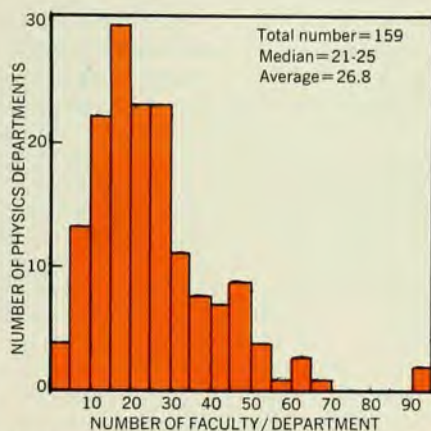


Quo vadis—small physics departments?

There is no question that science departments play a major role in producing the specialists, techniques and ideas that keep our country viable. The science departments that contribute to this role come in all sizes and shapes, but should they? The Subcommittee on Professional Concerns of The American Physical Society¹ states that the latest evaluative report on physics² suggests that "physics" is done almost exclusively at a few large prestigious institutions and that graduate students should be enrolled in these institutions as opposed to others. If this premise is true, is there then any future for smaller physics departments? In short, are they really needed? In my opinion, the emphasis in physics education should not be on a self-defeating competition for students between big and little departments. There are numerous reasons why both small and large departments will continue to exist. Our task is to make both better. This letter attempts to outline certain factors that illustrate the need to support both large and small departments and suggests that programming is essential for excellence in small departments.

Consider the information about physics departments presented in the figures. Figure 1 is a plot of the size of departments versus the number of departments of that size in the United States. Since some departments combine physics and astronomy some error is involved, but the data should be satisfactory for illustration. Figure 2 shows the location of physics departments with a permanent staff (assistant professor and higher) of more than 40 members. Even though available funding and student demand in some regions may be such that large departments cannot be supported (as shown in figure 2), the necessity for good physics and its interplay with society in *all* regions must be recognized. There is a regional need by industry, government and students for good physics programs.

The economic situation today is extremely fluid, and long-range planning by industry is difficult. As a result, industry has been limited to a fixed number of personnel involved in research, and as these people mature there is a need for the infusion of new blood. University physics departments face a



Distribution by size of PhD granting physics departments in the United States as measured by the number of permanent faculty (assistant professor and higher). Figure 1



Geographic distribution of large (at least 40 permanent faculty, including ranks of assistant professor or higher) physics departments in the United States. Figure 2

similar aging problem. A cooperative venture of personnel exchange between industries and universities could help alleviate this problem. Of course such programs work best for industries and universities in the same geographic region. This need for industrial-university cooperation was underscored by the representatives of the corporate associates of the American Institute of Physics and chairmen of graduate physics departments meeting at Rockefeller University two years ago. It was pointed out that students need to be more aware of industrial research goals because in the near future new PhD's will most likely have appointments in small colleges or will be involved in industrial research.^{3,4} Several of the industrial

managers also indicated they prefer to hire people from their own region.

The attack on energy and environmental problems requires expert scientific advice at the state level. The matters of uranium enrichment facilities, radiation waste storage and pollution require considerable expertise from qualified scientists within the confines of a state. Thus, it is important that each state have a wide range of university research facilities with qualified scientists available for consultation.

There are many reasons why talented students do not want to leave their home region to pursue undergraduate or graduate work. If the needs of these students are to be met, excellent physics departments *large* and *small* must be developed throughout the US. There is obviously a payoff between student need and the financial capability of a state to meet this need. Although every effort must be made to meet student needs, prudent planning and wise use of financial resources are crucial in developing and maintaining quality programs.

In states with population bases as small as three million, the available resources are such that two major universities cannot develop identical physics departments, especially since unlimited growth is no longer feasible.⁵ Therefore, coordination of programs is required. This type of coordination should have a regional base and is a necessity for schools with small or medium-sized physics departments. A "critical mass" of five to eight active research professors is needed to have an excellent program in a particular research area. Since the average size of a department is 25 permanent faculty members, such a department can emphasize, at most, three major areas of physics. This means it is imperative that every physics departments have a mission carefully "hammered out" by the departmental faculty. If no "road map" for the department exists, then it is improbable that a department can establish an excellent program in any area. However, the mission must fill the needs of the university, state and region and fit the desires and strengths of the faculty. It must be supported by the university administration and be sufficiently flexible to include such intangibles as "academic excellence." All

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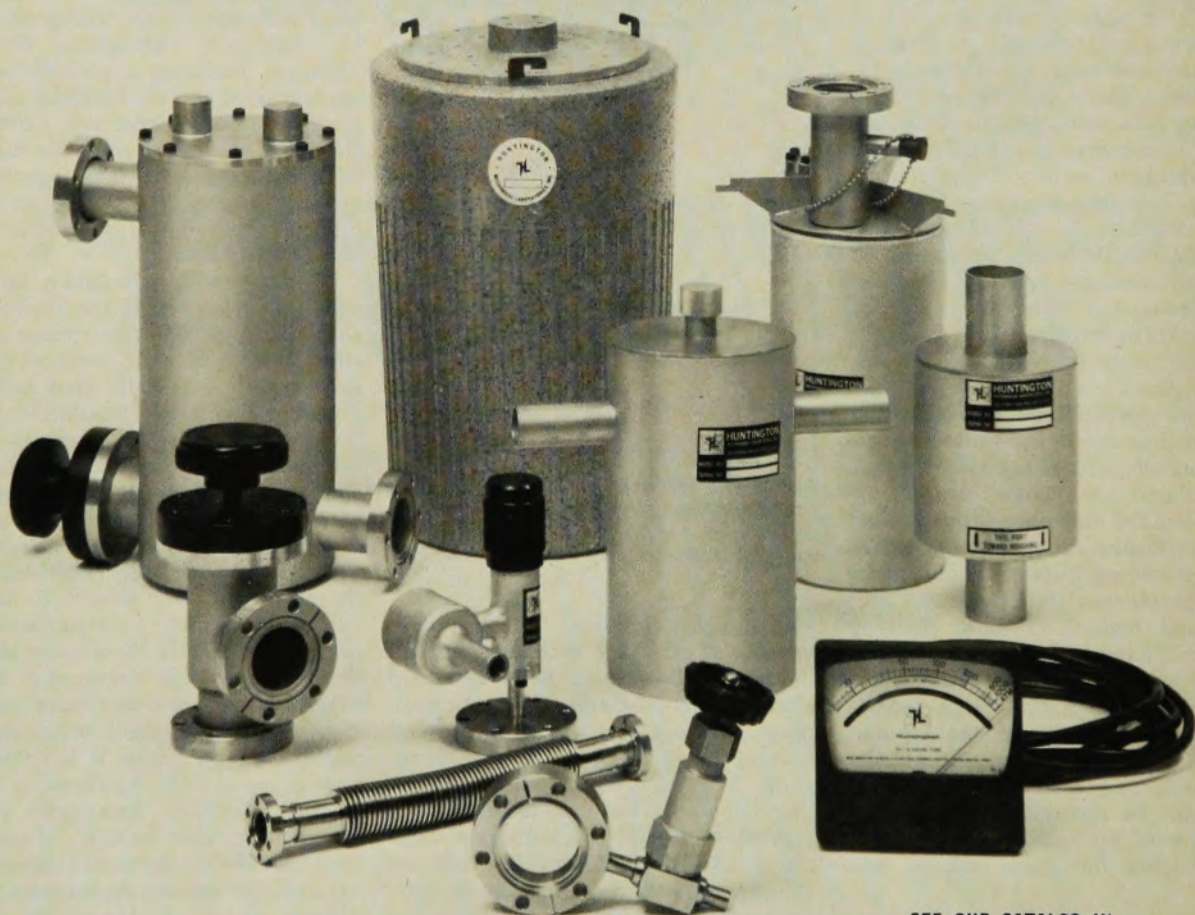
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of this requires careful planning and cooperative exchanges of ideas.

Faculty are obviously a key factor in any progressive program. Without good faculty pursuing established teaching and research goals, no amount of money or pressure will yield an outstanding department. Faculty members must be able to interact with one another on both research and teaching matters, thus providing mutual stimulation and critical insight. As mentioned previously, this means that in a physics department of 25 faculty members, two or at most three areas of physics can be attacked in depth. It is also important to remember that not all faculty members can have their expertise and training in the rather narrow areas chosen to be emphasized in the mission. The department must equip undergraduates to compete in technical occupations, in medical school or at any major graduate school and must invest in some faculty members whose training and research lie in fields other than those that form the major emphasis of a small department. Special consideration must be given to these people, because their need for outside communication is greater than those of faculty members in the areas of specialization of the department. Innovative teaching must also play an important part in any department.

Just as it is important to have a mission and able faculty, interested and capable graduate students are a prime ingredient of a good program. The departmental program must be responsive to graduate student needs in terms of education and personal development. Faculty members must spend personal time as individuals with the graduate students. One of the strengths of a small department is the opportunity for emphasis on interpersonal communication. There is no reason or excuse for a small department, despite the familiarity that exists between the faculty and graduate students, to graduate mediocre physicists.

The majority of the funding in most physics departments comes from state funds allocated for the purpose of teaching. Thus, the teaching base of any department must be considered in formulating the size and mission of a department. In physics, teaching and research are so intertwined that disentanglement is impossible, but it is important for the various publics of universities to understand that the emphasis of physics departments is on creative ideas, teaching and training. "Program budgeting" and "cost per student credit hour" are common terms in this day of cost accountability. When a physics department shows an exorbitant cost per student credit hour, there is pres-

sure to reduce the budget. It is important in the planning phase of building a department to understand what the teaching base for the department should be. As a rule of thumb, a solid teaching base would consist of a teaching load of 14 000 student credit hours per year for a full-time faculty of 20.

A major source of funds for the summer program, for travel and for equipment is federal grants. Federal funds are usually granted to scientists who do excellent research. This should be uppermost in the mind of the person in a small department responsible for planning departmental goals and emphasis. Only competent people capable of doing outstanding research will "win" grants. Competition for these monies has become greater each year and cooperative efforts by capable and energetic faculty members are required, under today's funding conditions, to build and maintain a well-balanced small physics department. Another source of research support is local industry. Departmental research programs should be coordinated with the needs of local industry. There must be a *quid pro quo* if industry is to invest in university programs.

In conclusion: I feel it is important to reiterate that for the next few years regional planning by physics departments should be of high priority and that the accomplishment of a major research effort and adequate graduate program involves a "road map," excellent faculty, and capable graduate students. If these elements are present, even in the face of modest resources, a viable, vigorous and valuable program can be developed.

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W. A. SIBLEY
Oklahoma State University
Stillwater, Oklahoma

Nebula error?

I suppose that anyone can call anything by any name, but if communication and transfer of information are the aims it is surely best to use names that others will understand. Rudolph Minkowski once despaired of giving an absolutely com-

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