

# The Academic-Industrial Complex

*A host of new agreements for industrial sponsorship of academic research are the focus of a growing debate*

At the Massachusetts General Hospital (MGH), Howard M. Goodman is setting up a new Department of Molecular Biology that will have a staff of 50 and ample research facilities. Its senior scientists will be recommended for faculty appointments at the Harvard Medical

throughout the United States, particularly those on the East and West coasts. From the university's point of view, the special appeal of the burgeoning industrial connection is quite simple—money. Federal support of basic research has been gradually declining for the past

that, in nearly every case so far, industry has chosen to support specific individuals whose research talents are complementary to its needs. Industry, it is worth noting, is not bestowing large, "string-free" grants for universities to distribute on the basis of peer review. For example, when Hoechst decided it wanted to create a department for Howard Goodman to head, no MGH or Harvard Medical School committee was asked for advice. That is the norm.

Although universities have had corporate ties of one sort or another for years—traditional patterns of faculty consulting are a case in point—the present concentration of industrial interest in academic science is generating no small measure of concern about whether the academy is selling its soul. There are some common elements to these new university-industry connections, but there is no set pattern to the agreements, which take a variety of forms as attempts are made to devise ways of writing contracts that offer maximum protection to academic values. A few examples suggest the range of new linkages between industry and academe.

• Channing Robertson of Stanford University and Harvey Blanch of the University of California at Berkeley each will receive approximately \$1 million over 4 years to support basic research in the development of chemical processes using genetically engineered microorganisms. The money comes from the Center for Biotechnology Research, a nonprofit organization which, in turn, is financed by a for-profit company called Engenics. Engenics was formed recently with capital from six major corporations—Bendix, General Foods, Koppers, Mead, MacLaren Power and Papers, and Elf Technologies of Société Nationale Elf Aquitaine—which see great promise in the work Robertson and Blanch are doing. Licensing agreements with the universities assure Engenics rights to commercially-useful research; if Engenics flourishes, so will the nonprofit center, which will derive future income from its 30 percent equity interest in the company. The center must spend its resources on basic academic research. This unusual nonprofit/for-profit union

The recent growth of industrial investment in academic science has raised a number of ethical and legal issues applicable to the formation of university-industry relations. Throughout the United States, universities are struggling to develop guidelines that will permit collaboration to take place without seriously compromising traditional academic values. In a series of articles, News and Comment will examine some of the major new agreements and assess the implications of the academic-industrial complex.

School, with which MGH is affiliated, but their support will come exclusively from Hoechst AG, a German pharmaceutical firm. Hoechst has founded the new department with a contractual guarantee of nearly \$70 million over the next 10 years. That figure is a minimum; it could well be supplemented if Goodman's research team is productive in ways that are valuable to the company. In exchange for the \$70 million, MGH has agreed to grant Hoechst exclusive worldwide licenses to any patentable developments that emerge from company-sponsored research.

At the Harvard Medical School itself, another new department is being established with substantial industrial investment. E. I. du Pont de Nemours & Company will spend \$6 million over 5 years to support the new Genetics Department headed by Philip Leder. DuPont is not the sole support of the department, but it will receive licenses to market any commercially useful research for which it has paid.

At Rockefeller University, Chua Nam-Hai is conducting research on the structure and regulation of plant genes involved in photosynthesis. As of this spring, Chua's work will be supported by a 5-year, \$4-million contract from the Monsanto Company, which will receive licenses to market patentable discoveries.

During the past 2 years, corporate investment in academic science has proliferated at major research universities

decade, and the situation has now been measurably worsened by the dismal state of the economy and the Reagan Administration's determination to reduce government spending. Grants from the National Institutes of Health (NIH) and the National Science Foundation, for example, are fewer in number and harder to get. For universities to turn to alternative sources of research support is not only prudent but downright essential. Scientists who 10 years ago would have snubbed their academic noses at industrial money now eagerly seek it out. University biologists who have collaborated throughout their careers only with each other are learning that collaboration with industrial scientists can be intellectually stimulating too.

From industry's point of view, its present investment in academic research arises not from some altruistic desire to help compensate for lagging federal support but rather from the very businesslike judgment that universities have something corporations want to buy—research talent and technical skill. Recombinant DNA technology, for instance, which is on the verge of great commercial exploitation, has its intellectual roots on campus. But with rapid scientific advancement, the conventional distinction between basic and applied research has become blurred. The molecular biologists who have invented and developed recombinant DNA work thus have become a commodity of considerable interest to corporations. The fact is

was pioneered by Stanford as a way of putting organizational distance between the university and the corporate world that is supporting university research.

• In another variation on the university-industry theme, Kenneth L. Melmon, chairman of medicine at Stanford, has invented the Institute of Biological and Clinical Investigation as an institutional buffer between faculty and business. Under the umbrella of the institute, some 80 senior faculty in the Department of Medicine become a kind of consulting collective to accept blocks of money from corporations in exchange for an agreed-upon number of days of consulting time. So far, Syntex and Hewlett-Packard have signed on as institute sponsors. For the next 3 to 5 years the institute will thereby provide the Department of Medicine with some \$600,000 a year, which will be used exclusively to support research by its junior faculty.

• The area in which corporate activity is greatest is biotechnology, but there is substantial industrial interest in academic research in energy and microelectronics as well. For instance, combustion research at the Massachusetts Institute of Technology (MIT) is being funded by the Exxon Research and Engineering Company. Under the terms of a 10-year agreement signed in 1980, Exxon will invest between \$7 million and \$8 million in research carried out under the direction of John P. Longwell and Adel F. Sarofim. If patentable discoveries result, MIT will grant Exxon royalty-free licenses for their commercial development.

• A new Center for Integrated Systems at Stanford is being established with funds from 17 microelectronics firms that are putting up approximately \$12 million for the construction of a new building. Negotiations for research support are under way. An interesting feature of this arrangement is that the center's corporate sponsors will be entitled to have their own scientists on site full time, thereby providing them with virtually unprecedented access to graduate students and academic research in progress.

• Another, and somewhat different, manifestation of the university-industry connection is the growth of small biotechnology companies that are popping up around the major research universities. Financed largely by venture capital, these companies each have ties to academic scientists who often have accepted equity positions or have agreed to exclusive consulting relationships. A majority of the country's leading researchers in molecular genetics and re-

lated disciplines are known to have affiliations with these new, highly competitive companies.

The potential ethical dilemmas that these university-industry connections pose seem to be legion. As William Griesar, the attorney who negotiated the contract for Hoechst, observed at a recent colloquium sponsored by the Association of the Bar of the City of New York,\* "The sheer magnitude of the Hoechst agreement raises important issues about university-industry relationships." Few observers expect there will be many contracts that rival Hoechst's in terms of dollars, but virtually all of the existing and anticipated arrangements present an implicit challenge to traditional academic values that university administrators and faculty are desperately trying to sort out.

The most evident manifestation of academic soul-searching occurred recently when the presidents of five universities convened a small, private conference† in Pajaro Dunes, California (*Science*, 9 Apr., p. 155). With 11 corporate leaders as "resources" for the discussion, the presidents and invited colleagues spent 2½ days contemplating questions such as these: How can universities preserve open communication and independence in the direction of basic research while also meeting obligations to industry? Is it acceptable for one corporation to dominate research in an entire department? Are there adverse consequences in terms of collaboration among faculty in various departments if one group must worry about protecting corporate rights to licenses? Will patent and licensing provisions delay scientific publication? Should corporate sponsorship be subject to peer review? Under what conditions may a faculty member have an equity position in industry? Do such ties compromise loyalty to university teaching and research? Will graduate students be compromised or poorly served? Will extensive corporate ties erode public confidence in university faculty as disinterested seekers of truth?

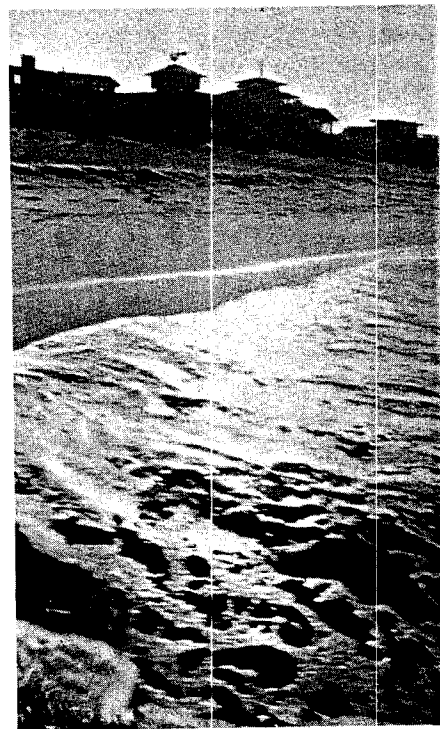
The conferees agreed on the importance of the questions but reached no consensus on the specifics of their resolution. But they did concur with the notion that universities' interest in industry is not entirely self-seeking. The collaboration, they said, also promotes the

\*"Can the Law Reconcile the Interests of the Public, Academe and Industry? Learning from Experience in Biotechnology" (Association of the Bar of the City of New York, 21 April 1982).

†Initiated by Stanford president Donald Kennedy, it was also sponsored by Derek C. Bok, Harvard University; Paul Gray, Massachusetts Institute of Technology; Marvin Goldberger, California Institute of Technology; and David Saxon, University of California.

public good, thereby justifying the fact that corporate profit will be made from research that was publicly funded in the first place. In a bow to the god of technology transfer, the Pajaro Dunes statement said, "There are several strong motivations for academic institutions and their faculties to seek industry support for research. First, there is a genuine interest in facilitating the transfer of technology—from discovery to use—to contribute to the health and productivity of society."

In his annual report to the Overseers of Harvard University,‡ president Derek C. Bok reviewed the values of technology transfer and observed, "With hard work and a bit of luck, a university might



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Industry funding and academic values were debated at Pajaro Dunes.

conceivably contribute to the nation's prosperity in ways that could increase its own resources, in order to strengthen its research effort to make still further contributions to the economy—and so on in an endless, synergistic process."

The university needs industry's money; it articulately states the rationale for accepting it. Why then, Bok asks, does the prospect "arouse anxiety on the campus of almost every distinguished research university?" The causes of concern, he writes, "... flow from an uneasy sense that programs to exploit technological development are likely to confuse the university's central commitment to the pursuit of knowledge and learning

‡*Harvard Magazine*, May-June 1981.

by introducing into the very heart of the academic enterprise a new and powerful motive—the search for utility and commercial gain.” He notes that “Academic scientists have always feared what Vannevar Bush once termed ‘the perverse law governing research,’ that ‘applied research invariably drives out pure.’ ”

There is a role for industry to play in the resolution of these conflicts, but as Edward E. David, Jr., president of Exxon Research and Engineering said at the bar association colloquium, “There is going to have to be compromise on both sides.” Researchers, for example, are likely to have to accept some delay in publication while corporate officers review manuscripts with patent applications in mind. Business, on the other hand, will have to curb its insistence on “micromanagement” of research, lest it so restrict academic science that it loses that very creativity it is buying.

Samuel Eletr, president of Applied Biosystems, Inc., of Foster City, California, contemplated the issues as a Pajaro Dunes conferee. “These problems, the ethical questions about conflict-of-interest and so forth, are really internal to the universities which have to decide for themselves what is acceptable to them,” he told *Science*. “There is only so much we can do to help.”

Although what Upjohn Company vice-president Theodore Cooper calls “commercial traffic through university labs” is increasing, it is not clear that it will long continue at the present pace. “The current situation is an aberration,” Rockefeller University president Joshua Lederberg said at the bar association colloquium in New York. Biotechnology caught industry “napping” and companies are now scrambling to catch up by drawing on university talent it does not yet have in-house. Or as attorney Griesar put it, “Industry is going back to school to learn genetics because it has fallen behind.” Applied Biosystems president Eletr also thinks the present situation is somewhat aberrant. There is a kind of “time compression,” he says, as far as basic and applied science are concerned that makes things different from previous instances of business capitalizing on university research. “Usually,” says Eletr, “the time between an invention and its full commercial development—the transistor, for instance—is a period of many years, a decade or two. But with biotechnology the promise of commercial development seems to be a very short time away. Two or three years maybe.” Industry saw the promise in molecular biology but hadn’t the “foggiest” idea about what was going on.

“Once industry catches up,” Eletr predicts, “things will be less frantic, industry will breathe a little easier.”

There is ample evidence already that industry is taking substantial steps to establish in-house strength in biotechnology. Its very collaboration with university scientists is part of that effort. Most of the present agreements, in addition to patenting and licensing provisions, also contain terms for university training of industry researchers. Through contractual provisions for seminars, prepublication copies of scientific papers, and arrangements for exchange of scientific personnel, industry is making sure it is getting an education for its investment. This new, and from the university’s vantage newly respectable, association with academe is also providing industry with unprecedented, informal access to the doctoral students it may wish to lure away from academic life. [Indeed, when Monsanto signed a \$23-million contract with Harvard for the support of cancer research by Judah Folkman and Bert Vallee (*Science*, 25 Feb. 1977, p. 759), the company declared that it was as interested in the basic biology it could learn from the collaboration as it was in any specific product that might result.]

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## Investment in academic science is one foundation of industry’s effort to develop the capacity to conduct biotechnology research in its own laboratories.

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In addition, many of the major pharmaceutical and chemical houses are currently beefing up their own capacity for research in molecular biology—Upjohn, Monsanto, and Allied Chemical among them. DuPont, which has collaborative agreements with researchers at the University of Maryland and the California Institute of Technology as well as the new one at Harvard, reports spending \$120 million on life sciences research in 1981—33 percent more than in the preceding year. A new DuPont laboratory for biotechnology research in medicine and agriculture is being readied; the company says it will create 700 new jobs. Eli Lilly and Company also recently announced plans to open a new Biomedical Research Center for which it will hire 600 scientists and technicians to “allow significant expansion of research with recombinant DNA technology.”

The list of major corporations joining the ranks of the molecularly savvy is long; observers see at least two predict-

able consequences. First, these corporations can be expected to acquire or drive out some of the small, scientist-founded biotechnology companies of which there now are nearly 200. That in no way abrogates the present need for conflict-of-interest guidelines but does suggest that some of the tensions attendant to large numbers of faculty with a personal stake in a fledgling business will fade.

Second, as Eletr notes, industry soon will begin to “breathe easier,” and the frantic pace of negotiations and investment will slow down. In the present political and fiscal climate, industry is seen as a complement to government in support of basic research. But corporate officers are quick to refute the notion that the private sector has the resources to even begin to take government’s place. Nor does it see as its responsibility the funding of fundamental science for its own sake. Industry will generally support only that basic research that fits its short-term interests.

Although recent agreements in the several million dollar range command considerable attention, the fact is they are relatively few in number and highly specialized as to research. According to Edward David of Exxon, industry now

spends about \$200 million a year in support of academic research nationwide, which is about 4 percent of the federal commitment. David, a former presidential science adviser, says, “I advocate tripling that amount to \$600 million or 15 percent of the federal effort.” Were that to happen, corporate support would still be comparatively small. (Even in these stringent times, the NIH budget alone is more than \$3.5 billion a year.)

Nevertheless, if a constant, stable pattern of corporate funding emerges over the next decade, industry’s influence on academic science, particularly biology, could be significant. Several of the recently signed contracts have been described optimistically as “models” of the way university-industry agreements ought to be. The validity of that assessment is becoming the subject of important debate as administrators and faculty try to come to grips with the new academic-industrial complex.

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