Forging new and stronger links between university and industrial scientists

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Item: U.S. university campuses are a vast reservoir of fundamental science. Nearly 60% (almost $5 billion this year) of the funds the U.S. funnels into basic research of all types winds up in academic laboratories and affiliated research institutes. For basic research in chemistry, the universities' share is a more modest 30%, but still a significant $200 million effort.

Item: Pressed by public demands for a quick fix for such social and economic problems as pollution and energy shortages and beset by stiffening technological competition from abroad, industrial scientists express growing concern about U.S. industry losing its long-vaunted innovative edge. Concern about lagging productivity and dwindling innovation is widespread in industry.

Item: University scientists long have been accustomed to look to the federal government as their principal benefactor. Two thirds of all research and development done in universities and colleges is bankrolled by federal agencies. Nearly 80% of academic R&D in chemistry is government supported. But budgetary constraints have slowed the flow of federal funds at a time when rampant inflation has sent the cost of doing research spiraling upward. The consequence, more and more academic researchers lament, will be an eventual drying up of the reservoir of basic knowledge.

Item: In recent years, industry has been more generous than the government in raising its R&D budgets. During the 1970's, outlays for both the chemical industry and all U.S. industry were rising at a 10%-a-year clip—or 3% a year if you factor out inflation. Government support, on the other hand, has shown only a 7% annual increase—which means it has been barely holding its own against price increases.

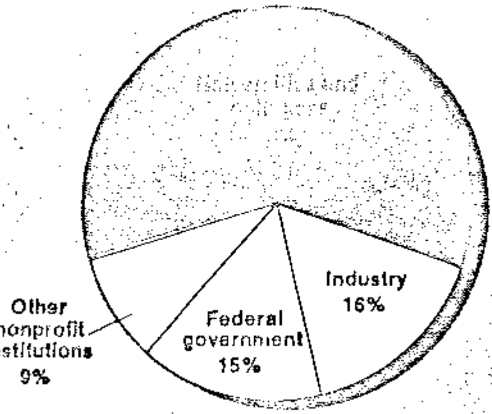
Given these trends, it is no surprise that in the past few years an increasing number of the movers and shakers of the U.S. research community, both in industry and academia—and in government agencies, as well—have concluded that a warmer partnership between U.S. corporations and U.S. universities would have great mutual benefits. Industry could then tap more effectively the academic reservoir of basic scientific knowledge. And schools of science and engineering would have a new (and perhaps more compatible) benefactor to tap for funds. "It's an idea," says Alfred E. Brown, director of scientific affairs at Celanese, "whose time has come."

It's an idea, too, that has been discussed increasingly whenever the makers of science policy have gotten together recently. Just this fall, for example, the subject was on the agenda of the annual meetings of the National Academy of Engineering and the Industrial Research Institute. It was the focus of the second annual conference on cooperative advances in chemical science and technology at Lehigh University last September. The National Commission on Research, which disbanded at midyear after a two-year study of key issues affecting the health of research and innovation in the U.S., issued a report last summer recommending improved cooperative research relationships between industry and the universities. A similar analysis on university/industry cooperation and its relationship to innovation was released by the Center for Science & Technology Policy of New York University in June. Such cooperation also is being studied by the General Accounting Office.

It is clear, from all this discussion, that the idea has many strong advocates. Equally clear, however, is the wide disagreement about how best to forge stronger links between academic and industrial research. The issue obviously poses many unresolved dilemmas. Is cooperative research a threat to academic freedom? How do you overcome the inherent conflict between industry's need to safeguard proprietary information and professors' desires to communicate with their academic colleagues? Who should profit from the results? How are goals set? Can the academic lamb really lie down safely with the industrial lion?

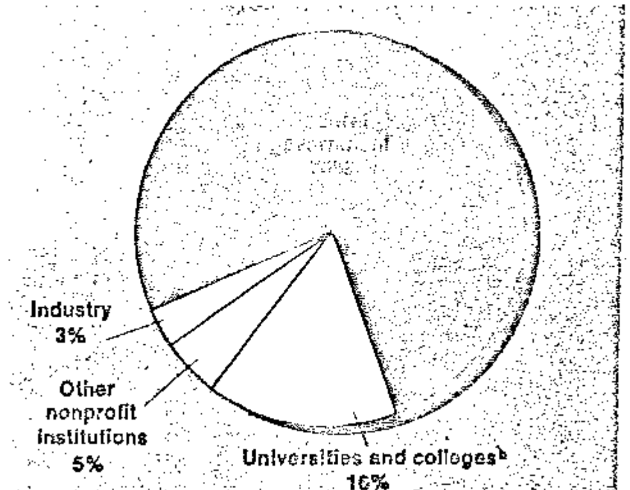
On the other hand, industry/university collaboration is not a radically new idea. Companies and the academic community long have recognized that they have many mutual research interests. Industry relies on the universities for the scientists and engineers who staff its

Majority of basic research is done in the universities ...



1980 total spending for basic research = $8.2 billion

... and they get most of their money from federal agencies



1980 total university spending for basic research = $4.9 million

a Includes federal R&D centers administered by universities. b Includes state and local government funds. Source: National Science Foundation

R&D facilities, just as the universities look to industry to absorb a large share of their graduates. There is a considerable flow of both ideas and people between companies and campuses. Many industrial firms are accustomed to turn to the academic world as a fertile source of expert advice, and professors find consulting fees a welcome extension of their regular salaries. Less frequently, professors spend a summer or a sabbatical year working in industrial labs, while industrial scientists or engineers teach as adjunct professors on university faculties. Continuing education programs, short seminars, cooperative study programs, and the like all have helped in the transfer of knowledge and experience between schools and companies. Industry executives serve on academic advisory committees and boards, while university people provide similar service to industry. Chemistry Nobel Laureate Melvin Calvin of the University of California, Berkeley, for example, has been on Dow Chemical's board of directors since 1964 (and a Dow consultant since 1946). At the same time, companies have long supported university scientists and engineers with contracts, grants, and contributions.

But financial ties, which had been relatively strong before and during World War II, gradually weakened following the war as government spending for research (on defense, nuclear energy, and medicine, for example) ballooned. In the mid-1950's, federal agencies provided about 55% of the funds spent by the universities and colleges on research. Industrial firms accounted for about 8% of the funds. (The balance came from state and local governments, foundations, private voluntary health agencies, and the like.) By the late 1960's, with the U.S. space program in full bloom, the government's share of academic R&D outlays had expanded to more than 70% of the total. Industry's share fell to under 3%.

Now the tide is showing some signs of running the other way, although not very strongly yet, to be sure. This year, according to estimates by the National Science Foundation, the government will fund about two thirds of all academic research and development, whereas industry's share is up slightly to about 3.5%.

That's still quite small, to be sure. This year, industry is expected to supply only $210 million for academic R&D, out of a total spending by the universities and colleges of just over $6 billion. Perhaps more to the point, however, industry spending for R&D overall has been growing at an appreciably faster clip than government support and actually may surpass total government outlays sometime during the next couple of years. In fact, during the past decade industry outlays for R&D have been growing at a rate nearly half again as fast as government spending. Nearly all of what industry spends, of course, supports its own laboratory and pilot plant efforts. But it's clear that at a time when federal budgets for R&D are appearing more and more niggardly, industry looks more and more promising as a source of funds.

But money—or, to be more exact, the lack thereof—is not the only basis for a growing disenchantment on the part of the academic research world with government support. University scientists also complain about increasing paperwork and red tape involved with federal grants and contracts. They may not argue with the basic premise that they must be accountable for the taxpayers' money that they spend. But many are becoming increasingly annoyed by the detail with which they justify their efforts. Accounting for the time and funds they plow into their projects seems an increasingly onerous and unproductive task. Academic researchers also are increasingly concerned about the reluctance, during a period of high inflation rates, of government agencies to bear all the costs for the research that they support, especially such indirect costs as administration, utilities, and library services. The tendency of federal support, when budgets are limited, to focus on short-range projects with a quick payoff and on small projects of short duration also is a cause for aggravation.

Thus there are reasons enough for academic researchers to seek new sources of support and to turn in that search to industry.

More interest from industry

This renewed interest, moreover, is not a one-way street. Industrial researchers' worries that their companies are losing their technological edge in an ever more competitive world has been leading them to look with greater interest on academic research. The universities, after all, perform most of the fundamental research that is the base for industrial innovation. They have come to recognize, too, that such research often can be undertaken most effectively in a campus setting and that to duplicate the facilities and staffs available in academia at industrial laboratories would be both wasteful and unproductive. They realize, too, that healthy universities are essential, as sources of trained personnel and basic research, to their own well-being, and that industry could promote this health by better collaboration. And they are aware, also, that the investment they would have to make probably would not be all that great in the overall scheme of corporate finance.

There are, of course, several obstacles that have in the past limited the extent of industry/university ties, especially during the past couple of decades. Perhaps foremost among these is the emphasis that industry has placed, in recent years, on short-term R&D goals with clearly attainable payoffs. Disillusioned with the results of unstructured, free-wheeling research once much in vogue, they lost interest in fundamental work. Funds for such research dried up as a result.

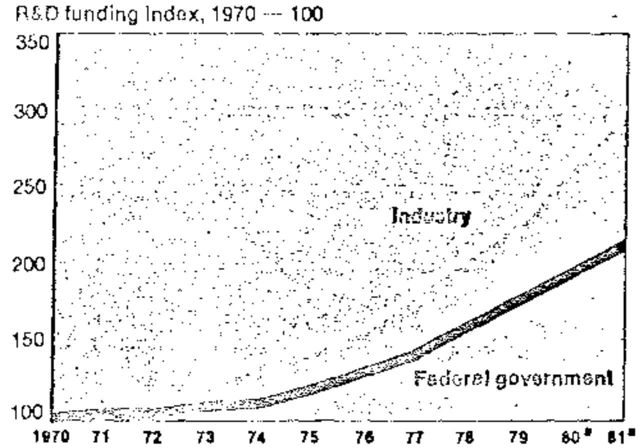
Another troubling issue stems from the distinct differences in the research environment between industry and academic labs. University scientists are jealous of their academic freedom. They want to work on projects of their choice and to publish their results freely. In the competitive, profit-motivated world of industry, the results of R&D typically are proprietary secrets of considerable commercial value; public disclosure is anathema. Patent rights are another contentious issue. The years of campus unrest in the late 1960's and early 1970's also weakened industry/academic ties, especially when companies producing defense-related or environmentally suspect products were involved.

What is new at present, however, is that the obstacles to industry/university collaboration on research seem to be increasingly outweighed by the perceived advantages. Industrial researchers and their academic counterparts are coming to recognize that although their objectives and working conditions may not be identical, they really do have much in common and can work together effectively.

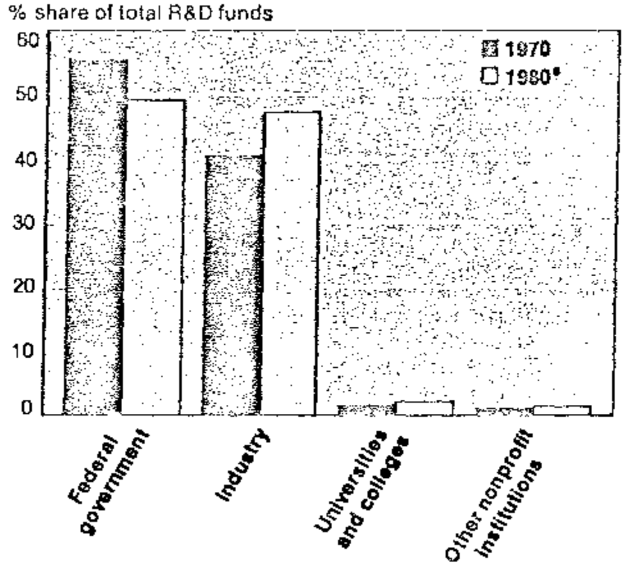
Cases in point:

- Exxon's agreement with Massachusetts Institute of Technology, signed last spring, to fund research on combustion over a period of 10 years.
- Monsanto's even more ambitious joint effort with the school of medicine at Harvard for research on molecular biology. The 12-year agreement, initiated in late 1974, calls for Monsanto to provide up to $23 million to equip a laboratory at Harvard and support research on the biochemistry of malignant tumors over a 12-year period.
- Current efforts in the chemical industry to establish a Chemical Research Council. Membership would be drawn from both the chemical industry and the universities to forge stronger research relationships between industry and academia and provide a conduit by which industry could funnel increased funding for research to university chemistry and chemical engineering departments.

Industry increased its R&D spending faster than government in 1970's...



...so that its share of the total has grown from 40% to nearly 50%



* Estimated. Source: National Science Foundation

Encouragement from federal agencies

These and other direct university/industry ties are being encouraged by government agencies, notably the National Science Foundation. The two key efforts at NSF are its industry/university cooperative research program and its university/industry cooperative research centers experiment. The first provides grants in partial support of individual research projects involving the collaboration of both academic and industrial researchers. The second helps establish and temporarily support research centers involving the participation of both universities and industrial firms.

The cooperative research center program got under way about seven years ago with NSF funding centers (which then were essentially experimental in concept) at North Carolina State University for research on technology for producing furniture, at MIT on processing polymers, and at Mitre Corp. on technology for New England's electric utilities industry. In the last program, Mitre served as a link between the industry and university researchers: The plan was that support would shift from NSF to the industrial participants over a period of five or so years, on the premise that by that time the program would be self-supporting from industry funds.

Neither the furniture institute nor the Mitre center proved successful. The furniture institute never attracted the strong industry support that had been hoped for. Funds from furniture makers dried up during the recession in the industry in 1975 and 1976. Adequate, sustained leadership never was attained. The institute, too, may have been oriented too much toward a broad in-

Harvard courts gene-splicing venture, then demurs

Harvard University's recent, somewhat unusual flirtation with venture capitalists trying to set up another new molecular biology-based commercial enterprise has more or less ended. But in the aftermath, the affair may provide some insight into and help to define the boundaries between the academic and industrial communities.

A good deal of confusion has swirled about the public side of Harvard's gene-splicing business plans. How much that confusion contributed to the widespread outcry against the plan is impossible to measure. Nonetheless, outcry, not only from a large contingent of Harvard faculty members but from the wider academic community across the U.S., forced Harvard president Derek C. Bok to drop plans for the university's direct participation in a new enterprise. Just what was all the hullabaloo about?

Harvard has been involved since 1975 in an "active technology transfer program," according to university general counsel Daniel Steiner. Out of that program, which has relied primarily on establishing patent licensing arrangements, grew a plan to get on the molecular biology bandwagon.

"We started discussions with Mark Ptashne last spring," Steiner says. Ptashne, a professor in Harvard's department of biochemistry and molecular biology, has done extensive research in molecular genetics and biochemistry. With a Japanese collaborator, he recently devised methods for producing interferon in bacteria. Those methods have commercial potential. But so do the methods of several other research groups, including groups that are plugged directly into commercial enterprises, such as California-based Genentech and Biogen in Switzerland, that are actively trying to realize that potential.

The discussions with Ptashne were "initiated by Harvard," Steiner says. And it was "Harvard's idea to initiate and form a company." Such a company presumably could have quickly entered the arena to compete with the growing number of other enterprises—including perhaps a dozen small independent ventures in North America and Europe, as well as teams in many of the large pharmaceutical and chemical corporations—now seeking to capitalize on recombinant DNA technologies.

Harvard's plan to form a new company naturally required a source of investment capital. "Harvard spoke with outside venture capitalists to supply capital and expertise to start," Steiner says. But Harvard's plan differs from those of others in that the university was to be a shareholder in the enterprise, although without furnishing any of the initial capital. Nor was the university to furnish space or its name to the company's operations.

Some details of the plan have been publicized in garbled form. But Harvard's Ptashne and Steiner insist that the role proposed for Harvard was to have been strictly limited. "There was to have been no general involvement of other Harvard resources," Ptashne says. The new company was to have been "just like any other company. The only thing different is that Harvard would have owned 10% of the equity."

Harvard's share of the equity and some arrangements for royalties on eventual sales and revenues were offered in exchange for "patents in my lab—only my lab," Ptashne says. This detail of the Harvard plan has received confusing treatment in the press, perhaps because of the way it was presented to the press.

Two things don't appear to fit together. One is Steiner's statement, backing Ptashne's, that the Harvard plan "did not call for broad-scale involvement of the faculty in general." The other consists of statements in a memorandum prepared by Steiner, part of which was excerpted in the *New York Times'* initial account of the plan. In that memorandum, Steiner raises several issues concerning the mixing of academic and commercial endeavors. Particular examples at least hint at broad-scale involvement of Harvard faculty and the potential problems that might arise in such a situation. However hypothetical those examples were intended to be, they have helped to spread confusion as to just who at Harvard was to be included in any actual plan.

This misunderstanding, if that is what it is, has figured importantly in the ensuing barrage of criticism. For example, Stanford University president Donald Kennedy was quick to criticize Harvard's seeming plans and to distinguish them from Stanford's involvement in recombinant DNA-based research as a means for making money. Stanford and also the University of California have applied for patents covering some of the fundamentals of gene-splicing technology. If granted, these patents could prove highly lucrative. Said Kennedy, "Stanford has an obligation to make certain that a proprietary atmosphere does not come to inhibit free scientific inquiry." His sentiments were echoed widely in newspaper editorials across the country.

"It's possible that if the university is a partial owner that some of the problems of the university and industry could be better handled," Steiner says. Thus the Harvard administration entertained the idea that "with a foot in both camps" the university might overcome some of the traditional problems that have plagued would-be cooperative members of the private and educational sectors. This idea "also created a host of problems," Steiner admits. "We have no good answers to all the questions that have been raised."

Harvard's official position is "not to go ahead" now with the proposed venture. But that decision was predicated on what Steiner calls a "serious expression of concern from faculty at Harvard and outside" the university. "We're not passing judgment on the formation of a company—only on Harvard's participation as a shareholder," he says. And that leaves the door open for Ptashne, or for anyone else, to put together just such a company without Harvard's direct involvement, leaving a very fine line between what might be and what might have been.

Might the outcome for Harvard have been different had the issue not drawn so much adverse publicity? It probably would not have gotten so much attention if "we were talking about a new way to make macaroni," Steiner says. But recombinant DNA technology is hot, and nearly every move in the field is being watched closely and often contentiously. Steiner insists that, for Harvard, "the result is just right." And so he rationalizes Harvard's close brush with starting a business as a valuable, "open" discussion.

Harvard's Walter Gilbert is one of the founders of Biogen. Herbert Boyer of the University of California, San Francisco, is a founder of Genentech. Both of these researchers—and of course thousands of others—have patent agreements of one sort or another with their universities. Do these agreements represent some compromise on academic freedoms?

If they do, they're certainly widely accepted and well-established compromises. Ptashne argues that the difference between the established routes for a university's participating in commercialization ventures and Harvard's recently scuttled plans "is really a matter of degree, not principle.

"Maybe it was a bad idea," he says. "It raised so many hostilities." In raising hostilities, the incident has done little so far in answering the question of when academic integrity actually risks being compromised. And it seems as many people these days are wringing their hands about the failure to make such arrangements as they are at the successes.

Jeffrey Fox, Washington

dustry, with many diverse technological problems: it never was able to focus its work on a single coherent technology.

In the New England Energy Development Systems Center, Mitre was to bridge the gap between research conducted at about a dozen universities, most of them in New England, and the needs for new technology by electric utilities also in New England. But the technology brokerage concept never really was pulled off. The utilities' interest in the technology being offered them was low. Lack of adequate funding from industry, again, was a problem.

The MIT polymer center, on the other hand, in the opinion of most observers has been an unqualified success and is now self-supporting. The center was formed in 1973 with mechanical engineering professor Nam Suh as director. Of $150,000 in initial funding, nearly two thirds came from NSF and the balance from three industrial sponsors. Its objective was to provide long-range basic and applied research needs for plastics processors, while at the same time offering research opportunities and financial support for MIT students and faculty. NSF funding expanded moderately during the first three years of operation, then dropped sharply for the next two years, stopping entirely after 1978. All in all, NSF provided $469,000 to the project.

Meanwhile, industrial participants increased steadily to a present total of 12, which Suh believes is about the maximum that the program can accommodate effectively. The participants cut across a broad range of industries that process and fabricate plastics, ranging in size from such giants as General Motors, Eastman Kodak, and Xerox to such relatively small businesses as Rogers Corp., Instrumentation Labs, and Lord Corp.

The center has worked on projects dealing with such matters as impact forming, injection molding, mixing and pumping polymers, glass reinforcement, and laminating and stamping processes. About 15 projects are under study, largely by graduate students, at any time. They are selected by the MIT faculty, although an advisory committee of representatives from the industrial participants provides suggestions. Strong interaction between the industry and MIT people—through periodic review meetings—is an important factor in the program's success. The fact that the MIT polymer center has been in the education mainstream at MIT, with strong participation by both faculty and students in its operation, is another factor that probably has made it more of a success than either the furniture or the Mitre centers, neither of which ever had very much campus visibility.

As Robert M. Colton, who heads NSF's university-industry cooperative research centers program, puts it, "Leadership is the most important factor in success. You need a university person, preferably well-respected, mature, with industrial experience, and academic tenure, to take charge. But the university itself also must really want the institute, as well, and be willing to commit space and some money and to reward the professors who are involved. There must be no doubt about the academic quality of the research. Finally, of course, it is necessary to have industrial firms who are likewise committed—willing to provide funds, maybe $50,000 to $100,000 each per year, for a sustained period."

Success at MIT has led NSF to try to duplicate its program at other universities. It now is backing eight other centers with funding ranging from $200,000 to $400,000 each. One of these, at the University of Massachusetts, also is involved with research on polymers; it has 13 industrial affiliates, each of whom contributes $20,000 a year, and gets about $250,000 from NSF. Colton believes it is about half-way to the point where it can support itself without NSF funding. Others are at Rensselaer Polytechnic, Kent State, Case Western Reserve, the University of Kansas, Ohio State, Worcester Polytechnic, and Catholic University. All of these are expected to become essentially self-supporting (requiring federal funds for less than 25% of their total budget) within five years of organization. Colton thinks that for at least some of the centers continuing NSF involvement—to help support graduate students, buy equipment, and take care of some overhead—may be needed on a limited scale. Total NSF spending for such centers this year will be $4 million to $5 million, part of which will go to support a somewhat parallel group (six at present) of university-based innovation centers, which concentrate on the needs of small new businesses. The innovation centers are set up to do research on entrepreneurship, provide training in managing small firms, and assist fledgling businesses.

NSF backs collaboration in research

NSF's industry/university cooperative (IUC) research program is a more recent experiment, set up three years ago to encourage, by means of grants, more effective cooperation and communication between scientists in industry and those in universities. The program started with eight projects in 1978 that were funded for a total of about $1 million. In the fiscal year ended last September, 74 cooperative projects received more than $6 million in NSF funds. During the current year, the IUC program hopes to back more than 100 projects, for a total outlay of $15 million to $16 million, according to Frederick Betz, who heads the program.

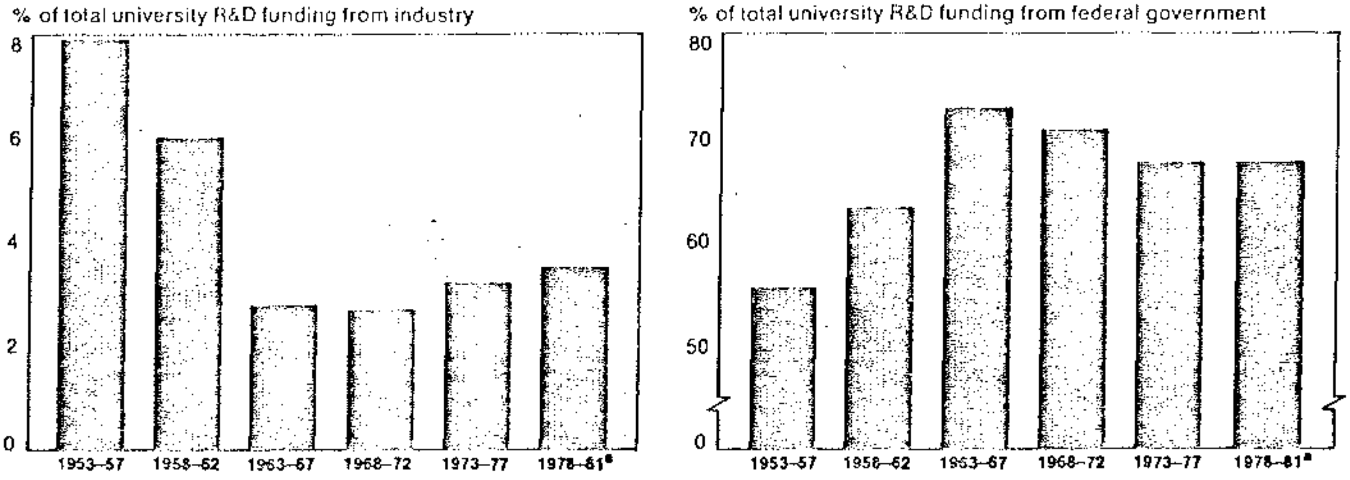
Not all this money comes from the IUC budget itself. The prime consideration for NSF support is that the cooperative research projects deal with first-rate scientific problems. Hence the grants are made jointly by IUC and whichever NSF division is responsible for the area of science or engineering involved. For example, a proposal dealing with a project in chemistry would have to pass muster with NSF's chemistry division—by going through the usual NSF peer review system—before it could win approval. Then support would come from both the chemistry division and the IUC program. Typically, about two thirds of the grant is provided by IUC. Grants are usually roughly $100,000 a year for a two- to three-year period.

Proposals are judged not only on the basis of scientific quality, however, but also on the likelihood of effective collaboration between university and industry researchers. NSF funds are to cover the university's share of the project's cost; companies must ante up between 10% (for small businesses) to 100% of their share. In addition, companies must be actively involved in the research, so that there will be direct and equal collaboration between the university and the industrial scientists. In some cases, one award actually will cover two parallel projects, one run in a university lab and the other in the company's facilities. Proposals must be submitted by both participants. NSF also requires that results be published quickly in a scientific journal.

So far, the IUC program has generated more interest from the universities than from industry. Aerospace firms were generally the first to be attracted, but Betz claims that more and more chemical companies are getting involved. About 27% of the 74 fiscal 1980 awards were for research in materials science, including polymers. However, 16% were for chemical engineering projects and 9% were in chemistry. Perhaps the most successful project so far, though, involves work on new catalysts for a reversible oxygen electrode, a project involving Stanford University, California Institute of Technology, and Hercules. Other chemical projects include a joint investigation of intracavity laser spectroscopy by Illinois Tech

Industry's share of academic R&D support has declined from 1950's ...

... and federal government's share has fallen more recently



a Estimate. **Note:** Data exclude R&D performed at federal R&D centers administered by universities. **Source:** National Science Foundation

and Bell Laboratories, and work on computer identification of mass spectra at Cornell and Hewlett-Packard. Typical chemical engineering projects include studies of membrane reactors done jointly at the University of Pennsylvania and General Electric, and an examination of hydrosulfurization catalysts being carried out by Cornell and Atlantic Richfield.

Two other government-funded programs that are likely to stimulate cooperation between industrial and academic research groups are still on the drawing boards. The Department of Commerce has plans to back the establishment of several cooperative generic technology centers in collaboration with other federal agencies, industrial firms, local government bodies, and other interested parties. These centers are to be designed to do research on technologies that cut across several scientific disciplines and would be valuable to a range of industries.

Commerce, which hopes to be able to spend about $5 million on the program during the current fiscal year, is studying proposals to set up centers to deal with such areas as computer-integrated processing techniques, welding and joining, powder metals processing, and friction and lubrication. The first center to be authorized—just last month—is to be established in Detroit to work on new computer-integrated techniques for forming metals, with initial funding of $1 million from the Commerce program. The plan is that Commerce will supply most of the seed money to get such centers started, then reduce its involvement gradually so that it would be supplying only about 20% of the funds after five years, with industry picking up the balance. What the role of the universities will be in this program is still uncertain, but according to Frederick L. Haynes, who heads the program under assistant secretary for science and technology Jordan J. Baruch, the centers will be encouraged to work closely with academic researchers.

Cooperation for automotive research

The Cooperative Automotive Research Program (which carries the rather unfortunate acronym CARP) will funnel money from the U.S. automobile manufacturers and the Department of Transportation into basic research on automotive technology needed for the 1990's. Unlike the generic technology center program, the aim is not to set up new research facilities but to support basic new work in existing labs, in industry, government, and the universities. The proposal calls for a federal investment of $12 million to get the program going in fiscal 1981, with funding rising to a total of $100 million in five years or so, split equally between the government and the auto industry. Most of the federal funds and part of the industry money will support university research.

These government efforts to encourage industry-academic cooperation have met with mixed reception from their intended beneficiaries. The generic technology center program, for one, has so far drawn scant interest from chemical firms, perhaps because they already are relatively sophisticated in their approach to R&D. It and CARP have been criticized for being too big and cumbersome, involving more participants than can work together effectively. Some critics, too, contend that these big-scale endeavors will be unresponsive to industry's real needs and difficult to close down if they are unsuccessful. On the other hand, the size of the generic centers may make them difficult to sustain by industry sponsors alone for the extended period necessary to generate economically useful results from basic research.

As Edward K. David Jr., president of Exxon Research, has noted: "There may be a few cases where federally inspired generic research could be productive. But these instances will be overwhelmed by the number of failures. The minimum requirement for generic research to be successful is that it have enthusiastic industrial involvement, fine leadership and management, and excellent research people. Such a conjunction will be rare. CARP and other massive proposals do not recognize these requirements."

The auto makers, too, have not been overwhelmingly enthusiastic about CARP, although all of them have now agreed to participate. General Motors, in particular, has indicated concern about the antitrust implications of the program, although both the Justice Department and the Federal Trade Commission have given it their blessing—as long as it restricts its work to "basic" research.

In any event, the fate of both the generic research centers and CARP now hinges on the policies the new Republican Administration evolves regarding science and technology when it takes office next month.

Even the more modest NSF programs have their critics. Some scientists see them as merely inserting an unneeded and costly layer of bureaucracy between the schools and the companies, and encumbering cooperative research projects with wasteful red tape and review procedures. To which Colton responds, "If industry-university cooperation had been taking place without government intervention, fine. Maybe in 10 years, it will. But it wasn't happening very often before we launched our program; in fact, it's only beginning to happen now."

Exxon funds research on combustion

That it is, indeed, beginning to happen on a larger and broader scale is certainly evident. Exxon's recent agreement with MIT for combustion research, for example, meets the criteria many observers say are necessary for successful industry-university collaboration: direct people-to-people relations and extended support. As Alan Schriesheim, general manager of engineering technology for Exxon Research & Engineering, puts it, "Just sending money, without people, doesn't work very well." Adds Peter J. Lucchesi, Exxon Research's vice president for corporate research, "We are primarily interested in the researchers who make up academic centers of excellence, rather than the institutions as such. Our focus is on people, because the whole thing depends on whether you can find a true partnership with some academic group which wants to work with your group."

Exxon will provide MIT a total of $7 million to $8 million over a period of 10 years to study such problems as the burning of coal and coal liquids, shale oil, and heavy crude oil. The object is to develop more efficient fuels. Exxon selects specific projects from a list of proposals generated by the university, and the professors involved will devote at least half their time to these projects. However, MIT can use 20% of the funds available at its discretion for other combustion studies.

MIT will be able to patent results of the work, with Exxon getting a nonexclusive, royalty-free license to use the patents. Exxon and MIT will share any license fees from other users.

This arrangement is similar to Monsanto's 12-year collaborative research project with Harvard, which now is at the half-way mark. Monsanto supplies both money and technology to support Harvard's fundamental research on the biology and biochemistry of organ development. For example, it provides services and large-scale quantities of experimental materials from its research, analytical, and pilot plant programs that Harvard would be unable to produce or buy on its own. Monsanto researchers also work in parallel in their own labs in St. Louis with the Harvard scientists, and ideas and information are exchanged freely. Thus, Monsanto has a window on the current world of biological and medical research, as well as help in building its own research capabilities in areas where it had not been active earlier.

Harvard researchers, in turn, can carry out their work as they see fit and are free to publish their findings. So far, about 100 publications have come out of the program. They also can patent results of the work they do, with Monsanto having an exclusive right for a limited period to commercialize useful products growing out of the research. One unusual aspect of the agreement is an advisory board, whose members have no formal connections with either Harvard or Monsanto, set up to ensure that public interests be served.

Work to date has centered on the mechanism and structural/functional relationships of macromolecules such as proteins which serve as catalysts in hormonal and similar functions in the body. The program continued work previously under way at Harvard on the proliferation of blood vessels, including a study of tumor angiogenesis factor. This substance is thought to be produced by tumors and may play a role in inducing the body to build the new networks of blood vessels needed to support tumor growth.

In addition to one-on-one arrangements such as these, a number of programs have sprung up in recent years by which several companies jointly support university research.

One that has attracted a wide participation from chemical companies is the Center for Catalytic Science & Technology at the University of Delaware. The center evolved out of Delaware's chemical engineering department when Prof. James R. Katzer was seeking money to buy large equipment for catalysis research and talked with some local chemical companies. It started in the spring of 1977, with nine industrial sponsors and some funds from NSF for equipment, to do long-range fundamental research in catalysis problems of interest to industry.

The center now has 20 sponsors, most of them either chemical or petroleum companies, each of whom provides $25,000 a year. In return, they have access to all the research done at the center (except for some proprietary work). A strong interaction between the center and its sponsors is the key to its success, according to Katzer. Company people can spend sabbatical periods ranging from three months up to a year working at the center, as well as attend an annual research review conference. Each company has one representative on the center's advisory board, which can offer suggestions regarding research projects or criticize them. The board has no veto power over the work, however; the final decision on what work to do rests with the center's staff. Typical projects include catalytic hydroprocessing of coal liquids, development of polymer- and metal-supported catalysts, and spectroscopic studies of the catalytic process in situ. Delaware owns many patents stemming from such work, which are made available to any of the industrial affiliates.

The major problem the center has run into, according to W. F. Howard Jr., its assistant director, lies in interacting with 20 different partners. "It's a heavy drain on our time to respond to so many people," he notes. Therefore, the center is not now actively recruiting new affiliates, although it never so far has turned anyone down.

Although the center is an outgrowth of Delaware's chemical engineering department, it is interested in getting the university's chemistry department more involved with its work, which basically is applied chemistry. Most of its 10 postdoctoral staff members have chemistry degrees. And it is funding some research by the chemistry faculty.

A new source of industry funds

Several research executives in the chemical industry have become convinced that if it is to foster the basic research it needs, something more is needed than such direct company-school arrangements as Monsanto's agreement with Harvard or Delaware's cooperative program in catalysis. One proposal that has excited many of them calls for the establishment of an industrywide organization that would promote academic-industry cooperation and provide a new source of money for university research.

The proposal was initially broached in October 1979 by M. E. (Mac) Pruitt, then vice president for research and development at Dow Chemical (and now retired). At a scientific conference sponsored by Dow that brought together in Midland, Mich., a large number of university professors and industrial research officials, Pruitt suggested that an institute formed to collect industry funds and dole them out to the universities was "something that "ought to be looked at." Pruitt argued that such an organization "would provide a more stable long-range funding mechanism" and "build closer cooperation between the chemical industry and academic research."

At the end of the Midland conference, it was decided to hold a second conference a year later, and a task force was formed to follow up on Pruitt's suggestion. The second conference was held last September in Bethlehem, Pa., with Air Products & Chemicals and Lehigh University serving as cohosts. It attracted attendees from more than 90 universities and about 40 companies, as well as several government research officials.

They learned of a rather detailed plan put together by the task force to form a Chemical Research Council (CRC). Its key objective would be "to provide colleges and universities with new, significant, and continuing sources of funding for basic research of potential value to the chemical industry." Other goals: "to promote mutual understanding and cooperation between academe and the chemical industry," to improve "the national climate for creativity and innovation," and to "promote the education of highly qualified science and engineering professionals."

Primarily, CRC would serve as a new forum for industry-university collaboration. As Pruitt puts it, "Much talk has gone on for the past couple of years about the need for a cooperative effort between industry and universities, but there has been no vehicle or mechanism for bringing this about." He adds, "Industry must provide more funds to the universities. And the universities must show more interest in the problems and basic needs of the chemical industry. As we move along this cooperative path together, funding has to be an essential part of our program."

Members of CRC would be both academic institutions and companies "engaged in research of potential interest to the chemical industry." They will be represented by deans of science or engineering schools and heads of science or engineering departments in the case of universities and by vice presidents or directors of research in the case of companies. Each member institution will have one voting representative and as many as three alternates who also can attend the council's functions. For universities, dues will be $1000 a year for the voting representative and $500 for alternate representatives; companies will pay $5000 a year for their voting representative and $2500 a year for any alternate. The council would study such issues as new ways to stimulate university research, manpower supply and demand problems, government policies regarding research, and the conflict between schools and companies regarding patent and publication policies.

But the glue or catalyst that many of CRC's advocates think will really make it viable is a second proposed organization, a Chemical Industry Research Fund, to be set up within CRC. Industry members would be asked to contribute to the fund, which would be used to support basic research in universities. The goal is to make an ambitious $10 million a year available within three years after the fund is established. Just how this money is to be collected and distributed is still being thrashed out. One suggestion is that companies contribute to it at a rate of 0.015% of their annual chemical sales, with a minimum of $100,000 and a firm commitment for no less than three years. A board of trustees, two thirds of whose members would be selected from companies that contribute to the fund and one third from academic members of CRC, would oversee the fund. (The governing board of CRC itself will be made up equally of industry and university representatives.) Grants from the fund would be made either to individuals—at the rate of up to $30,000 for a period of three to five years—or to several investigators in amounts ranging as high as $200,000. It also has been suggested that money be made available to facilitate personnel exchange and cooperative programs or for improving laboratory facilities.

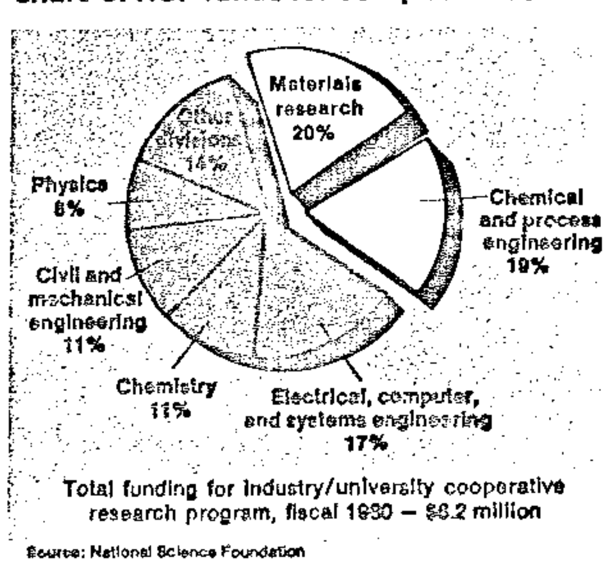
Reaction to the CRC proposal generally was favorable at the Bethlehem conference, especially from university people in attendance. Many of them did urge, however, that the fund find some means of distributing its money in ways different from that used by such established sources as NSF or the Petroleum Research Fund. Several think that grants should be more people-oriented—that is, made to exceptional individuals, especially young professors, for use at their discretion rather than for specific projects subject to peer review. Other academics expressed the need for assurance that money channeled through the fund be in addition to rather than as a substitute for support already available.

Whether CRC can be sold to the top executives and directors of chemical companies is yet to be determined. Many companies are likely to insist they need more control over the way their basic research dollars are spent than CRC provides and prefer one-on-one relations with academic recipients. There also are questions about whether a new permanent organization really is needed to support basic science.

But there is no question that CRC has a lot of enthusiastic supporters at high places in both the academic and industrial worlds. They see it as an effective new way not only to couple industry funds to university labs but to enhance the flow of information and understanding as well. A founding committee was selected at the Bethlehem conference to hammer out a final charter for the organization. Its 12 members, split evenly between industry and academic officials, have met twice since then, set up a number of subcommittees to handle various organizational details, and selected a counsel to help them iron out legal aspects. They hope to have some concrete plans in place when a third conference on the matter meets next September at Rochester, N.Y., with Eastman Kodak and the University of Rochester as hosts.

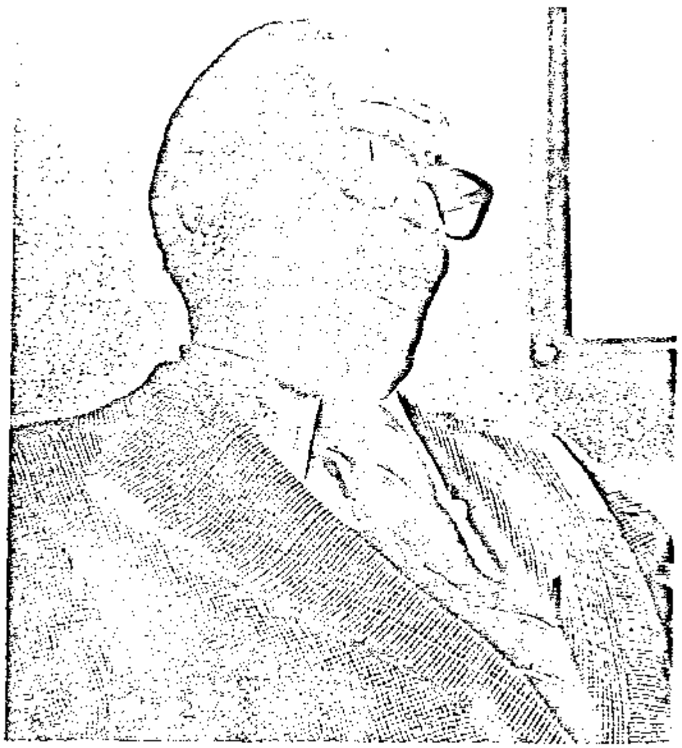
These plans may differ considerably from what was proposed at the Bethlehem conference. The research fund concept, in particular, may be much modified, perhaps to something less ambitious or less centralized. Companies may be more receptive to CRC, some ob-

Materials, chemical engineering get big share of NSF funds for co-op research



Total funding for industry/university cooperative research program, fiscal 1980 — $6.2 million

Source: National Science Foundation


C&EN staff photo

Pruitt: academic researchers can get involved with industry without losing their academic freedom

servers think, if its role is more that of a broker that would bring its industry and academic clients together to discuss needs and problems of mutual concern, thereby encouraging the flow of research support from companies to campus without necessarily acting as a direct conduit for that support. Despite the continuing debate about how it is to be implemented, however, chances seem good that at least a paper CRC may be in place by next year.

One thing does ring clear in current efforts to form CRC: There is little if any mandate for government to have a direct role in its functions. In fact, a definite consensus seems apparent among both university researchers and industry people that new procedures for backing academic research—ones that would ease its present dependence on federal largesse—now are highly desirable. Although NSF's industry/university cooperative programs generally win praise, dissatisfaction with the federal role in supporting R&D, with its emphasis on project funding on a peer review basis, appears to be widespread. When it comes to innovation and practical application, many see little fallout from federally funded projects except when (as is the case with defense or space programs) the government has some real use for the results.

Many industry executives have been arguing, in fact, that the most effective step the federal government could take now to stimulate university research is to enact tax incentives that would encourage industry to funnel more dollars to the campus. One suggestion in particular, the proposed Research Revitalization Act (H.R. 6632), has garnered broad industrial approval. Under it, companies would win a tax credit of 25% on money they put into a reserve to fund university research. In effect, the credit would cut the cost of industry's support of such research in half. The bill to do this was introduced by Rep. Charles A. Vanik (D.-Ohio) this year, gained considerable backing from other members of Congress, but made little progress. Vanik is retiring from the House at the end of the current session, but similar legislation is likely to be introduced again next year.

It is still far too early to judge whether all the activity on the industry-academic interface really portends a significant change for either private companies or the universities. Misunderstanding still runs deep on both sides. And just a lack of recognized mutual interests has deterred communication. For industry, the bottom line is profits; for the universities it is the number and quality of its graduates and the productivity of its research. In industry, attaining a competitive edge depends on moving swiftly and keeping competitors in the dark; in the universities, time is not of the essence but freedom to exchange information is. The reputation of a professor depends not just on what he or she knows but on the opportunities for letting colleagues know that he or she knows it. The inherent tension between industry's single-minded pursuit of income and the universities' penchant for diversity and redundancy, between the essential openness of the academic community and the essential need of companies to protect their proprietary knowledge will not be eased readily.

Overall mistrust, too, still is widespread. It is worth noting that much of the concrete cooperation that has taken place during the past few years has involved engineering schools, which traditionally have been a few steps closer to industry, more so than science departments. Writing in *The Nation* last Sept. 20, David F. Noble, who teaches the history of technology at MIT, and Nancy E. Pfund, research associate at Stanford medical school, warn of businessmen's attempts to co-opt university-based experts in order to bestow ideological sanction and scientific legitimacy upon industry's campaign against government interference. Academic freedom now is up for sale, they fear. "With industrial support," they write, "the primary consideration guiding university funding is not social need but rather the profit needs of the firm itself. Moreover, the firm, in purchasing access to the university's resources, is blocking access to others and has no obligation to share that access. . . . And the industry is getting far more than it is paying for: It is getting the cumulative social investment—one that took decades and sometimes centuries to create—in return for little more than operating expenses." Monsanto's agreement with Harvard, they argue, for example, "has in essence transformed a part of a public-sector social resource into a private-sector preserve, with little public scrutiny or accountability over its use."

That industry overtures are only self-serving, that companies want access to the campus at only a minimum of cost and offer little in return is a common professorial reaction. "We don't mind companies coming to visit, but somebody better count the silver before they leave," says one academician.

Nevertheless, there is no ignoring the groundswell of recognition that companies and the academic world have much to gain from mutual endeavors. "I believe academic researchers can get involved with industry without losing their academic freedom," says Mac Pruitt. Adds Celanese's Al Brown, "There isn't a university I could visit where I wouldn't learn something of value." What has been happening recently to bind industrial and academic research more strongly together is still largely in the nature of experiments. The experiments so far have yielded little in definite results. But they are being widely discussed. And that in itself is no bad thing as a step toward easing a long-standing estrangement. □

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