Ethics and the Welfare of the Physics Profession

Responding to a survey by an APS task force on ethics, younger members of the physics community have raised significant concerns about the treatment of subordinates and about other ethical issues.

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In 1987, as the biological sciences were grappling with several high-profile cases of research misconduct,[1] the council of the American Physical Society (APS) adopted a statement on integrity in physics. The statement, published in the June 1987 issue of PHYSICS TODAY (page 81), begins:

> The physics community has traditionally enjoyed a well-deserved reputation for maintenance of high ethical standards and integrity in its scientific activities. Indeed, the American Physical Society is one of the few professional societies which has not felt the need for a formal code of ethics.

Although the second sentence conveys an unfortunate arrogance on the part of the physics community's leadership at that time, the statement goes on to exhort physicists not to take its good reputation for granted, and to work to maintain and transmit "the high standards of professional integrity in the physics community [to] younger colleagues and, ultimately, to future generations. . . . The welfare of the profession depends on it."

In 2002, the physics community was rocked by two highly publicized cases of data fabrication: one occurred at a prestigious government laboratory—Lawrence Berkeley National Laboratory; the other at a respected industrial laboratory—Lucent Technologies' Bell Laboratories. (See PHYSICS TODAY, September 2002, page 15, and November 2002, page 15.) In each case, the fabricated data and resultant false claims appeared in multiple-author papers that had been subjected to peer review and published in respected journals. The discovery of the fabrications prompted considerable soul searching in the physics community and raised concerns that APS should perhaps be doing more to promote ethics in physics.

How is the well-being of physics associated with issues of ethics and professional integrity? All physicists know that the unbiased search for truth and understanding is fundamental to the scientific method. Indeed, identifying and eliminating or minimizing biases is one of the first lessons in teaching students to devise experiments and use data to test hypotheses. The public image of physics is important for many reasons, not the least of which is that much of physics research is supported by government funding. The public must have confidence that physics research is done with the highest standards of professional integrity, and that the field can police itself.

Equally important, however, is the recognition among all of us in physics that scientific integrity and trust in the work of others in the field is essential to the success of our own research work (see the article by Caroline Whitbeck on page 48 of this issue). Imparting these values to the next generation is critical. But are we doing a good job? What do the younger members of APS have to say about ethics issues? The goal of this article is to highlight some of their concerns.

In APS, matters of professional ethics are taken up by the subcommittee on ethics of the panel on public affairs (POPA). In the wake of the revelations of data fabrication in 2002, the subcommittee worked to update APS statements on ethics. It also recommended that a task force be formed to look at the state of ethics education in physics, and monitor "the activities of the society and its units and suggest further steps regarding professional ethics, standards and practices for the Society." We served on that task force, together with Joseph Hamilton (Vanderbilt University), Edward Kolb (Fermilab), and Peter Meyers (Princeton University). The task force on ethics completed its work in January 2004.

Surveying the community

Because our task force was small, and its perspective therefore limited, we used surveys designed with the assistance of Roman Czjuko of the American Institute of Physics. The goal of these surveys was to determine the kind of ethics training that physics students receive, the extent to which ethics awareness has been raised in the physics community, the processes that exist in various institutions for resolving ethical problems, the concerns that physicists at all levels have with respect to ethical issues, and what role APS can play. The task force surveyed undergraduates who are members of both APS and the Society of Physics Students (SPS), junior members of APS, a number of large experimental collaborations, physics department chairs, and leaders of APS divisions, forums, sections, and topical groups. Surveys were tailored to the specific characteristics of each group.

By far the highest response rate and the most exten-

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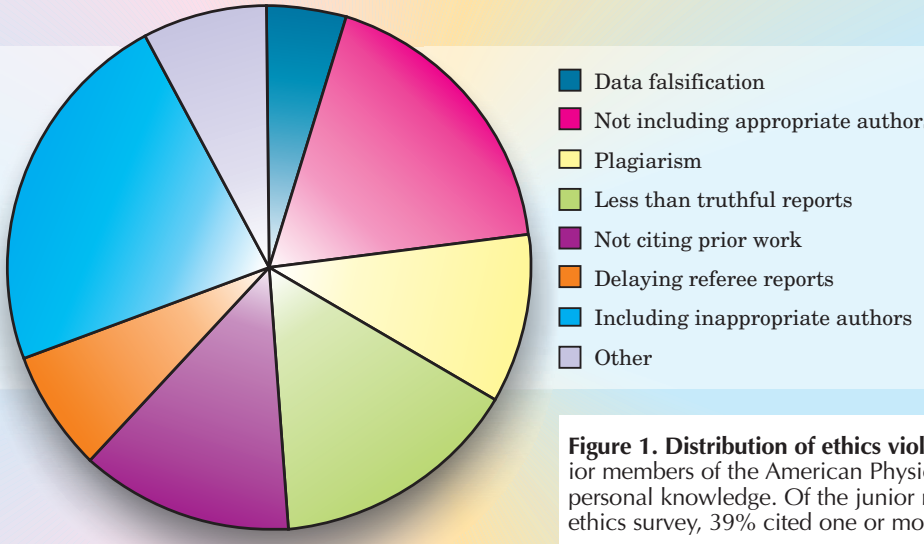

Figure 1. Distribution of ethics violation categories of which junior members of the American Physical Society reported having personal knowledge. Of the junior members responding to APS ethics survey, 39% cited one or more of these transgressions.

sive and heart-felt answers to the open-ended survey questions came from the junior members of APS—that is, physicists within the first three years after getting the PhD. Clearly, issues of ethics and professional conduct find strong resonance in that group of young physicists. Here is a small sample of their many responses:

> The only real answer to the ethics problem is for tenure review boards to stop rewarding the *Science/Nature/PRL* culture above all else.
>
> Our scientific community promotes the search of the surface and superficiality [to the] detriment of content and deepness.
>
> Many breaches of ethics arise from the pressure to publish . . .
>
> The researcher . . . will be judged [by] the number of articles, and the corresponding journal names, appearing on the CV. He or she will not be judged [by] the work spent on each paper, how many backup checks were performed to confirm the results, and so on. High number of papers, in highly ranked journals, is what builds a career. . . . The recent sad events [show] that it is for many people more important to publish spectacular results than to publish true results.

The junior members' concerns over careerism and other issues are echoed again and again in response to the survey question, "What do you see as the most serious professional ethics issues which could/should be addressed by APS?"

The entire junior membership of APS was surveyed via the Web. Almost half of them responded, many within hours of receiving the survey. That is an excellent response rate, considering that no additional reminders were sent. We saw this group as being of central importance to the work of the task force because it uniquely spans recent experience both in the educational system and in the real world of working professional physicists. Our goals in surveying this cohort were

- to assess level of awareness and concern about ethics issues among recent PhDs
- to learn how young physicists are being trained in ethics issues and professional codes of conduct
- to learn of their knowledge and personal experiences of ethics violations
- to collect ideas about what kinds of ethics training would be effective
- to learn what they regard as the most serious professional ethics issues that APS should address.

As we read the responses of the junior members, it became clear that fabrication of data, which had been the

Box 1. Statement on Treatment of Subordinates

(Adopted by the APS Council 30 April 2004)

Subordinates should be treated with respect and with concern for their well-being. Supervisors have the responsibility to facilitate the research, educational, and professional development of subordinates, to provide a safe, supportive working environment and fair compensation, and to promote the timely advance of graduate students and young researchers to the next stage of career development. In addition, supervisors should ensure that subordinates know how to appeal decisions without fear of retribution.

Contributions of subordinates should be properly acknowledged in publications, presentations, and performance appraisals. In particular, subordinates who have made significant contributions to the concept, design, execution, or interpretation of a research study should be afforded the opportunity of authorship of resulting publications, consistent with APS Guidelines for Professional Conduct.

Supervisors and/or other senior scientists should not be listed on papers of subordinates unless they have also contributed significantly to the concept, design, execution or interpretation of the research study.

Mentoring of students, postdoctoral researchers, and employees with respect to intellectual development, professional and ethical standards, and career guidance, is a core responsibility for supervisors. Periodic communication of constructive performance appraisals is essential.

These guidelines apply equally for subordinates in permanent positions and for those in temporary or visiting positions.

Box 2. Web Links to American Physical Society Ethics Statements

Statement on Treatment of Subordinates:
http://www.aps.org/statements/04_1.cfm

Statement on Improving Education for Professional Ethics, Standards and Practices:
http://www.aps.org/statements/02_4.cfm

Statement on Policies for Handling Allegations of Research Misconduct:
http://www.aps.org/statements/02_3.cfm

Guidelines for Professional Conduct (2002):
http://www.aps.org/statements/02_2.cfm

Supplementary Guidelines for Responsibility of Coauthors and Collaborators, Research Results, References in Publications:
http://www.aps.org/statements/02_2.cfm#supplementary_guidelines1

Guidelines for Professional Conduct (1991):
http://www.aps.org/statements/91_8.cfm

Box 3. What does "professional ethics" mean?

In the surveys sent out by the American Physical Society Task Force on Ethics and in this article, we assume that ethical behavior encompasses

- truthful, careful handling and reporting of data,
- responsible, respectful interactions with colleagues and subordinates,
- adherence to APS publication guidelines, including proper recognition of research contributions.

This scope of ethical behavior is broader than that articulated in the Federal Policy on Research Misconduct,[3] which states:

> Research misconduct is defined as fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.
>
> *Fabrication* is making up data or results and recording or reporting them.
>
> *Falsification* is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
>
> *Plagiarism* is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
>
> Research misconduct does not include honest error or differences of opinion.

main issue involved in the two high-profile cases of 2002, is relatively rare. Instead, the junior members were calling particular attention to a variety of other ethics issues, more pervasive and in some ways more subtle.

Ethical treatment of subordinates

Until recently, APS ethics statements had focused mainly on issues related to publication of scholarly work, authorship, and refereeing practices. But a clear majority of the junior members responding to the survey feel that APS ethics statements should be broadened to include treatment of subordinates, especially graduate students and postdocs. Many of their open-ended responses described the unethical treatment of subordinates in research as a very serious problem:

> abuse of graduate students by advisers.
>
> slavery of graduate students. Professors threaten to not write letters of recommendation unless graduate students stay in their group to produce more data.
>
> Too often students are treated as labor instead of [as] students and progress towards finishing [their degree] relegated to secondary importance.
>
> Truthfully, graduate school's purpose is to provide cheap, talented labor to get science done cheaply.
>
> Treatment of 'subordinates' is appalling—students and postdocs are merely vehicles for publication. There are no checks on abuse—and reporting of any abuse usually results in the end of a subordinate's career—even if the complaint is correct and justified.

Junior members expressed concerns over not giving students credit for research by leaving their names off published papers. They also wrote of supervisors imposing grueling hours on their graduate students and sometimes pressuring them to do unethical things such as overlooking data that did not conform to expectations.

Particularly shocking to the task force was how often the words "abuse" and "exploitation" were used to describe the treatment of graduate students. A number of junior members suggested that ethics training should first be made mandatory for professors, so that they could "learn how to treat their students and postdocs in a humane way." Several wrote of the "powerlessness" of graduate students and postdocs, who depend on their supervisor for letters of recommendation and therefore cannot afford to blow the whistle on instances of mistreatment.

One of the most important recommendations to come out of the task force study was that APS ethics statements should be broadened to include treatment of students and subordinates. That has now been done and adopted by APS council in April 2004. The statement appears in box 1. Web links to this and earlier APS ethics statements are listed in box 2.

When APS junior members were asked if they had ever observed or had personal knowledge of ethical violations while they were graduate students or postdocs, fully 39% of those responding to the survey said yes. The top seven offenses they cited are shown in figure 1. "Fabrication of data" represents only 4% of the violations reported by the junior members. But that is still a big enough number to cause concern in the physics community.

In contrast to the high response rate among junior members, only a quarter of physics department chairs responded to the survey they were sent. And of those chairs who did respond, only about 10% indicated instances of ethics violations involving students or faculty in their departments within the last 10 years. That low percentage could be due in part to the chairs' limited institutional memory; they often serve for only three years. It may also reflect the confidentiality generally imposed on academic ethics proceedings. Nonetheless, it is safe to say that direct experience with unethical conduct of various types is not rare in physics departments. Still, a quarter of the responding department chairs stated that their institutions did not have policies and procedures for handling professional misconduct, and another 8% did not know whether

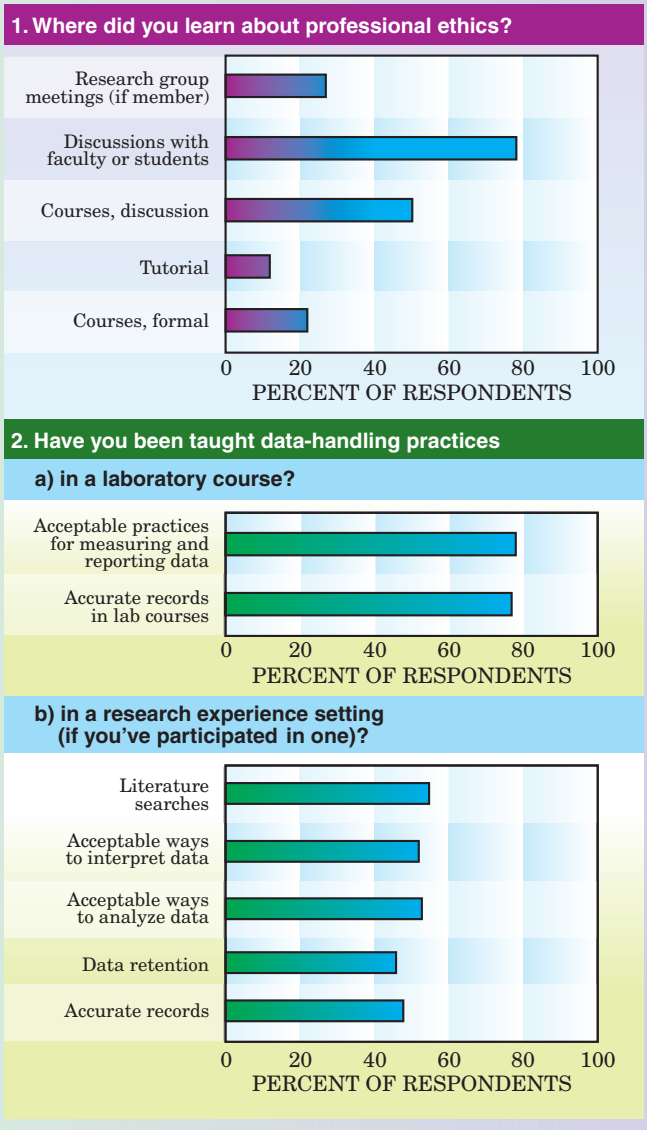

Figure 2. Undergraduates surveyed by the APS task force on ethics answered questions about where they were learning acceptable professional practices.

Figure 3. Where did junior members of the American Physical Society learn acceptable professional practices? In the APS ethics survey of junior members, question 2 was specified to include all settings in which data handling might be taught, including research groups as well as laboratory courses.

their departments had established such policies. Only 20% of the responding chairs reported that the much-publicized data fabrication cases of 2002 have led to a new emphasis on ethics in their departments.

It appears that norms of professional conduct assumed to be familiar and practiced by all are, in fact, not universally understood. Our operating definition of "professional ethics" is outlined in box 3. The surveys of undergraduates, junior APS members, and department chairs sought to examine how professional standards are taught and learned. The survey responses paint a consistent picture. As illustrated in figures 2–4, all three groups report that scientific ethics education is largely informal; much of it occurs in discussion among colleagues. Proper data handling and record keeping are mostly, but not universally, taught in laboratory classes. Not all research groups make a serious effort to teach students how to record data properly and keep a research record.

It is safe to conclude that a significant fraction of physics students earn their doctorates without any formal instruction in basic norms of data collection and recording. Some students can pick up what they need to know by watching their coworkers. But that cannot be taken for granted. Recent pedagogical research has shown that some highly intelligent and capable students need direct instruction.[2] In our increasingly computer-based age, the concept of a research record is not well-defined. As one junior APS member noted, "Too much emphasis is placed on the physical 'laboratory notebook' rather than the concept of recording your work. [When the computer is used exclusively, students] tend to disregard not just the reality of a laboratory notebook but the concept of a timeline of when and where the data came from."

Based on its findings, the task force made several recommendations for actions by APS and the physics community:

- ▶ Update the ethics statements to include treatment of subordinates
- ▶ Sponsor and promote development of ethics education programs
- ▶ Work with other professional bodies to develop a set of recommended standards for research records in the electronic age
- ▶ Work with sister societies to develop an internationally accepted code of ethics
- ▶ Consider whether to appoint a standing committee on ethics that would be responsible for ongoing projects.

Many of these recommendations are actively being addressed. The APS council has already approved statements on ethical treatment of subordinates and on the importance of proper referencing. The possible activities of an ethics committee are under discussion. Martin Blume, editor-in-chief of *Physical Review*, has initiated an international effort to formulate common standards for

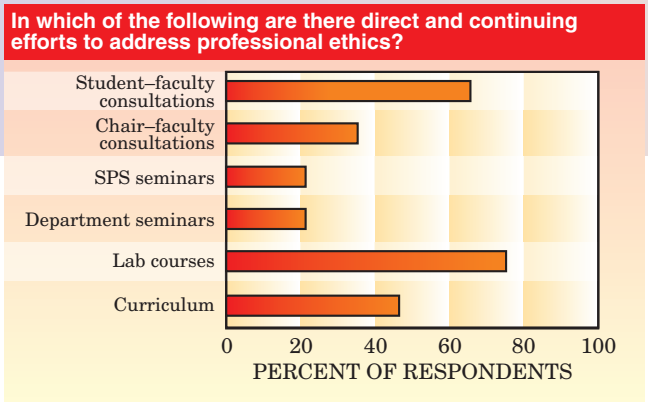

Figure 4. Responses of physics department chairs to the survey question as to how their departments are addressing the teaching of professional ethics.

ethical publication practices and develop interjournal processes for dealing with allegations of plagiarism and other misconduct. It has been proposed that the National Research Council conduct a study of best practices and standards for recording and archiving electronic data and research records.

"The silence that exists now"

A much larger issue is the task force's recommendation with regard to ethics education. When asked what APS could do to help in ethics training and education, the junior members gave many interesting responses. Several said that *anything* APS did to bring ethics issues before the community for discussion would be welcome—certainly better than "the silence that exists now" among physics faculties. "APS publications," wrote one respondent, "should have more stories on ethics issues to keep the much needed discussions going." Another suggested that it would be useful to have "published standards from APS sent to all members in the form of a booklet." Others suggested that ethics workshops be held at APS meetings and that APS maintain a website listing resource materials on scientific ethics.

"The silence that exists now" aptly describes the state of formal ethics education today. Not everyone agrees, however, that teaching ethics in a classroom would be effective. "I seriously question whether or not ethics 'training' can help some people who cannot understand how their actions can hurt others, or are simply unfair," wrote one skeptic. Another argued that "the importance of ethical behavior is likely learned (or not) far earlier than professional training as a physicist."

Many respondents said that proper mentorship by supervisors was absolutely key to establishing patterns of ethical behavior. Quite a few suggested mandatory ethics seminars and discussions for first- and second-year graduate students. Others felt that senior professors should be the first to undergo such training; then they could lead by example. Several respondents pointed out that misunderstandings can arise because students come to graduate school from many different countries, with different cultural norms. For example, some may not realize that plagiarism is wrong. Ethics training would ensure that all understand the expected standards.

Open issues

Two areas of clear concern to junior members deserve focus and debate by the entire physics community. One is the matter of coauthorship. Although APS statements are very clear that authorship of a paper must be earned and that it carries important responsibilities, the statements are appropriately nonspecific. Norms vary widely as to who should be included on an author list and how involved every author is with the published paper. Large collaborations, for example, have rules for inclusion of authors and ordering of names on author lists, internal procedures for manuscript approval, specific responsibilities of authors, and processes for resolving objections from individual authors. Despite such careful procedures, several junior members noted that, in practice, the pressure to publish quickly may lead to less than thorough review of results and manuscripts. Small collaborations involving just a few principal investigators have less formal practices. Yet they too face important challenges in management of the research record and publication process, often across several institutions and disciplines.

Beyond the procedural issues, physicists must discuss other knotty authorship questions: Should the person who secures funding automatically be listed as a coauthor? What contributions should only be acknowledged? Must every coauthor in an interdisciplinary collaboration understand and vouch for every detail of the paper? Are all coauthors responsible when one of them has violated professional ethics in the published work?

The second area of concern is the emergence, over the past 15 years, of a "research system [that] stimulates continuously the competition in fashionable subjects in search of spectacular results," as one survey respondent wrote. Many junior members echoed one respondent's suggestion that "there is enormous pressure to do quality work in a short period of time" that is difficult or impossible to live up to. Some physicists may not be equipped to handle the pressure if they feel that their careers are at stake. Such pressure is, of course, not unique to the sciences. Stories of illegal dealings on Wall Street, journalistic fraud, and cheating in high schools to gain advantage for admission to prestigious colleges remind us that it has emerged in many parts of our society.

Young physicists, the lifeblood of our field, are calling for more attention to ethics questions. They are pointing out behaviors and practices that seriously compromise work in physics. Their concerns may, in fact, be shared by many senior physicists, but that was not obvious from the survey responses. Because some of the issues raised by the junior members have no easy answers, it's important to keep the community's attention focused on ethics. It is time for us, as scientists and as human beings, to examine what's happening in our profession, and to ask what the consequences will be if we ignore those concerns.

On behalf of APS Task Force on Ethics, we thank Judy Franz, Roman Czujko, Martin Blume, and Ken Cole for their support and contributions to our work. We also thank the many members of APS who took the time to respond to the surveys.

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