagan. As to my own university's private energy-research initiative, I note that this activity is engineering, not science, and thus irrelevant to the discussion.

In the end, however, I must emphasize that my piece was not intended to indict anyone making a living doing practical things. The Schön affair has occurred in the context of very hard times for physics, in which everyone, including me, has spent sleepless nights wondering how to move forward. My proposed solution is simply to focus on integrity as the sustaining asset, even as one makes the compromises necessary to do

one's job. Actually, this is not such bad advice generally.

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Bayesian Probability and One Bad Apple

The brilliant, attention-capturing sentences at the beginning of Michael Berry's "Singular Limits" (PHYSICS TODAY, May 2002, page 10) appear untenable unless one considers conditional (Bayesian) probability. In fact, biting an apple and finding no maggot may indicate either the worst or the best experience of the apple eater. Respectively, the eater may have swallowed the entire maggot with some bite or no maggot at all. The outcome depends on a pre-existing condition: the presence, or absence, of a single apple inhabitant.

Real things may be even more complex: A particularly unfortunate eater may have gotten an apple with multiple maggots. The situation described also appears to be a suitable illustration of the collapse of probability by observation.

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Reader Inquires: Who Was Thomas Hakon Gronwall?

I am a university professor researching Thomas Hakon Gronwall, a Swedish-American mathematician who did work in physics and physical chemistry. In the late 1920s, he was a research associate at Columbia University and worked extensively in physical chemistry with Victor K. LaMer on Debye-Hückel theory and with K. W. Lamson on reflection of radiation in plates. Gronwall also published papers on the hydrogen and helium wave equations, the latter posthumously in 1937 after his notes were collected and organized by F. Bohnenblust and J. H. Bartlett Jr.

I would appreciate hearing from anyone who has knowledge of Gronwall's life and work, especially regarding his time at Columbia University and the influence, if any, of his work on the development of the respective research areas.

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