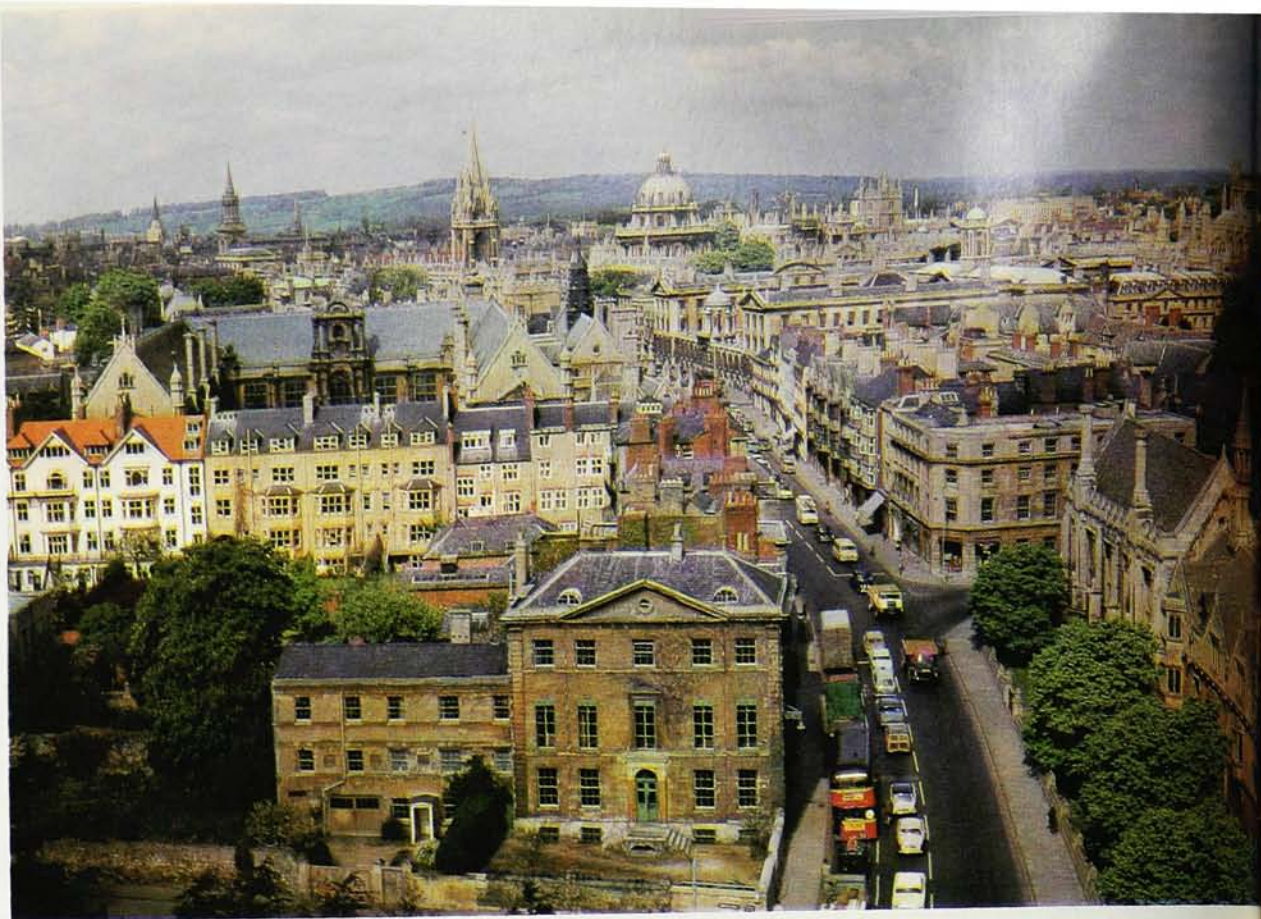




Britons Seek Closer Relations Between Industry and University

Traditions that have produced great science do not always meet today's needs. Not enough trained physicists move from college to plant. Both altruistic and selfish motives spur teachers and managers to find out what, if anything, is wrong and what should be done about it.

by R. Hobart Ellis Jr

IF YOU TALK TO A British physicist, one of the problems he is likely to speak about is the failure of British universities to supply enough physicists to industry and the failure of industry to attract, use and hold those it gets. Having bumped into the problem frequently when I was in Britain in 1966, I went back again recently with the special intention of asking about it. The problem remains; many persons are worrying about it and studying it; correction programs are in operation; others are starting or being planned.

British traditions, both academic and industrial, make for separation of pure and applied science. On the

other hand many motivations lead scientists and managers to seek a change. They range from altruistic (desire to aid the economy and improve science) to selfish (realization that support of science requires it to make itself useful). Under their influence much is being done. Committees and conferences are studying the question. From their recommendations some profound changes—some academic, some industrial—are occurring, and more are likely to occur in the future.

The nation that discovered Newton's laws, Rutherford's nucleus and Dirac's theoretical positron is understandably proud of its academic traditions and

somewhat fearful of damaging its educational system with too much meddling. For a long time science was on the defensive, and no one wants to put it in that position again. F. Philip Bowden, a professor at the Cavendish Laboratory, Cambridge, and head of its surface-physics section, told me that in the early days of this century Cambridge experienced a profound change in accepting science despite its humanities-oriented past. Physics is even newer at Oxford, which established its Clarendon Laboratory in 1872 with a long-forgotten legacy that had originally been designated for a school of equitation. There had been



GOWN TOWN AND DOWNTOWN. Four views of old and new in Britain show the town of Oxford dominated by its college towers (opposite page), Christ's College gate in Cambridge (top left), the nuclear-physics laboratory at Oxford, which houses the department accelerator (lower left) and a part of the Rolls Royce engineering facilities at Derby. (The Oxford pictures are through courtesy of British Motor Corporation, Cowley, Oxford, and the Clarendon Laboratory, University of Oxford, respectively.)

professors and readers in "experimental philosophy" from the mid 18th century on, but the physics program at Oxford really got going in the early 1930's when F.A. Lindemann (later Lord Cherwell) invited distinguished European refugees to come there. Among them was Franz E. Simon (later Sir Francis Simon) who, according to Nicholas Kurti, "had a lion's share in putting the Clarendon on the map." Simon was professor of thermodynamics and later Cherwell's successor as Dr Lee's Professor of Experimental Philosophy and head of the Clarendon.

British industry has its traditions,

too, and many of them did not in the past encourage the flow of scientists from campuses to factories. The more traditional industries got many of their technical men, not by way of the universities, but by the route that leads to Higher National Certificates. These are awarded to persons who demonstrate that they can pass examinations administered by the Combined Engineering Institutions after preparing for them in any way they choose. Often the preparation is by evening attendance at the local technical college while the candidate fills a daytime job as an engineer.

Sir Nevill Mott, director of the Ca-

vendish, told me, "The whole issue is bound up with the swing away from science in the grammar schools." Britain, like the US, is threatened with decreasing physics enrollments in colleges. A committee of the Council on Scientific Policy under Frederick S. Dainton, vice-chancellor of the University of Nottingham, is looking for the reasons and last year issued its first interim report.¹ Another group with Mott as chairman has recently been established under the education committee of the Institute of Physics and the Physical Society to look into education for industry. Mott says that physics, and indeed science in general,



BOWDEN



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seems less glamorous than ten years ago to boys and girls of 16, and at that age most British school children must choose between art and science. "The reason," he said, "is perhaps the increased importance and interest of the social sciences and a certain disillusion with the technical aspects of the 'affluent society.' Physics is associated with armaments and the less human applications of technology such as supersonic passenger aircraft."

Divergent views

Although a situation requiring change is generally recognized, one can not find unanimity about what should be done to cure it. When I talked with Sir Martin Ryle, Cambridge radio astronomer, for example, he expressed his fear that attempts to alter education in favor of industry might lead to abuses. For example, he feels that the custom whereby a department head holds an industrial post can lead to a situation in which, without conscious intent, ideas originated by junior staff and PhD candidates are handed over to an industrial organization and no proper credit goes to the originator. "Such a situation" he said, "is not likely to lead to a favorable reaction from the PhD student."

On the other hand he is all in favor of coöperative research projects and two-way exchange of information on other relevant projects. "But this should be regarded," he said, "as a joint venture between the two organizations, not a private arrangement of the head of the department. It should involve contact at all levels and may include temporary interchange of people."

Ryle feels that the most worthwhile result may be bringing the PhD candidate into contact with industrial problems and industrial staff. "To me this contact seems the most likely avenue by which the student will in fact enter industry on completion of his PhD."

Mott says he has little worry about the loss of university integrity. He says that few of the universities have a close enough involvement with industry that they would lose integrity by increasing involvement.

For its part, industry often demonstrates open hostility to higher academic training as preparation for work in industry. Stephen Bragg, chief research engineer at Rolls Royce and the son and grandson of Nobel-prize physicists, feels that the right way for a young man to advance in industry is to leave the university at the end of his undergraduate days and to gain early experience of the sort of problem that industry has to solve. He would, however, recommend that a man return for postgraduate courses at a later stage and maintain university contacts throughout his career.

Ryle expressed what appears to be the general university view on this question. "The development of advanced devices certainly involves competent engineers," he said, "but it may also require an imagination in applying scientific discoveries that is just not present in young men trained as engineers. It is no use being disappointed if a PhD is given a piece of development engineering and makes a poor showing of it.

"Of course the answer is that organizations with a first-class research laboratory—and Stephen Bragg's is certainly one of these—can give just the same type of training that a university can. It is the less research-minded organizations that are in real need, and unfortunately it is in just these groups that the value and application of PhD's is not understood."

Louis Cohen, permanent secretary of the Institute of Physics and the Physical Society and a former industrial physicist, told me that students still have "a degree of suspicion" of industrial physics. In an effort to correct the error Brian H. Flowers of the

University of Manchester held a two-day conference last March involving the University of Manchester, the Institute of Science and Technology of the University of Manchester and the University of Salford. The conference drew about 200 registrants, but despite the best efforts of industrialists to tell their story, the lectures seemed to scare the students away rather than encourage them to turn to industry. Cohen and IPPS hope to start an educational program aimed at correcting wrong mental attitudes.

US-UK differences

For what reasons are the United Kingdom and the United States so different with respect to academic-industrial relations? I asked the question of several persons and got several answers, most of them similar. Mott, for example, says that British education is poor training for scientific managers because scientists specialize too early and neglect the human part of their education. Through their early specialization, too, he says, many potential managers are turned away from their study of science.

Sir Gordon Sutherland, master of Emmanuel College, Cambridge, and a recent president of the Institute of Physics and the Physical Society, speaking in a similar vein, said that the US is more appreciative of its scientists. Top management in the US is usually much more technically oriented than in Britain.

Clifford C. Butler, head of physics at Imperial College, London, pointed out that Britain has no great industrial laboratories of the Bell and International Business Machines type to improve the image of the industrial laboratory.

Bowden spoke of the "Edisonian way" in which US science has developed, and Sutherland, too, said that in his experience able young US scientists are much less prejudiced against

applied science and technology than the corresponding men in the United Kingdom.

Several of the persons I talked to, Butler in particular, feel that British industry fails to recruit and use scientists wisely; consequently it fails to keep the ones it gets. Sutherland spoke of the contrast between the ways US and UK firms treat their PhDs. At Michigan he had a graduate student who went to work for a well known large company. For a year or two the company gave him all facilities to let him continue his PhD work as he saw fit. By the end of that time, said Sutherland, the company had sized up the man, and the man had been skillfully introduced to certain company problems. In fact he had become much more interested in them than in his original academic work. Soon he was accomplishing difficult and interesting research that was useful and became integrated very happily into the research program of the company.

Often in Britain, said Sutherland, the company establishes a research laboratory partly for prestige reasons and then virtually forgets it. Persons working there go their way and the company goes its own with little mutual understanding or appreciation. Eventually someone in management decides that the laboratory is an unproductive expense and abolishes it.

Another circumstance that has limited the flow of physicists into British industry in recent years is the ready availability of academic jobs. It is a temporary situation caused, during the last two decades, by rapid expansion of British universities and the creation of new universities and technical colleges. Ryle pointed out that this expansion is nearly complete and industry will have a better buying position in the future.

Difficulties of small companies

Economics makes the way of the do-it-yourself industrial scientist a difficult one. Unlike the United States, from whose universities have grown many corporations like Varian Associates, Polaroid and High Voltage Engineering Corp, Britain has few companies that have budded from its physics departments and then blossomed into maturity and independence. In Ryle's

view the reason is size: "I think the main difference can be attributed simply to the smaller market for any new device—at any any rate until an export market can be built up."

Martin Wood, president of Oxford Instruments Ltd, showed me the difficult path he has followed to sufficient venture capital. Wood is an engineer at Oxford's Clarendon Laboratory and a fellow of Wolfson College. Feeling that the magnets and cryogenics he was working on had commercial potential, with his wife Audrey, he set up the company to exploit it. At first their financial support came from bankers who were personal acquaintances. Difficulties soon arose as they needed more capital on longer terms—not the normal business of British banks. Recently the company won a "Queen's Award for Industry" for "outstanding technological innovation," and Technical Development Capital Ltd, a purely commercial consortium of several banks and insurance companies with what Wood refers to as "an enlightened policy on venture capital," came forward and provided long-term finance on acceptable terms.

Butler, too, expressed his feelings that British industry is too conservative and that little risk capital is available for an enterprise that may pay off but also may fail. Sutherland agreed with this analysis.

Studying the problem

Faced with a situation that they recognize as a threat to their country and its science, many British physicists have involved themselves deeply in finding out what is wrong and contriving remedies. Last March a working party set up by the Council for Scientific Policy under Sutherland issued a report² on relations between universities and government laboratories, between which far more contact and mutual assistance is needed. This report received very favorable comments from all parties in a House of Lords debate last June, and it is already having considerable influence in accelerating a growing liaison between universities and government research establishments. The Secretary of State for Education and Science has had two committees at work on scientific-manpower studies. The label for the Dainton committee is "Enquiry into

the Flow of Candidates in Science and Technology into Higher Education." Another, under Michael M. Swann, principal of the University of Edinburgh, is termed a "Working Group on Manpower Parameters for Scientific Growth." It issued an interim report³ in October 1966.

The Swann report inspired Kurti, cryogenic expert of the Clarendon and Stanley G. Hooker, technical director of Bristol Siddeley Engines, British Aircraft Corp, to make their own effort. On behalf of the Royal Society they called two meetings to find out what industry-university relations are and what they should be. Last March they invited about 30 participants, 20 of them industrialists and the rest from universities, government establishments and the Royal Society. They asked the group to consider questions like the following: What sort of scientists and engineers does industry want? Does industry use them correctly? Why is recruitment difficult?

When I talked to Kurti recently at Oxford, he said that the first conference revealed a depressing lack of understanding and agreement among the participants. There were two diametrically opposed views about the nature of training for engineers. This diversity of opinion was exemplified by the remark of one of the university



RYLE, talking with the author



COHEN



SUTHERLAND

people that "all industrial training officers should be shot," which drew the reply that engineers' training would be greatly helped if the treatment were accorded to university professors of engineering.

The lack of agreement inspired Kurti and Hooker to summon another conference of 30 persons, 16 of them from industry, and restrict it to only two subjects: What type of collaboration should exist between universities and industry? To what extent should universities award degrees for work done in industry?

Several formulas that emerged are likely to define some academic programs of the future. For example, a man might put in his first year of graduate study in a university and then do his thesis work under university supervision in an industrial laboratory. Perhaps three or four PhD candidates would be allowed to combine efforts on a single project. Of course a cooperative project sometimes serves the purposes of several candidates now, but the pattern matches that of the US: At least for the records the university maintains the fiction that each man does an independent piece of work.

Another suggestion is a two-way migration of senior personnel between industry and university. Some university people would like to see more industrialists contributing a year at a time to the universities. Speaking of the conferences he and Hooker managed, Kurti told me, "The emphasis here was on encouraging more industrialists to get associated on a continuing but very much part-time basis with universities by their accepting visiting or associate professorships. At the same time many people thought that consulting by university people in industry should not be restricted to the senior staff but that younger men should be encouraged or given an opportunity to do so."

Others, too, want more professors to act as consultants to industry, and at least one of the British universities has established a pool with the intention of locating professors who have the knowhow to solve industrial problems. Cohen feels the technical colleges will establish liaison offices for closer academic-industrial contacts.

What is to be done?

I found that all of this discussion has led to considerable agreement about what is to be done and what steps should start it. Ryle and Mott both feel that industry is going to learn to use its PhD's better. Bowden and Cohen feel that more consultant relations will appear. Bowden, who has been for some time a director of English Electric Co and a professor at Cambridge, feels more dual associations like this can build a bridge between ivy-covered walls and factory rooftops.

Bridges of this type, he says, can help establish and maintain a real working contact, and it is this contact and mutual understanding at all levels that is essential. He points out that some academics underestimate not only the quality and excitement of the research work but also the ability and originality of the scientists in industrial research laboratories. In many of the leading British industrial organizations these properties are very high, and management makes effective use of both research and scientists. The main difficulty is to get enough scientists. Bowden thinks that the present policy of the Royal Society in electing as fellows distinguished workers in applied science and also in making awards in technology is a helpful move.

Sutherland suggests short sabbatical leaves from industry so that industrialists can be students, guest professors and industrialists in residence.

Changes within the universities,

meanwhile, would permit their laboratory students to take on problems that are related to industry. Mott, for example, feels that the Cavendish now has students at work on many problems that meet the description. Two or three students are working under a special scheme, one of many supported by the Science Research Council, in which they spend part of their time in industrial laboratories. The number, says Mott, could well be increased. Others felt that the universities should allow recognition of not only joint research projects shared between industry and university but also of work done wholly in industry. On this point university scientists are not unanimous.

A joint committee of the Federation of British Industries and the Committee of Vice-Chancellors and Principals of Universities is now studying the problem and the general question of better liaison between universities and industry.

British tradition is rooted deep in the soil of solid accomplishment. Its science, though, is not providing the sustenance that the nation needs in the new climate of an island economy lacking the benefit of colonies and facing the storms of vigorous economic competition. How, then, does one encourage new branches without threatening the main stem that has supported great accomplishments from the birth of modern science to the present? No one is quite sure, but physicists are determined to find out. One feels they will succeed.

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