CAN THERE BE A SHORTAGE OF PHD PHYSICISTS?

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In this short note we present an analysis of what the likely demand for research-oriented Ph.D.'s in physics will be during the next decade. While many predictions of supply demand have been made in the past, they were usually made on extrapolations from old data and trends rather than from the facts on hand. In addition, one usually finds those responsible for predictions on manpower have some self-interest at stake in the results of the analysis. Therefore a new look at the problem of Ph.D. supply in physics is required. In this brief paper we analyze the three main sectors employing physicists--education, industry, and government--and conclude that it is very unlikely there will be a shortage anytime within the next decade and a half. In addition, we argue that the so-called “shortage” of physicists can be solved in ways other than the over production of physicists, as is presently the case.

EDUCATIONAL INSTITUTIONS

At the present time there are 10,000 physics faculty members in higher education with 5,000 at Ph.D. granting institutions. The total number of bachelors graduated throughout the 1960's has been between 5,000 and 6,000 per year. Physics Ph.D. production more than doubled from less than 600 in 1960 to over 1500 in 1970. Within the same period the faculties and numbers of Ph.D. institutions about doubled. Since undergraduate enrollment remained virtually constant, clearly the expansion in faculty was related to Ph.D. students and not to the total undergraduate enrollment or to undergraduate physics majors. In most of the current manpower projections, the growth in required physics Ph.D. faculty has been tied to growth in undergraduate enrollment and especially assumed the continued growth in graduate education. With a decreased requirement for Ph.D. production, these projections will probably be optimistic. In fact with fiscal pressures on Ph.D. institutions, and alarmingly large ratio of physics faculty to physics bachelors (an order of magnitude larger than, say, psychology) there will be pressure to reduce graduate enrollment and concomitantly large physics faculty. At both marginal and fiscally troubled Ph.D. granting institutions, this policy is already leading to a reduction in the physics faculty.

Projections in the education sector are not projections in the ordinary sense. For example, the number of 18 year olds is known till 1988 since it is based on children already born. At the present time a very high proportion of high school graduates ~60% go to college and with some modest assumptions concerning a rise in this projection, the total college population can be given to within a few percent for the next 18 years! If one assumes the current student-faculty ratio in physics will remain the same (as noted above this may be optimistic) Cartter [1] arrives at a total demand for new Ph.D. physicists on the order of 300 to 400 a year for the next fifteen years.

Thus we see the educational sector can absorb at most 400 Ph.D.'s per year over the next decade. In addition much of the past growth of faculty was associated with graduate education, which is quite likely not to grow very rapidly. This current year, for example, the total change [2] in physics faculty across the nation was only slightly more than 100 out of a total of 10,000, indicating a growth rate of only 1%. Since we are currently, and will for the next years, be graduating 1500 physics Ph.D.'s, the education sector will accommodate at most only 25% of the total rather than the 55% of the past.

INDUSTRY

Industry's interest in Ph.D. physicists has been twofold, one in basic research and the second in applied research and development. When employment opportunities were good, industry had to offer attractive basic research positions to physicists in order to recruit them. At the present time, industry seems most interested in the applied scientists and thus Ph.D. physicists are facing severe competition from Ph.D. engineers (which have grown to over 3,000 in 1970). Even with the sharp emphasis on science, the growth of employment of Ph.D. physicists in industry during the past decade was only about 4% with more that ½ the support related to DOD and NASA funds. With DOD unlikely to grow at a rapid rate in the 1970s and with NASA's shaky future, the outlook in industry is not promising. In fact, over the last two years Ph.D. physics employment in industry declined [2] by about 150 Ph.D.'s per year (~3%). Even if we choose a most optimistic growth rate of employment of 4% a year for the next decade this averages out to a need of about 250 physics Ph.D.'s per year.

GOVERNMENT

Almost 80% of Ph.D. physicists employed in government are supported by the DOD, AEC, or NASA in either military affiliated labs or national laboratories. There are good indications that basic research in physics in these laboratories is likely to stabilize in the 1970's due to the decrease in the NASA commitment to basic research and the completion of the last large accelerator laboratories for a long time. We will generously assume a growth rate again of 4% in new personnel which gives an average of about 150 physics Ph.D.'s in government per year over the next decade.

Thus the likely maximum need for Ph.D.'s from educational institutions, industry and government is approximately 400 + 250 +150 = 800 Ph.D.'s per year….If there is any significant downward change in demand at educational institutions, which is quite likely, the total demand could easily be as low as 700. Yet the 1970 production of Ph.D. physicists is 1500 and will remain near that level for the few years.

Some might argue that industrial and government demand for physicists in societal areas such as urban problems, health, transportation and environment will increase rapidly in the 1970's leading to a large demand for Ph.D. physicists. This is specious for two reasons. First, a 4% growth rate upon the large Ph.D. physicist's base in industry and government is quite generous in light of the leveling off of DOD and NASA funding. Second, and more important, there is little reason to believe that the present research-oriented physics Ph.D. degree is very useful or even a good way to approach solutions to these new problems. In fact, graduate schools are educating large numbers of

students in exactly these new areas. Presently and in the near future a large number of excellently educated Ph.D.'s will be graduating in the fields of urban problems, environment, transportation and health in response to federal funding and societal needs. It would be far wiser for most students to choose graduate careers in the societal areas directly, which require wide backgrounds rather than the current narrow physics Ph.D. Students and graduate schools seem to be so responsive in these new areas that if they are not careful, the graduating students might easily swamp the societal needs demand market.

It must be emphasized that a 10% oversupply of physicists is very serious because the nature of the physics profession. Since more than ¾ of all jobs are protected by tenure or equivalent job security, at any one time only ¼ of all jobs are on the open market. Thus the 10% oversupply is competing for only 25% of the job market which worsens the jobs to applicant ratio by a leverage factor of 4.

Now we turn to the concept of a "shortage" of physicists usually associated with the word "crisis". In spite of the large over production of Ph.D.'s in physics and other sciences and the lack of demand commensurate with present supply and production capabilities, many leaders on the scientific community independent of the facts are warning of the possibility of shortages in the late 1970's. I maintain that with the very large base of Ph.D. physicists developed in the last 20 years there is no possibility of a shortage and certainly no crisis. The so-called "shortages" in the 1960's were artificial and manufactured by vast DOD and NASA demands rather than public demands. Suppose that in 1975 there are 1000 Ph.D. physicists and a demand for 1500 physicists, indicating a shortage of 500 physicists. In the past many would argue there is a 50% shortage, 1,500 needed and 1,000 produced. Actually one must compare the total number of Ph.D. physicists say, 25,000 to the total demand 25,500. This is a mismatch of only 2% and probably is healthy for the profession. A minor change in efficiency would easily wipe out this shortage. Suppose further, the 500 person Ph.D. shortage would continue for 5 years, this would mean a cumulative 10% shortage. Within that 5-year time period, the system will have a chance to respond and the shortage can then be accommodated . . . . . In medicine there really is a shortage of medical personnel based on unmet public demand, and it is immoral not to have enough doctors. In physics the so-called shortages are not immoral. What may be immoral is an over production of miseducated people.

RECOMMENDATIONS

At the present time there are too many institutions granting research-oriented Ph.D. degrees in physics (~170 institutions). While some of the major institutions have cut back on graduate students (mostly for fiscal reasons rather than an appreciation of the oversupply of Ph.D. physicists) a good number of smaller institutions are planning to grow and in some cases have doubled their first year graduate enrollments. The net effect has been to have approximately the same number of graduate students with the probable general educational level lowered. If the demand projection of ~800 Ph.D.'s is correct, then only 5 Ph.D.'s per year per school should be granted and each faculty member should produce only one Ph.D. student every six years. Unfortunately, it seems most unlikely that graduate schools and faculty members will cooperate to produce fewer Ph.D. physicists.

To help relieve the problem of oversupply a real cooperative effort will be needed in the graduate schools. I believe 170 graduate schools are much too many for quality education. The fantastic growth in the 1960's of the Ph.D. faculty is unstable because it was mostly designed to produce more Ph.D. faculty. As a result, graduate education has developed a very complex and disastrous feedback system. If there is less need for Ph.D. physicists, less graduate faculty is needed, which in turns affects the main employers of Ph.D. physicists.

The emphasis and reward in graduate education must shift away from only basis research. The present Ph.D. education is so narrow that in most cases the graduating student is ill prepared for the outside world. A greater emphasis should be made on teaching. Although there will be some jobs for undergraduate teachers, very few of the present research oriented Ph.D.'s are capable of creative teaching especially of physics and science to the nonscience students. If we are ever to create a demand for physics Ph.D.'s we will have to expand the fraction of students enrolled in college who wish to take courses, but not a major in physics.

1. A. M. Cartter, “Scientific Manpower Trends for 1970-1985, The oversupply of Ph.D.’s will affect higher education and national science policy.” Science, 172, 132 (1971).

2. Lee Grodzins, MIT professor (private communication).

3. AI.P. Manpower Studies.