DOCUMENT RESUME

ED 059 889 SE 013 313

AUTHOR Silvert, William
TITLE Accreditation of Physics Graduate Programs.
INSTITUTION Kansas Univ., Lawrence.
PUB DATE 72
NOTE 20p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Accreditation (Institutions); *Admission Criteria; Career Opportunities; College Science; *Doctoral Programs; Educational Demand; *Graduate Study; *Physics

ABSTRACT

The author of this paper assumes that more persons will desire to enter the field of physics than will be able to find employment in this field. The question is how and at what stage in their careers should some of these prospective physicists be "deflected" from their chosen field. A case is made for this decision being made at the entrance to graduate school. The problems and difficulties with reducing graduate admissions are discussed. In order to reduce admissions, an accreditation board is suggested to be established under the supervision of the American Institute of Physicists. Among the criteria suggested for this accreditation would be faculty/student ratio, competence of the faculty, and research productivity. Certain programs are listed which might receive special consideration with regard to innovations and specific student groups. Several alternative methods of using the faculty/student ratio are discussed. Specific oppositions to program accreditation are cited and defenses described. (Author/TS)

ACCREDITATION OF PHYSICS GRADUATE PROGRAMS

William Silvert
Physics Department
University of Kansas
Lawrence, Kansas 66044

This is a position paper requested by the Economic Concerns Committee of the American Physical Society in support of the author's proposal that graduate programs in physics be restricted in size and number by some mechanism such as accreditation.

INTRODUCTION

This paper is based on the assumption that there is at least a fair possibility that people will continue to desire to enter the field of physics at a greater rate than they can be absorbed. So long as this situation continues, some of these people will obviously have to be refused admission to the field at some stage in their careers. The goal of this proposal is that this decision (whether or not a given person becomes a physicist) be made at a stage in the person's development that is least disruptive to his own career, to physics, and to society as a whole.

The above assumption is based in large part on the Grodzins Report (ECC Special Report, Bull. Am. Phys. Soc. 16, 736, 1971) and Cartter's recent projections (Science 172, 132, 1971), but since this paper is directed to the ECC, it would perhaps be fatuous for me to devote much space to defending an assumption based in large part on ECC data.

CAREER DECISIONS

If there appear to be more prospective physicists (PP's) than jobs, we should study how and at what stage in their careers some of the PP's are deflected from their chosen field.

There appears to be no reason to discourage PP's from undergraduate majors in physics. A recent study by R. S. Lee (paper D3 at AAPT Summer Meeting, 18 June 1971) indicates that physics majors are admissable to a wide range of graduate programs in other fields, and therefore retain a wide choice of careers.

The earliest time at which the PP should make a definite career choice regarding physics is consequently at the time of application to graduate school. The latest time is when he finds himself out of a job. The most likely decision points are these:

When entering graduate school
During graduate school
Upon completion of the Ph.D.
After working for several years

Let us consider these in reverse order.

The man who is forced out of physics after several years in his chosen profession is in an especially unfortunate situation. His prospects are bleak (as documented in the Grodzins Report), and, since he is probably an established family man, he may lack both the mobility and the economic flexibility required by an extensive retraining program. He also suffers all of the traditional disadvantages of an older person in the job market.

"The new Ph.D. has many advantages over the experienced Ph.D. in the job market." (Grodzins Report again.) He may not find the job he wants, but he is more likely to find some job than the older man. But is this really good? Do we really want to maintain a flood of fresh Ph.D.'s in the field, inexperienced but willing to work for low wages until things get better? If we do, we will virtually guarantee that older Ph.D.'s will be swept out and replaced on a regular basis. A pattern is already emerging of schools consistently firing untenured professors at the end of their probationary period and replacing them with a fresh crop of novices. The fresh Ph.D. may find himself faced with a career expectancy in physics of perhaps half-a-dozen years.

We cannot expect new Ph.D.'s to leave physics voluntarily, but their excess availablility creates a crisis for themselves, for physics, and for society. For themselves, because of their limited career expectancy; for physics, because they displace more experienced physicists from jobs; for society, becuase of the waste of a great intellectual resource, and because of the extravagance of supporting a field in which the average practitioner spends more time being educated than working. It would be better if career decisions were made at an earlier stage.

Most departments have mechanisms for removing or otherwise pressuring students at a stage roughly two years after admission to graduate school. Poorer students are often weeded out by examination, and are awarded a face-saving master's degree. Remaining students can be pressured to go into various research areas. While recommendations

5, 6, 7 and 8 of the Grodzins Report would help greatly if followed at this stage, there exist serious obstacles to their implementation. First, if standards are raised at this intermediate stage, they should also be raised at the admission stage. High attrition is not fair to the students, and the master's degree in physics is not a very valuable degree. On the other, master's candidates fill classrooms as well as Ph.D. candidates, and this is important to departments which are struggling to keep their graduate programs alive. Flooding the market with more master's and fewer Ph.D.'s might represent some improvement over the present situation, but not much. Second, graduate research areas for continuing students are determined by department politics and funding, not by the needs of the students. Funds to support RA's are generally controlled by research groups, not by departments, and if the accelerator has money, the accelerator gets students. It seems impossible to implement recommendation 7 at the departmental level.

A serious obstacle to any attempt to deflect PP's during their graduate education is the role that graduate students play in faculty research. Any effort to discourage students from working with Professor X may be construed as a direct attack on the research productivity, and hence the career, of Professor X. Inevitably, in the stresses of departmental infighting, the interests of the graduate students come last.

By the time the PP has entered graduate school, he is committed to a gamble that only a few top students can win. The axe may fall at many different times; after two years he may flunk prelims, after five or six years he may be an umeployed Ph.D. another six years later he may be displaced by a younger man. Unless he is one of the very few who make it through to a permanent career, he will probably end up considerably worse off than if he had looked for a more promising vocation directly upon graduation from college. That is the time at which the decision should be made; but a decision at that time requires that the student who does enter graduate school in physics have a reasonable chance of establishing a career in the field. This is only true if the number of students entering graduate school, allowing for <u>normal</u> attrition, does not produce an excess of postgraduates entering the job market.

Despite the frequent contention that working for the Ph.D. is fun

and enriches the mind, few unemployed Ph.D.'s accept their plight with equanimity. It would be far better if more PP's were discouraged from entering graduate school in physics in the first place. Therefore, my proposal is directed at reducing the number of beginning graduate students in physics.

GRADUATE SUPPORT AND STUDENT DISAFFECTION

There are two principle mechanisms affecting the entrance of new students into graduate school; money and student interest. Federal funding cutbacks have charply reduced the amount of RA support that physics departments can offer their graduate students, and this will certainly have some effect on the size of graduate programs. The effect, however, is not as great as might at first be expected. According to Lee Grodzins (private communication), the number of self-supported graduate students is up markedly. Since, however, incoming students are rarely supported by RA's, the cutback in funding has mostly affected students who are well along on their doctoral research and have too much already invested to drop out. Of course many universities award TA's to these students, but using the support to attract new students usually has top priority. In fact, since the loss of research support, and hence overhead, often leads to long hard administrative looks at the size of physics department staff, a precipitous drop in graduate enrollments could be disastrous from the departmental point of view. Therefore the drop in research funds is not likely to have a major effect on graduate school recruitment.

Incidentally, experience with graduate admissions suggests that the "gentleman physicist" who gets a Ph.D. for the fun of it and has no regrets about his subsequent unemployment is fictitious. Very few unsupported students enter graduate school, and the amount of support offered is often an important factor in students' decisions.

There is of course the question of whether enough students will continue to apply to graduate school. Applications have fallen precipitously at many institutions, but the tendency is still to attract as many students as can be lured with the available support. This obviously leads to pressures for a reduction in standards, and it also drives many departments to spread their reqcruitment net very wide. The extent to which departments will go is illustrated by the widespread

practice of wholesale recruitment of foreign graduate students, the success of which is often based on their hope to remain in this country permanently. Since foreigners are usually at a severe disadvantage in the U.S. job market, and since the countries from which most of the warm bodies come (mainly India and other oriental nations) have their own Ph.D. surplusses, this way of filling graduate programs is cruelly exploitative.

There is another problem associated with the decline in graduate school applications. This may in large part be due to the growing anti-rationalism of today's youth, but it also reflects their awareness of the poor job prospects in the field. Except for a few hot shots who expect to succeed in whatever they do, career anxiety is as likely to scare away good students as mediocre ones. In fact, since the decision to switch fields upon graduation from college requires some measure of initiative and adventurousness, we may lose some very desirable physics majors that way. This effect, plus the necessity of admitting a larger fraction of applicants, lowers the quality of our graduate students at a time when the declining job market suggests we should be doing just the opposite.

I believe that if we were to raise our admission standards and restrict admission numbers to the point where most entering graduate students had a reasonable prospect of continuing to a Ph.D. and a career in physics, the caliber of our applicants would rise. By turning out better qualified Ph.D.'s, we might also increase the hiring of physicists for work in areas where they have to compete with engineers and other types of scientists.

DEPARTMENTAL AND FACULTY SELF-INTEREST

It is not in the best interests of physics departments and their staffs to reduce graduate admissions. There are several important reasons for this:

All academic departments strive for a high "head count", since the number of faculty positions is usually tied by formula to teaching load. Graduate students are generally weighted heavily in the computation, and thus a reduction in graduate student enrollments may result in a loss of faculty positions.

Most schools will not offer courses unless there is some specified

minimum enrollment. Since only a fraction of all the graduate students in a department will be enrolled in any given course at a given time, there is a critical size which a department must maintain before it faces a drastic reduction in its graduate course offerings. If a department falls below critical size, its graduate program may deteriorate rapidly, or be lost altogether.

Graduate students may carry a major share of the teaching load, and they certainly carry the most unpopular share. This is especially true in the departments with many service courses, where graduate assistants handle the unpopular laboratory and recitation sections.

Professors like teaching graduate students. Graduate courses are usually considered highly desirable, and any cutback in the number of course offerings would deprive the faculty of their most enjoyable teaching.

Perhaps most important, graduate students contribute heavily to their advisors' research productivity. The loss of graduate research assistants therefore strikes not only at professorial prestige, but also, because of the emphasis on research by most university committees on promotion and tenure, damages the faculty's career prospects. The importance of research in the faculty scheme of things is emphasized by some remarkable data in a recent paper by H. William Koch (Physics Today, June 1971, p. 23) which indicate that while over half of all Ph. D. physicists work for colleges and universities, less than one-third of these academic physicists view teaching as their primary work activity. Certainly post-doctoral research associates and research professors constitute only a small fraction of this amazing majority of physics faculty who think teaching comes second. (It is a pity that Koch does not quote any comparative survey of college administrators!) With such priorities, I almost wonder if many professors would even consider it ethical to let concern for their students' careers conflict with research activity.

The above factors are likely to be reinforced by university-wide interest in the prestige value of a substantial graduate program and extensive faculty research. If a university can afford to support a graduate program, it will; everybody gets something out of it, except perhaps the students.

SUMMARY OF THE PROBLEM

So long as more people want to enter physics than can be absorbed by the profession, we will be turning people away at some point in their careers. I have tried to show that the major deflection of PP's from physics ought to come at the beginning of their graduate careers. Encouraging an excess of PP's to proceed to the Ph.D. level not only creates problems for them, it is also detrimental to both physics and society; to physics because we discourage bright students from entering the field and create a viciously competitive, inexperienced, and unstable physics population, and to society because of the enormous intellectual and economic waste involved in educating a surplus of Ph.D. physicists.

I have also tried to show that neither tight money nor bad prospects are satisfactory mechanisms for controlling physics enrollments So long as departments place a high priority on recruiting new students and direct available funds to that end, the budget squeeze will be a small factor. Similarly, so long as departments worry more about numbers than standards, the decline in graduate applications will have no effect (unless of course the number of applicants falls below the number of slots available).

The blame for department recruiting policies lies in the entire reward structure of the university. Most academic physicists would like to raise admissions standards, and they would like to have more success in placing their graduates. They would like to see the job crisis solved. But if the solution requires a drop in graduate enrollments that might lead to a reduction of the departmental budget and possibly staff, to elimination of desired graduate courses and maybe even of the graduate program itself, to the loss of graduate research assistance and consequently of publications, prestige, promotions and raises, then few departments will voluntarily implement it.

We are caught in a bind between an erratic government, responding to a hostile body politic; an extraordinary university structure that has yet to find a mechanism for treating its students as well and as humanely as it serves its faculty; and the students themselves, aspiring physicists who would like to aim at their chosen profession without having to gamble away a decade of their lives in the process. The only agency that has yet to enter the arena is the physics community itself. It is organized, through the AIP and its member organizations, and I

believe that it has the potential to get us out of this bind.

GOALS

I believe that we should devise a mechanism for reducing the number of students entering graduate school in physics. This mechanism should be responsive to the projected need for physicists, so that the employment prospects of the new Ph.D. who has survived the normal graduate school attrition processes will be reasonably good.

Any such control mechanism, since it unfortunately runs counter to university pressures for maximal enrollments, cannot be effective unless it can be enforced. The reduction of graduate enrollments in physics must be made a well-known nationwide policy, and it is essential that university administrators and others be informed that the cutbacks are part of a general change, and do not reflect adversely on individual departments.

Since graduate school admission would become the gateway to the profession, admission requirements should reflect social factors affecting the employment of physicists. There must be sufficient flexibility to allow cultural, geographical, and other considerations to be taken into account in setting admission standards.

ACCREDITATION

The above goals can be met by a modified form of the accreditation procedure used by several professional groups to evaluate programs in their areas. There are several innovations in my proposal, and it has been suggested that "accreditation" is an inappropriate word.

The most important feature of this proposal is that a maximum student/faculty ratio be required of all graduate programs independently of how well they meet the other accreditation standards.

The accreditation mechanism would function in the following way. An accreditation board would be established under the AIP, possibly as a joint board of the APS and AAPT. The board would be charged with evaluating graduate programs in physics and accrediting those programs which met certain criteria. While the board could not force departments to comply with these criteria, the withholding of accreditation by a prestigious professional organization is usually an effective sanction.

This basic proposal could be implemented in many different ways.

In the balance of this paper I shall discuss some particular approaches that I think might be most appropriate for the needs of the physics community. Some of these may turn out to be ill-advised, but few of these individual details are crucial to the proposal as a whole. Certainly the most satisfactory accreditation plan can only be worked out through careful consultation with all concerned parties, and a spirit of tolerance and compromise must be present if the plan is to work. I hope that the following recommendations regarding implementation will be viewed only as one man's suggestions, and that the entire proposal will not stand or fall on the basis of recommendations that have not yet been adequately debated.

WHAT PROGRAMS SHOULD BE ACCREDITED?

There are several graduate programs offered by physics departments. Should they all be evaluated?

In addition to the Ph.D. programs, which are after all what we are talking about, there are the standard MA and MS programs. Because these usually feed and overlap the Ph.D. programs, it seems unreasonable to separate them. I have perhaps unfairly slighted the master's as a terminal degree, but it is so often just a way station (or getting off point) on the route to the doctorate, that I think that students enrolling in master's programs should be viewed as actually working toward the Ph.D. The problem of distinguishing the two does not arise at many institutions, but some schools do offer specialized terminal master's degrees to train technicians. The biggest problem regarding the master's degree is whether departments that offer the master's but not the Ph.D. should be accredited, especially if many of their graduates transfer to other institutions to complete the doctorate.

The MAT, being a terminal degree for those who wish to be certified secondary school teachers, probably need not be evaluated by the accreditation board. MAT students should not count in the student/faculty ratio.

The DA, on the other hand, being preparation for college teaching, feeds into the Ph.D. job market and should be evaluated, although the differences between these two doctoral programs will undoubtedly lead to problems.

The basic issue, of course, is to define a physicist. Operation-

ally he may be defined as a member of a certain labor pool, although there are no sharp lines that can be clearly drawn. I feel, for example, that the Ph.D. physicist is not in the same job market as the MAT, even though a few Ph.D.'s have entered secondary school teaching. Perhaps a more careful examination of the manpower data will clarify this matter.

CRITERIA OTHER THAN THE FACULTY/STUDENT RATIO

The most difficult part of any accreditation program is to establish fair and meaningful criteria for evaluation. This is especially hard in evaluating graduate programs, where standard curricular considerations may be outweighed by close faculty-student contact. It is not even immediately clear that evaluation of graduate programs is essential, if our principle goal is to control Ph.D. production through graduate school admissions. Lee Grodzins recently pointed out (private communication) that the 20 top schools in the 1964 Cartter Report turned out almost half of the 1966-67 Ph.D.'s in physics, even though there were 158 doctorate-granting institutions in the country at that time. The mathematicians, faced with a similar job crisis, feel that "...reduction [of Ph.D. supply] must occur in the size of the long-established big departments that nobody considers for elimination." (AMS Notices, March 1971, p. 490) Never-the-less, I believe that there are grounds for looking at the smaller programs too.

One reason that the least prestigious schools have small graduate enrollments is that they simply cannot find enough students. If graduate enrollments at the major institutions are restricted, more phycics majors will apply to these schools, and both their enrollments and their Ph.D. productivity will go up. If we end up producing the same number of Ph.D.'s, but more of them go to the poorest schools,we will truly have leaped from the frying pan into the fire. It is therefore highly desirable that all schools granting the Ph.D. degree in physics meet meaningful standards.

A similar problem is the proliferation of new graduate programs, which further expand our Ph.D. production capacity at a time when production should be dropping. Comparison of recent editions of the AIP Directory of Physics and Astronomy Faculties indicates that between the years 1969-70 and 1970-71 there were six new doctoral programs in physics started, and 16 new master's programs. (W. Silvert, "Changes in

Graduate Physics Programs," to be published) Some of these new programs may prove unimportant but others are seriously involved in graduate education and have the staff and resources to turn out appreciable numbers of Ph.D.'s. Not all proliferation is bad, but if we encourage the creation of marginal new programs by turning students away from the prestige schools without attempting to control quality, we may again create a worse situation than we started with.

Accreditation might also have some unrelated but beneficial side effects. Many physics majors are not well advised, and their choices of graduate schools are often haphazard. Few students can evaluate a graduate program without guidance. Accreditation would help provide that guidance; it would also be of use to many employers of physicists who, not themselves being in the field, have difficulty evaluating applicants' credentials.

Let us turn now to the search for valid criteria, excluding for the moment the matter of student/faculty ratio. Most accreditation programs stress heavily the curriculum and resources of the department. The wide diversity of graduate curricula, and the major role of informal faculty-student contact, plus the fact that many excellent departments offer study only in certain areas, makes a general standard for graduate curricula almost impossible to define. Additionally, a major criticism of accreditation is that it tends to stifle innovation. This could be in large part avoided if we did not attempt to judge curricular matters. Resources can be evaluated in relation to the goals of the department. Laboratory space and equipment constitute an obvious resource, but may be unimportant in a theoretically inclined department. Similarly, many physicists do not use computors. The best test of resources is whether they are adequate for the actual needs of the specific department.

I would in fact suggest that the best criterion for judging a graduate program is not whether the department conforms to preconceived ideas about courses, laboratories, computers, and libraries, but whether the faculty has the basic capability to do a good job, as evidenced by its demonstrated competence and the work being done by graduate students.

Evaluation of faculty competence involves subjective factors, but it is virtually impossible to eliminate these from any evaluation program that does not rely on the sort of rigidly set standards that are likely to destroy innovation and creativity. Research productivity and

citations provide at least some measure of a man's contributions to his field. The sorts of judgements that would have to be made are similar to those routinely made by appointment, promotion, and tenure committees, except that the evaluations would be averaged over the entire staff. Of course established accreditation groups have been dealing with this problem for years, and they may have some valuable suggestions.

The basic philosophy I am proposing here is that we give the department the benefit of the doubt regarding its teaching program; if it is capable of offering a decent program, assume that it does. This unfortunately reinforces the common policy that research competence is the only criterion for faculty evaluation, but it would be very difficult for a new accreditation board to be more progressive than the universities themselves in evaluating the other components of teaching effectiveness. This is not as serious a problem as it would be in accreditation of undergraduate programs.

There are of course a number of factors related to student evaluation that ought to be considered. Admission requirements should obviously receive very close attention. Standards should be high, but the accreditation board should be prepared to make allowance for programs for disadvantaged and other groups meriting special treatment. The ultimate criteria for granting of graduate degrees ought to be examined from both the viewpoints of research competence in the student's specialization and of his general educational background.

Some other factors that should perhaps be considered are tuition and support, teaching requirements, residency requirements, and so forth.

SPECIAL PROGRAMS

There are a number of factors that should be taken into account by the accreditation board that go well beyond strictly professional considerations. A few examples, which are of course not exhaustive, come to mind:

New programs may be very difficult to evaluate. While new programs ought not be encouraged, they should not be banned either, and some form of provisional accreditation should exist to help departments develop when the need exists.

Admission requirements for disadvantaged students should be fairly flexible. Specifically, since the employment possibilities for black

and other minority group physicists are likely to remain fairly good, stricter admissions standards should not be used to reduce their graduate enrollments.

Programs for special student groups should be considered in accreditation evaluations. These would include programs that offer evening or off-campus coursework.

Geographical distribution is important, both to enable students to study near their home communities and to meet regional needs. In particular, programs that play special roles in their communities should be encouraged.

Innovative programs of benefit to physics and society should be encouraged. Accreditation should not have the effect of discouraging departments from moving into fields such as environmental or health physics. Nor should it inhibit the development of interdepartmental programs.

Certainly it is a truism to say that any physics program should strive to serve the students, physics, and society. This should be foremost in our minds.

STUDENT/FACULTY RATIO

The bulk of Ph.D. production in physics occurs at a small number of prestigious institutions which unquestionably would conform to any reasonable set of accreditation criteria. An informal survey of these institutions, based mainly on data from the 1968 AIP publication "Graduate Programs in Physics and Astronomy" and on information from the Cooperative College Registry,indicates that most top schools produce more Ph.D.'s per year than they have faculty members, or at least were doing so in the 1960's. These figures do not allow for the fact that many departments were growing in size at that time; new faculty members usually do not turn out Ph.D.'s for several years. Clearly any policy that does not affect graduate enrollments at these institutions will not have a significant impact on Ph.D. production. (As was mentioned previously, the 20 top-ranked institutions in the Cartter Report turn out roughly half of all Ph.D.'s in physics.)

There is of course some decline in enrollments at these as well as other institutions due to the reduced level of funding. On the other hand, the drop in graduate applications is not as serious for the top

institutions as for less prestigious ones, for they will undoubtedly continue to attract enough top students to fill all their available places. This leads to an unfortunate chain effect, since if the top schools take almost as many top students as they have in the past, but the total number of applications to all graduate schools in physics is down appreciably, then the average quality of the remaining candidates must go down. If all the graduate programs that do meet the accreditation standards are to have a reasonable chance to survive, they must have a reasonable chance to attract good students. This will not happen so long as an increasingly disproportionate fraction of the top students enroll in a handful of prestige institutions.

It is therefore necessary to incorporate in any plan of action some mechanism to restrict the size of student enrollments in individual graduate programs. The most straightforward way of doing this is by adoption of some formula that would relate the size of graduate programs to the number of graduate faculty.

There are several possible formulae that might be considered, depending on how one defines the "size" of a graduate program. Three possible definitions are; number of Ph.D.'s produced per year, size of entering class, and total number of students.

Since the goal of this proposal is to control Ph.D. production, it is tempting to restrict the number of Ph.D.'s produced per year. Unfortunately, however, this number is subject to fluctuations, and cannot be considered a reliable measure of the size of a Ph.D. program unless it is averaged over several years. Furthermore, it would not necessarily reduce first-year enrollments appreciably, since schools could still recruit large numbers of students to fill their classrooms, and then force a high attrition rate by stiff examinations and other hurdles. In fact, such a standard would discriminate against schools with low drop-out rates, when it seems we should do the opposite. (At most of the top schools, two Ph.D.'s are graduated for every three new students admitted, an attrition rate of 33%; many good, but less prestigious, institutions have attrition rates over twice as high.)

It would be far more in keeping with some of my earlier arguments that admission to graduate school should offer a fair chance of entering the physics profession, if the number of entering students were required not to exceed some fixed ratio to the number of faculty. This

would be an easy standard to implement, since the number of incoming students is easy for a department to regulate. This system would slightly favor the better schools, since the they usually have low attrition rates; this seems fair enough, and also a raising of admissions standards across the board would mean fewer drop-outs from those schools that now take marginal students. The present highly competitive situation is certainly very hard on many good schools which do not have the reputation to attract top students; this is especially true of emerging institutions. On the other side of the coin, there might be reluctance to maintain standards at the intermediate graduate level, since positions opened up by students flunking out at, say, the prelim level, could not be filled. There might also be less willingness to gamble on marginal students, especially those from disadvantaged backgrounds, and this would be unfortunate.

The third alternative is to require each department to maintain a student/faculty ratio below some fixed value. This might be difficult for departments near the maximum ratio to adhere to, since the number of returning students may fluctuate, and estimates of when individual students will complete their dissertations are notoriously unreliable. Fluctuations above the specified ratio would have to be dealt with fairly, but departments should be expected to inform the accreditation board of how their projections were made. Such a program would permit departments greater flexibility in setting intermediate standards and adjusting the size of the incoming class to suit their individual attrition patterns. There would be an additional incentive to shorten the time to the Ph.D., a reform held desirable by many, whereas the preceding method (admissions/faculty) might actually tend to lengthen this time (since by doing so the number of students doing research could be increased without upping admissions).

Either a student/faculty or admissions/faculty ratio would be an effective measure to control Ph.D. production, and, while I favor the total student/faculty ratio for the above-mentioned reasons, either would be acceptable. Or, a more complicated formula involving all of the above factors might be used. It is essential though to have some way of controlling Ph.D. production at the handful of prestigious institutions which dominate physics graduate education in this country.

THE ARDEN HOUSE PROPOSAL - HOW IT FITS IN

The idea that new Ph.D.'s who cannot find jobs should be kept in a post-doctoral holding pattern has received popular support but little implementation. A principle difficulty seems to be that if assistantship money is diverted from graduate students to post-doc's, the consequent loss of graduate enrollments may be reflected in the budget. Adoption of the above accreditation proposal would free assistantship funds at those institutions that now take in inordinate numbers of students, and it is far more likely that these institutions would be able to implement the Arden House plan without administrative prejudice if the reduction in enrollments were part of a nationwide policy.

This would furthermore greatly enhance the opportunities for Ph.D.'s from second-rank institutions to go on to post-doctoral positions at the prestige schools, so that despite their reduced graduate enrollments, the educational contribution of the top physics departments might actually be enhanced.

COST

A major consideration is the probable cost of the proposed accreditation program. The cost of accreditation in chemistry or engineering is $1000 to $1500 per department, as quoted in the CUPM Report (Committee on the Undergraduate Program in Mathematics Report on Accreditation and Certification, Jan. 1970, p. 17). Obviously a sum on the order of magnitude of $200,000 is not presently available to the physics community, and a cost this great would be prohibitive. It does appear, however, that considerable room for economy exists, and that an economical approach to accreditation might be quite feasible.

The reports required by both the Engineer's Council for Professional Development and the Committee on Professional Training of the American Chemical Society are huge; a recent evaluation of the engineering program at the University of Kansas consists of three volumes and is about two inches thick (about the size of a CRC Handbook of Chemistry and Physics). The amount of detail is staggering, and, I suspect, unnecessary. Detailed descriptions of coursework and laboratory equipment also impose an avoidable workload on the departments. By focussing on material that is inexpensive and readily available, and avoiding questions of marginal utility, both the cost and difficulty of

accreditation could be greatly reduced. For example, most departments keep such items as curricula vitae of the faculty, lists of publications, and graduate requirements on file. These can simply be Xeroxed and sent in with minimal inconvenience, which is not true if the information must be transferred to special forms. A willingness to risk slight subjectivity in certain cases can save thousands of dollars; need it cost over a thousand dollars to ascertain that a department with dozens of faculty members, several Nobel laureates, and multi-million dollar facilities is qualified to give the Ph.D.? Perhaps automatic accreditation (except for the student/faculty ratio) might be granted departments ranked acceptably in the ACE ratings. Certainly the bulk of the available resources should be devoted to visiting, evaluating, and advising marginal departments, and I believe that constructively oriented site visits might prove a boon to many schools.

ACCEPTABILITY - THE WORD "ACCREDITATION"

In addition to opposition within the physics community, the establishment of an accreditation board may encounter opposition from other quarters.

The Federation of Regional Accrediting Commissions on Higher Education (FRACHE) and the National Commission on Accrediting (NCA), which accredit the accreditors, are strongly opposed to specialized accreditation of programs (as opposed to general accreditation of institutions). Their position is that specialized accreditation should be developed "...only in answer to real social needs and essentially for the protection of the health and welfare of the population." (Letter to College and University Presidents from FRACHE and NCA, 26 May 1971). I think that physics qualifies. In large part their opposition to specialized accreditation is that they view attempts by professional groups to reduce entry to the profession as purely self-serving. This is certainly true in some fields (medicine is the prime example), but in academic fields like physics large number of people are paid to reproduce themselves. Members of graduate faculties, who constitute perhaps the most influential bloc in the physics community, are far more threatened by the prospect of reduced graduate enrollments than they are by overcrowding in the field. If my accreditation proposal is adopted, it will be due more to the altruism of physicists than to their

self-interest. More on this later.

Part of the FRACHE-NCA concern arises from their belief that "...accreditation is designed to protect minimum levels of quality in institutions and programs and not to regulate manpower needs." (ibid). Perhaps a different word might be more acceptable, but, as I have pointed out previously, any program to restrict graduate enrollments without an associated accreditation policy might have the effect of merely shunting students to inferior schools. Accreditation is not the whole plan, but it is a vital part.

The American Chemical Society, which uses the word "approval" rather than "accreditation," is considering graduate accreditation, as are the engineers. Both groups are well aware of the FRACHE-NCA opposition to their doing so. The American Institute of Professional Geologists has a program of "cooperative evaluation." The American Historical Association has been pondering graduate accreditation for a number of years, and it is reported that "...the displeasure of the NCA does not carry much weight in their considerations." (CUPM Preport, p. 9). The American Mathematical Society is giving serious consideration to both accreditation and individual certification. The NCA and the FRACHE may certainly be expected to oppose all such proposals. However, I believe that some of their opposition is based on a misunderstanding about motives, and I further believe that the spirit of this proposal is quite compatible with their goals.

Universities are not generally sympathetic to accreditation plans, largely because of the vast amount of paperwork involved. If the accreditation process were streamlined as recommended previously, and this fact were made clear to the universities, their objections might be avoided.

Other groups, such as the students and employers of physics, would probably endorse the idea. Most students I have spoken to about this feel that a reduced chance of admission to graduate school would be worth it to know that if they were admitted, their chances of being able to stay in the field would be much improved. They, and employers, would also obviously benefit by knowing which departments were and were not accredited.

FREEDOM OF CHOICE

A common criticism of all proposals to limit graduate enrollments in physics has been that this would restrict the right of students to get the Ph.D. if they want to. As Lee Grodzins recently put it (private communication), "If I were head of a department...I doubt if I would refuse students who want more education." This seems to say that there should be no admissions requirements at all. Yet despite the sizeable number of physicists who feel that it is wrong to limit students' freedomdom to choose graduate education in physics, I have never heard of any university in the country (or in the world, for that matter) which has open admissions at graduate level. All graduate departments have some sort of admissions standards, and these standards are primarily determined by the need to fill all the available openings in the individual departments. This is a pretty arbitrary way of setting standards, and depends more on available support than on the needs of prospective students. My proposal would indeed raise standards, but in a way more consonant with the best interests of the students themselves; it would improve the average level of graduate education by not accrediting very poor departments with, incidently, the lowest admissions standards, and it would insure those students who made it past the higher admissions hurdles a fair chance of becoming career physicists.

Our present system not only does not really give students a freedom of choice, it deprives them of that choice; even the better students cannot really chose physics, they can only gamble on it. The present system does not serve the student, it exploits him.

IS ACCREDITATION UNIONISM?

The most common objection to my plan has been that it smacks of the AMA type of protective exclusion. Most physicists are apparently too ethical to support such a policy of self-interest. This is good, because accreditation in physics is precisely the opposite of medical trade unionism. The medical profession appears to oppose expanded medical education because new physicians compete with older physicians for patients and their fees. More physicians might even drive down the cost of medical care. But very few Ph.D.-producing physicists have to compete with new Ph.D.'s, in fact graduate faculties are paid to produce Ph.D.'s. A decline in graduate enrollments is considered by most departments to

be a serious threat, not an economic benefit. It may lead to the loss of desirable graduate courses, fewer students to help with research, and even a cutback in the number of faculty positions. The possible reduction in publishable research output, the usual route to pay raises and promotion, is a greater personal threat than the likelyhood that a fresh Ph.D. will steal one's job or grant (the most productive advisors are usually tenured anyway).

This proposal will not benefit those already well-established in physics careers. It will, however, benefit physics, society, and a large but powerless group of aspiring physicists who deserve a fairer route to a career in physics than the one we now offer them.

William Silvert