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.

Reference

1. P. H. Abelson, *Science* **143**, 218 (1964).

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-

mit him to take a full-time graduate course. The Police Department was the answer, and Fox was happy to be taken into its ranks. At his request, he was appointed to a midnight to 8 a.m. Harlem beat, near Columbia. Miss Hayner, with whom he studied spectroscopy, recalls that he changed into civilian clothes before coming to the laboratory, but, as police regulations required, "he always wore his gun off duty, which is probably what first drew my attention to him. I can't recall any other student who came to lab with a pistol."

She also recalls that he was one of the most determined and highly motivated students she has encountered in 40 years of teaching and research. "He would never skim over anything. He had to understand everything thoroughly, and if he didn't get something, he would insist that you go over it again and again. He was never embarrassed to say he didn't understand." Fox wrote his doctoral thesis on "Equilibrium relationships between fluid interfaces: the system of methylene iodide-water-air," and received his degree in 1944.

Hindsight might suggest that at this point he would have done well to drop police work in favor of science. But Fox's teachers recall that he had developed a kind of monomania for pursuing the line of research that he had begun in the course of getting his degree, and that, rightly or wrongly, he had no inclination to become part of a research team or to adapt his scientific interests to anyone else's. Fox, it seems safe to say, was something of a scientific loner. A veteran policeman who knows something of Fox's police work and scientific career says: "I think there's a lot in common between being on the force and working in the lab. Now take a plainclothes squad. The chief of the squad gets a tip on a suspect and he assigns two men to tail him. When they're ready to make the 'collar,' he takes off those two and lets some other guys get the credit for the case. Now it's just the same thing when a big team is working in the lab." Fox himself just smiled when this analogy was related to him. Like a good policeman he referred all inquiries on police matters to the Department's press office. But he preferred to do research alone.

A year after Fox received his degree he was assigned to the police laboratory, but not before Professor Thomas

William Fox

personally brought him to the attention of Mayor LaGuardia. His assignment to the police laboratory lasted for 2 years, and was followed by a series of assignments that at times somewhat reflected his educational background and at times did not. After a tour as a plainclothesman from 1947 to 1952, he served as a precinct sergeant for 5 years and then served for another 5 years as a lecturer at the Police Academy, teaching courses on "Patrol function" and "Investigative function." Last year he was reassigned to precinct duty, and 5 days a week he now takes up his post as lieutenant of the 22nd precinct, covering Central Park.

Throughout these 25 years of police work Fox was, of course, tempted to leave the force for a scientific job, but it is hard to know what makes anyone tick, and it is especially hard to divine this in the case of someone as complex as Fox. Each year on the force enlarged his pension rights, which was not an inconsiderable factor when viewed against his early financial hardship; employers in whom he was interested found it difficult to believe that a long-time policeman could really be a competent chemist. But perhaps most significant of all, Fox found satisfaction both as a basement scientist and as a policeman.

He can become quite eloquent in discussing the role of the police in an urban society, and he is regarded as a good policeman. His rank in the highly competitive New York force attests to that, as does his receipt of a "Meritorious Duty Award" for acquiring evidence in a murder case earlier in his police career. In 1949 he took a year's leave to work in the Bureau of Mines petroleum experiment station, in Bartlesville, Oklahoma, but he returned to the force without any desire to stay with the Bureau. In terms of weight of paper, his publications have been few and often many years apart, but his Columbia teachers say that it would not be hard to find reams of publications that contain vastly less scientific substance. Along the way, working at home with several thousand dollars' worth of equipment that he improvised or purchased with his own funds, he produced results which he reported in a series of papers, including, "Contact angles and their relationship to the wetting and spreading of liquid-liquid gas systems," presented to the American Chemical Society, 1949; "A convenient cell-stage for fluid profile measurements," published in the *Review of Scientific Instruments*, 1950; "Fluid phases in mutual contact," published in the *Journal of Physical Chemistry*, 1959; and "Conservation of forces at the line of contact of three phases," presented last August at the 4th International Congress on Surface Active Substances, in Brussels.

Thus, Fox went his own way, doing research at his own pace and in response to nothing but his own intellectual curiosity. Occasionally he would engage in a bit of scientific controversy in the letters columns of professional journals, and now and then he would attend a professional meeting, but William Fox, no matter how he might rate as a chemist, was clearly outside the social and organizational patterns of American science—and this was to have disappointing consequences for him when he turned to the federal agencies that support the bulk of American basic research and asked them to judge him as a scientist. What he wanted was some money for equipment to carry on his research. Just how much he wanted was never spelled out, since his dealings with the federal agencies never reached the point of detailed budgets. But, it was plain that he was thinking of relatively small sums.

In 1953, when the National Science Foundation was young, Fox received $225 in NSF support to attend a 3-week instrumentation conference at New York University. But after that he came to consider himself lucky if he got an answer to his inquiries. When it became clear to him that the name William Fox, standing alone, drew no response, he conjured up the name

Oakland Research Associates (after the name of the Staten Island street on which he lives) and identified himself as William Fox, of Oakland Research. That helped a bit, but Fox was up against the fact that the major federal agencies are in the business of wholesaling money, and despite the official party line of federal support for independent scientific research, the apparatus was too big and insensitive to take note of a full-time policeman doing research in a Staten Island basement. In 1959 an inquiry to the Office of Naval Research brought the reply that "the statutory authority [of ONR] permits the making of grants only to educational institutions and certain other non-profit organizations and only for the purpose of basic research." Fox replied that Oakland Research Associates was a nonprofit organization and that he was engaged in basic research, but ONR wasn't interested.

In May 1961, in response to an inquiry, the National Aeronautics and Space Administration told him that it has "considerable interest in the physics of fluids," and invited him to submit a proposal. Fox promptly submitted a proposal related to investigating the phenomena of fluids in space vehicles. When 5 months had passed without a reply, he sent NASA an inquiry. A month later NASA informed him, "We have carefully evaluated your proposal . . . but do not feel that the work is closely enough related to our space-sciences mission to warrant support. Please feel free to submit any future proposals you may have to this office."

Last April, when Fox was invited to present a paper in Brussels at the congress on surface activity, he noted that NSF had announced that it would have available a limited number of travel grants. He applied for $526.30 for round-trip air fare. Twelve other persons applied. Travel grants were provided for six. Fox was not among them. He attended the meeting at his own expense.

It can be argued, of course, that Fox has no one to blame but himself if he chooses to be a scientist outside the scientific reservation. It can also be argued that science long ago moved out of the basement, and it is only reasonable to expect multi-billion dollar federal agencies to rely on institutional affiliations as a guide to competence. And, finally, it is necessary to concede the possibility that Fox's proposals simply didn't make the grade scientifically with the agencies whose support he wanted.

But his Columbia teachers say that they have seen ample federal assistance go to lesser scientists who were fortunate enough to have the right institutional credentials. Kusch, who has boundless admiration for Fox's drive and determination, looks at it another way. "I don't want to say if I think he's better or worse than the people who are getting government grants. But he is obviously competent and enthusiastic. He has made an investment in science at his own expense. He didn't dream up projects to get support, as some people do. He followed his own curiosity, he had a vision of what life could be and that's what led him on. And if somehow or other we can't work out public policies to encourage and help people like Fox, then there's something very wrong with the whole system."

—D. S. GREENBERG

Federal R&D: Congress Continues To Boost Budget, but Increases Are on Last Year's Reduced Scale

The financial fortunes of federal science can be roughly charted from year to year by comparing the original budget requests of the administration with the final appropriations voted by Congress. By this imperfect measure, the science budget this year continued to burgeon, though at the more modest rate imposed by Congress last year.

A horse-trading tradition prevails for science as it does in almost every sector of the budget, with the President naming a high figure, one house of Congress, usually the House of Representatives, countering with a low one, and the final figure falling somewhere in between.

As Representative Otto Passman (D–La.) is reported to have put it this spring, "There's an asking price and a settling price." Passman is chairman of the House Appropriations subcommittee which handles the foreign aid money bill and, until this year, held the long distance record for persuading his committee and Congress to cut foreign aid appropriations to his specifications. This year, however, the settling price was a lot closer to the asking price in foreign aid and in other budget areas. Largely responsible for this turn of events was President Johnson's tactics of first announcing that he was presenting a "barebones" budget trimmed to total less than the big round number of $100 billion and then exercising his considerable skills in getting what he asks from Congress.

It is difficult at this early stage to go beyond science agency budgets to analyze the effects of the appropriations at the level of programs, but it appears that total funds for federal R&D (lumping together basic and applied research, development work, and money for construction of facilities) will rise to about $16 billion. A somewhat larger proportion of the total amount this year seems to be earmarked for basic research, although this basic research portion still amounts to about a tenth of the total. Primary explanation for this shift lies in the reduction this year in expenditures by the Defense Department for development work.

Defense. The Department of Defense remains far and away the biggest spender in the federal R&D budget. This year, however, funds for military R&D, like the overall defense budget, declined somewhat. (The authorization for military procurement was down $1.3 billion from fiscal 1964.) Spending on conduct of research and development is expected to total about $7 billion compared with $7.3 billion-plus last year. Only about 3 percent of this goes into basic research. Defense Department funds for basic research this year will go up to an estimated $220 million compared with about $205 million last year. The reduction in the military R&D budget, according to the Defense Department, is primarily due to declining costs for development, testing, and evaluation in such major weapons systems as the Atlas, Titan, Polaris, and Minuteman.

NASA. The space program accounts for the second largest lump of money in the R&D budget. The National Aeronautics and Space Administration chalks up most of its expenditures to research, development, and R&D facilities. This year Congress voted a total $5.25 billion to NASA, with about $4.9 billion of it earmarked for R&D and construction. The fiscal 1965 appropriation represented a cut of some $76.5 million, which can be viewed as minor cheese-paring when compared with the $600 million cut by Congress last year. The rough handling of the space budget in the '63 session seems to have been prompted by congressional shock at the steep upward trajec-