have come to involve dozens of physicists from several universities and laboratories. Nuclear-physics research increasingly centers on a small number of large facilities such as the Los Alamos Meson Physics Facility. In the future, the Continuous Electron Beam Accelerator Facility at Norfolk and perhaps the Relativistic Heavy Ion Collider at Brookhaven will increase this trend toward centralization. Even in condensed-matter physics, more and more research is being done at large national facilities such as the synchrotron light sources and pulsed neutron sources. Astronomers and astrophysicists use large national facilities, such as those at Kitt Peak and Cerro Tololo, and space-based observations along with smaller local facilities.

Students interested in such research typically take courses for about two years on campus upon entering graduate school. They may work part time and summers for research groups, generally on a component of experimental equipment. Once accepted as a thesis student in a research group, the student spends most of his time at the facility where his experiment will run. In high-energy physics, for example, the student typically goes to a national laboratory such as Brookhaven, Fermilab or SLAC, where the experiment is assembled, debugged and operated, and where often the data are later reduced. An experimental "run" may go around the clock for several months. The student may then return to his home campus to complete the data analysis and to write his PhD thesis. A single major experiment usually provides theses for several students, and usually results in a long string of publications and conference papers for which the student is listed as one of a large number of coauthors.

There are both positive and negative aspects to this form of education. On the negative side are the relative anonymity and loss of independence associated with being a member of a large group. The student's professor may be at the lab infrequently (due to teaching and other obligations), so that the students and postdoctoral fellows are on their own much of the time. The schedule of operation of an accelerator is often capricious and unpredictable; the machine may break down and repairs can take hours or months. Research timetables often (indeed usually) slip, and unpredicted events totally outside the student's control may even force a change of thesis topic. And of course there is the disruption of the student's personal life as he moves between the campus and the laboratory.

But there are certainly compensatory positive factors. The national laboratories provide an educational environment totally different from that of

Consider graduate-student life

Beyond the general feeling that "students should live only as well as I did when I was in school," the physics community apparently gives little consideration to graduate-student life. As chairman of the physics-graduate-student organization at Cornell University, I recently completed a survey of the living expenses of physics graduate students at Cornell. This survey was the latest in a series conducted annually to monitor how well salaries for teaching and research assistants keep up with the cost of living. While preparing my report I found that there seems to be no way of determining whether such support is adequate other than comparing the value of the support from year to year. Through discussions with administrators, faculty and other graduate students it became apparent that departments give little thought to what kind of life graduate students lead.

The lack of concern for graduate-student life is manifested in many ways. For instance, though many articles have appeared in PHYSICS TODAY pertaining to graduate enrollment statistics and job prospects, there has not been a feature article discussing graduate-student life since March 1969! More directly, this lack of consideration is reflected by the treatment of graduate-student support here at Cornell. In determining assistantship salaries, the council of deans always starts with the current salary, and budget constraints are the primary consideration in determining how to modify this figure. Little consideration is given to the actual level of support or to how any changes will affect graduate life. I must emphasize that my intention here is not to complain about current stipends, but rather to point out that no one is answering the questions: What do we give to our physics graduate students, and what do we expect in return? What sacrifices are they expected to make?

Financially, the physics graduate students at Cornell are doing reasonably well, but an unmarried graduate student supported solely by a teaching or research assistantship lives frugally—after basic living expenses there is little money left over for repairs or extraordinary expenses. Students are particularly concerned that they lack the resources to cope with medical emergencies not fully covered by the nominal student health insurance. Most students agree that graduate school is not the place to start a family, especially considering the fiscal constraints imposed by current stipends. As it typically requires five or six years to complete a PhD, most students will be 26–30 years old before having the resources (not to mention the time) to start a family. The sacrifice is greatest for women, who will have spent their safest childbearing years in graduate school only to then have to choose between starting a family and embarking on a career. Though this is true in many other professions requiring advanced degrees, it should be of particular concern in physics, where women are severely underrepresented.

What are the implications of these conditions? For instance, to what extent are qualified undergraduates discouraged from continuing with graduate work in physics? And for those who do continue, do the prospects of financial success influence the choice of research field? At institutions where support for every student is not readily available, graduate students will be lured to fields that are currently well funded. Similarly, job prospects vary widely by subfield, creating an incentive for students to pursue the "hot" new areas of research. This situation creates the danger that we will end up with a plethora of experts in currently active research areas, though these will not necessarily be of primary importance in years to come. One might also consider how the variation in completion time from field to field influences students' research choices. It may be that students under financial pressure will choose projects that will enable them to finish quickly rather than undertaking the projects for which they have the most enthusiasm. Lastly, one might consider whether the conditions of graduate life are conducive to the most productive graduate work. One hopes that students do not become so discouraged that their work is affected. Though I suspect graduate students will endure, I wonder what effect years of such sacrifice have on the attitudes of our future academic, industrial and government laboratory leaders.

I would like to stress again that this discussion is not a plea for higher graduate-student stipends, but an attempt to bring to light an important issue that I feel is rarely discussed: the life physics students are expected to endure. Though dedication in the pursuit of knowledge should be expected, one would hope that graduate school affords an opportunity for personal as well as intellectual growth. This can occur only within a community that is concerned with—and aware of—the needs of those just entering it. Given the continuing concern about the physics profession's ability to attract and keep the best and the brightest, more thought and discussion should be given to these issues. I hope that this comment will generate such a response.

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