An Invitation

Because we believe that our findings demonstrate the feasibility of research on the effects of experience on the brain, and because we believe that such research offers many challenges and a wide field for investigation, we hope to see it taken up in other laboratories. To this purpose we offer qualified investigators animals from our special lines and complete information about our behavioral, biochemical, and anatomical procedures, either through written descriptions or by direct demonstration.

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University Organization for Geophysics Education

University of Miami evolves new pattern for graduate education in earth and planetary sciences.

Werner A. Baum

Most faculty members prefer to consider the problems of university organization as inconsequential and certainly of no interest. This is wishful thinking in our age of big science and big universities, as those of us in "interdisciplinary" or "multidisciplinary" subject fields know very well. Geophysics is in this category, involving as it does many specialties of physics, of chemistry, and even of biology.

Philip H. Abelson focused clearly on the problem in the Third Annual Klopsteg Lecture (*1*):

> In this résumé of important trends in research it is apparent that almost all active fields involve multidisciplinary effort. Opportunities in some older disciplines seem limited. With the fast-shifting nature of research frontiers, it is apparent that the young student is faced with a difficult problem in preparing for research. If he specializes too early and too completely he may find that much of his knowledge is obsolescent even before he finishes graduate school. The situation calls for flexibility, and for a mastery of the fundamentals of two or more disciplines. . . .
>
> The universities have a special responsibility. They must ask themselves whether they are preparing students for the 1980's or for the 1940's. Many schools are training their students for the 1940's. The curricula call for far too much specialized training. The student is overloaded with required courses in his specialty. He is given neither opportunity nor guidance to train himself broadly. Indeed, some departments consider a student disloyal and rather undesirable if he indicates a wish to take too many courses elsewhere. Moreover, the prejudice is usually amply conveyed.
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> As long as universities are organized in departments along disciplinary lines such narrow viewpoints are certain to come to the surface. To meet the new challenges will require a complete recasting of the administrative structure or at least the formation of interdepartmental arrangements designed to help the student, not to preserve the vested interests of the faculty.

The Academic Department

I believe this criticism to be basically valid. Departments do tend to be a serious impediment to change within a university. Of course, not all change

Dr. Baum is Vice President for Academic Affairs, Dean of the Faculties, and professor of meteorology at the University of Miami, Coral Gables, Florida. This article is based on a talk given at the American Geophysical Union's Symposium on Geophysics Education, held in Washington, D.C., in April 1964.

being for the better, the department becomes the proverbial wife one can't live with or without. While the department is the single strongest deterrent to curricular and procedural changes in tune with the knowledge explosion of our times, it is probably also the single greatest source of academic strength to the large, multipurpose university.

For one thing, *some* organizational pattern is needed just to prevent chaos. More important, the department carries the primary burden for maintenance of standards; it bars the doors to much dilettantism that would delight in roaming the halls of academia. Also, the department is the major source of intellectual companionship and stimulation for faculty and advanced students; it is to them, in the "multiversity" setting, fully the equivalent of the family home in the metropolis.

Thus the department continues to flourish as an entity. Despite rather obvious difficulties, it seems most unlikely that widespread basic changes will be made in the immediate years ahead. Accordingly, faculties and administrations have sought to solve the very real problem of multidisciplinary efforts through other mechanisms.

Typical Solutions

Three approaches have typically been attempted: operation within one of the traditional departments, interdepartmental graduate programs operated by committees, and institutes of a non-degree-granting nature. Though one can find isolated examples of reasonably satisfactory use of each of these devices, they have not generally worked well because each has fundamental weaknesses.

The intradepartmental approach seems to work fairly well, for example, at the University of Minnesota, where good atmospheric physics has come from the department of physics for years. By and large, however, such efforts have proved to be highly transient, generally being dependent upon the presence and persistence of a single individual or two. The arrangement normally does not represent an institutional commitment. For the graduate student, degree requirements tend to become unattractively and unnecessarily excessive; he is frequently expected to do everything the "traditional" student does, plus a great deal more.

The interdepartmental program operated by committee—the approach followed in many instances—has recently been applied to geophysics at the University of Washington, for example. It tends to fail because it does not provide a true intellectual and physical home for students and faculty, because it suffers from underfunding by virtue of its anomalous character in the organizational sense, and because it makes time demands upon faculty members which are not weighed heavily by those responsible for salary and promotion recommendations. Indeed, more often than not the committee chairman does everything —or nothing—as he chooses.

The non-degree-granting-institute mechanism seeks to overcome the latter difficulties, and largely does. Such institutes tend to have a physical and intellectual coherence. However, by virtue of the fact that degrees must be conferred through the departments, two major difficulties arise. One concerns the requirements placed on graduate students; again these tend to become excessive, as the degree-granting entity invokes the firm belief that every student coming from the department must have such and such a background. The other difficulty is the mandatory nature of dual appointments, in the institute and in a degree-granting department, if the individual is to function as a member of the graduate faculty. More time has been wasted, and more animosity generated among colleagues, over this question than any of us would care to admit.

The Miami Solution

This was our analysis of the situation when, at the University of Miami, by virtue of a special endowment, we were afforded an opportunity to move the university to the forefront of at least one major segment of science. Since the University of Miami already had an unusually strong program in the Institute of Marine Science and there was good reason to believe that the geophysical sciences on a solar-system scale hold outstanding promise for scientific progress during the next generation, the policy decision was made to embark upon a program of graduate education and research which would treat the environment as one, from the center of the earth to its crust, to oceans and atmosphere, and out into space.

How should the activity be organized? If the foregoing analysis is correct, one answer follows simply: combine the advantages of departments and institutes by making the institutes degree-granting, free to set their degree requirements within the framework of the Graduate School, and free to make their own faculty appointments (hopefully but not necessarily jointly with a department).

We have therefore established a School of Environmental and Planetary Sciences, fully equivalent to any other school of the University—for example, the School of Medicine. Instead of consisting of departments, the School consists of institutes, which are in effect interdepartmental departments.

Serving as dean of the School is S. Fred Singer, formerly professor of physics at the University of Maryland and formerly director of the National Weather Satellite Center in the Department of Commerce.

The Institute of Marine Science, under the direction of F. G. Walton Smith, who has developed this institute from a small laboratory to a major scientific center over about 20 years, is an on-going enterprise. Indeed, it is educating more graduate students than any other marine group in the United States; at latest count, of a total of fewer than 350 students enrolled for the Ph.D. or M.S. degree in oceanography in United States institutions, 85 were at the University of Miami.

Directors are now being appointed for the Institute of Atmospheric Science and the Institute of Space Physics. A fourth component, dealing with lithospheric problems on a solar-system scale, will be evolved later.

The fifth component, the Institute of Molecular Evolution, is directed by Sidney W. Fox, formerly director of the Institute for Space Bioscience at Florida State University. This biological component of the School concerns itself primarily with the development of life processes under geologic and "exotic" environmental conditions.

The School of Environmental and Planetary Sciences operates entirely at the graduate level. Entering students are expected to have a strong B.S.-degree background in one of the applicable basic disciplines. Degree programs are developed by institute faculties, subject only to general Graduate School policies. "Interdisciplinary squared" programs, such as programs for students concerned with problems of the air-ocean interface, are worked out between institutes within the

School; they become, at worst, the equivalent of interdisciplinary programs under the traditional organizational patterns.

Faculty of the School may hold appointment in a department of the College of Arts and Sciences, the School of Engineering, or even the School of Medicine, if this is agreeable to the individual and to the department. The faculty member may then offer undergraduate or graduate courses in that department; he may have some graduate students follow the departmental route, rather than the institute one, in a degree program. Thus the presence of the institutes has a profound direct effect on the strength of these departments.

Probably the most critical consideration for success or failure of the institutes will prove to be the development and maintenance of standards for the doctor of philosophy degree. These cannot be unrealistically high, in the quantitative sense, or one major reason for the whole effort will have been vitiated. On the other hand, there can be no compromise on quality. The dissertation phase of the program should be no problem. The structuring of formal course work will be; it must provide an opportunity for mastery of a great range of fundamental science related to particular problem areas. Curriculum development will be one of the more exciting challenges to be faced by the faculty of the School.

We have just begun this effort. It may not work effectively, because this pattern, too, may have its shortcomings, and we may have to make modifications. Certainly no pattern guarantees success, because people are all-important. However, we begin with the firm belief that, with the proper injection of personnel, our organizational framework provides unusual educational and research opportunities in one multidisciplinary phase of science.

Abelson's indictment is not to be taken lightly. Science, responsible for the era of accelerating change in which we live, is itself caught in the throes of rapid change. The resulting educational problems—and geophysics is only one example from a growing class—must be vigorously faced by the universities. The diversity of American higher education, the willingness to experiment, has been a great source of strength; but this willingness to experiment often does not extend to graduate education in the sciences. Imitation probably is a safer route to respectability. In view of the changing needs, I hope that more universities will assume their responsibility and take some chances.

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News and Comment

Basement Science: What Happens When a Do-It-Yourself Scientist Looks to Washington for Support

William Fox is a lieutenant in the New York City Police Department. He has been on the force for 25 years, and, in the jargon of the police, he is not a "hot house cop"—that is, a policeman who has had a sheltered career. He pounded a Harlem beat for 5 years; he spent another 5 years on a Manhattan detective squad, and now, at age 50, he puts on a uniform every working day to serve as desk lieutenant in the Central Park precinct house.

In appearance, manner, and speech, Fox fits the popular image of the tough, big-city policeman. There are certain things, however, that clearly distinguish him from all other career policemen: in his spare time he acquired a doctorate in chemistry, at Columbia University, and in the basement of his home in Staten Island he has been carrying on research on the physics of fluid interfaces. Arthur W. Thomas, professor emeritus of chemistry at Columbia, under whom Fox received his doctoral degree, states without any qualification that "Fox is a brilliant chemist." Lucy Hayner, under whom he studied physics, recalls Fox as an "outstanding student." And Polykarp Kusch, of Columbia, a Nobel laureate in physics, who first met Fox several years ago, states that Fox's research represents "an honest and serious extension of knowledge." Fox, on the basis of research in his basement laboratory, has published in various journals, including the *Journal of Physical Chemistry* and the *Journal of the American Chemical Society*, and he has delivered papers before the American Chemical Society and the 4th International Congress on Surface Active Substances.

In short, and without getting into the difficult and often unpleasant business of rating scientific ability, it must be acknowledged that Fox, the scientist-policeman, is well within the generally accepted boundaries of professional scientific competence. And, it is because of this that he stands as a wonderfully illuminating case of what happens when the massive establishment for supporting American science is confronted by the relic of a former age, the basement researcher. The answer is that it gags and looks away.

Before going on to chronicle Fox's encounter with the agencies of American science, it would be well to dispose of the inevitable question of why this scientist chooses to earn his living as a policeman. The answer tells us a good deal about Fox, but it also tells us a good deal about the organization of science in this country. It is probable that, if Fox had come under the sway of a good guidance counselor, his career might have gone otherwise. But, in 1940, and in conditions of financial hardship, he was quite delighted to receive an appointment to the police force. He had worked his way through New York's City College during the worst of the depression, receiving a bachelor of science degree in 1935. There followed a series of tough and unrewarding jobs, including greasing pans in a New Jersey bakery, while he sustained himself and his parents and took graduate courses at Columbia.

Eventually he concluded that if he was to get an advanced degree in chemistry he would have to find a relatively well-paying night job that would per-