Electronics Firms Plug into the Universities

Private companies are stepping up support for research and helping universities build major new facilities

While attention has been focused on the expanding links between academic biologists and the corporate world, a second revolution in university-industry relationships has been taking place in a different field. Electronics companies, faced with growing competition from Japan and fearing a shortage of well-trained Ph.D.'s, are pouring unprecedented amounts of cash into university electrical engineering and computer science departments.

The Academic-Industrial Complex

This is the fourth in a series of occasional articles about the emerging relationships between industry and universities.

Corporate support is helping at least half a dozen universities to establish multimillion dollar research facilities. In addition, a group of major electronics companies has launched a cooperative research fund that could eventually channel up to $35 million a year into academic research. And corporations are not putting just money into universities; in many cases, they are putting their people into academic laboratories as well. Many of the arrangements being worked out include provisions for industry scientists to spend up to a year working in university facilities that their companies have helped finance.

Stanford University is a case in point. A new facility, the Center for Integrated Systems (CIS), is being established on campus with $12 million from industry and $8 million from the Department of Defense. Once it is completed, "our interaction with industry will increase by a substantial amount; ten times wouldn't be an exaggeration," says James Meindl, a codirector of CIS. Major corporations are also sponsoring similar facilities at Massachusetts Institute of Technology (MIT) and Rensselaer Polytechnic Institute (RPI). In Arizona, Minnesota, and North Carolina, university microelectronics centers are being established with a combination of corporate funds and state government appropriations. And several universities, such as Carnegie-Mellon (see box on p. 512) and Purdue, are attracting substantial corporate investment into work on robotics and other forms of industrial automation.

These developments represent a significant new trend in science policy. In effect, corporations and state governments are taking initiatives in areas that just a few years ago would have been considered the exclusive preserve of the federal government. This trend, it should be noted, meshes with the Reagan Administration's goal of shifting responsibility for some types of R & D support away from Washington.

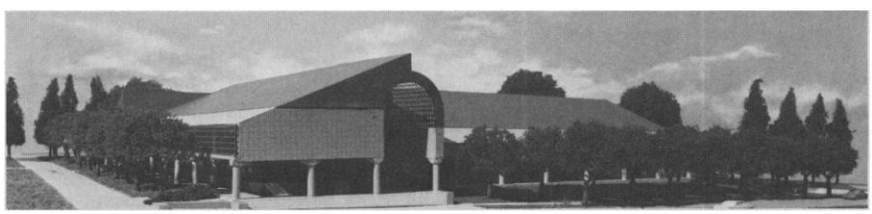
Although corporations seem eager to enter into these new arrangements, the first moves have generally come from the universities. At a time when federal R & D funds are getting increasingly tight and microelectronics equipment is getting increasingly expensive, universities cannot afford the facilities required to do some types of microelectronics research. The equipment for making state-of-the-art integrated circuits, for example, costs millions of dollars. The National Science Foundation has funded one microelectronics center at Cornell University but is unlikely to establish any more. Corporate funding therefore looks very attractive.

But there is another, more subtle, reason why the universities are welcoming these new developments. For some time, there has been growing awareness, in both industry and the universities, of the need to dissolve some of the boundaries that have formed between traditional academic engineering disciplines. Circuit design, materials science, and computer applications are interrelated, for example; yet these activities usually take place in different departments. The establishment of these corporate-funded microelectronics centers thus provides an opportunity to bring researchers from several departments together to work on interdisciplinary projects.

That, in any case, was a driving force behind the establishment of the Stanford facility. John Linvill, a codirector of CIS, says he began making plans about 4 years ago for a multidisciplinary center at Stanford that would work on everything from integrated circuits to telecommunications. The scope of the proposed center was such that Stanford would have to look to places other than the federal government for support, however. Linvill thus began sounding out top executives of some of the electronics companies in Silicon Valley.

His plan met with an enthusiastic reception. A CIS development committee, chaired by John Young, president of Hewlett-Packard, was formed in 1980 to help raise funds. Other members included Robert Noyce, president of Intel, George Pake, head of Xerox's research center in Palo Alto (whom Linvill had met in 1979 while waiting in line at a gas station), and Richard DeLauer, then head of research at TRW (now Deputy secretary of defense for research and engineering). The committee drew up a novel plan for corporate sponsorship of CIS.

In essence, major corporations that agree to sponsor CIS give Stanford an unrestricted grant of $750,000, spread over 3 years, to help pay for a new building and research equipment. So far, 17 corporations have signed up, and their names read like a Who's Who of the electronics industry.* In addition, the



The Center for Integrated Systems

Seventeen companies are helping finance Stanford's new research center.

*The corporate sponsors are, in order of their joining: General Electric, TRW, Hewlett-Packard, Northrop, Xerox, Texas Instruments, Fairchild Semiconductor, Honeywell, IBM, Tektronics, DEC, Intel, ITT, GTE, Motorola, United Technologies, and Monsanto.

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Defense Advanced Research Projects Agency (DARPA), has agreed to provide $8 million to establish a facility at CIS for rapid fabrication of large-scale integrated circuits. (The Department of Defense currently sponsors about half the projects that will be transferred to CIS.)

What do the industrial sponsors get in return for their money? One tangible benefit is that each company can send at least one of its own scientists to work at CIS, an arrangement that will give them a window on all the research going on at the center—including that which is supported by public funds. A committee of CIS sponsors will also advise on policy and programs at the facility, though Linvill says that final decisions on research programs will rest with faculty members.

A less tangible but perhaps more important benefit is that CIS should help attract good graduate students to Stanford, and the industrial sponsors will be well placed to recruit the best and the brightest of them.

With $12.75 million in hand from corporate sponsors, and another $8 million from DARPA, Stanford has enough to establish its new facility. Construction of a building is about to start, and it should be completed in late 1983.

Although Stanford is farthest along in its fund-raising, it is not the only university beating the bushes for industrial support to establish a microelectronics center. MIT and RPI are not far behind.

MIT has established a Microsystems Industrial Group to build a $20-million research facility on campus. Like Stanford, it is seeking major corporations willing to put up $250,000 a year for a minimum of 3 years. Unlike Stanford, however, it is also seeking smaller companies willing to donate $50,000. According to Paul Penfield, professor of computer science and electrical engineering, the response so far has been good. At least a dozen companies are expected to sign up, and completion of the facility is currently scheduled for late 1984.

RPI is establishing a $30-million Center for Integrated Electronics (CIE), which will bring together faculty members from five different departments. According to Andrew Steckl, CIE's director, all the money is expected to come from industry. Already, IBM has donated a $2.75-million electron beam lithography system for imprinting integrated circuits on silicon chips, and General Electric has agreed to provide $1.25 million in research support over the next 3 years. By the end of 1982, Steckl predicts, RPI will have secured another $6 million in corporate support. In one sense, RPI is already ahead of Stanford and MIT. "We are the first kids on the block with an actual building of our own," says Steckl: last month, CIE moved into a building donated by the Norton Co., a manufacturer of oil drilling and mining equipment.

Industry is providing the bulk of the funding for these three centers, but in some other places, state governments are dipping into their coffers and new university-industry-government partnerships are being formed. One of the most ambitious is at Arizona State University (ASU) near Phoenix.

With a promise of about $20 million from the state government, ASU is in the

CMU's Growing Corporate Connections

Pittsburgh. Paul Wright, a professor of mechanical engineering at Carnegie-Mellon University (CMU), has spent a good deal of time recently installing equipment in a Westinghouse plant in Winston-Salem, North Carolina. Together with some graduate students, he has even driven a truck, loaded with computers and robots, from his lab at CMU to the Westinghouse facility. "It does not exactly fit the image of a pipe-smoking university professor," he admits. It does, however, illustrate the close ties that have developed between CMU and industry.

Wright is working on a project aimed at developing a flexible, computer-controlled system for manufacturing turbine blades. The work is being sponsored by Westinghouse as part of a $1.2 million per year grant to CMU's Robotics Institute. The grant is also supporting research on a process for manufacturing fluorescent light bulbs and the use of robots to insert components into circuit boards.

The fact that Wright is actually helping to install the system in the Westinghouse plant is not the only unusual feature of his project. Another is that Westinghouse will hold any patents that may arise from the research. A similar patent agreement has also been reached with Digital Equipment Corporation (DEC), which is sponsoring about $1 million worth of research a year at the Robotics Institute. CMU is believed to be the only U.S. university that has signed over patent rights to a corporate sponsor.

"The function of a university is to create and disseminate new knowledge, and we should not insist on hanging on to patents if that becomes a bar to conducting research," argues CMU president Richard Cyert. The arrangement with Westinghouse, which would give CMU a share of royalties generated by any patent, is likely to be a model for other industrially sponsored projects at CMU, he says. This willingness to compromise reflects a belief that runs through the CMU administration that closer ties with industry are in CMU's best interests—for both financial and academic reasons.

"We need industrial participation [in CMU research] to get feedback and to make sure that we are looking at real problems," says Daniel Berg, provost for science and technology. The university has so far been extremely successful in attracting such participation. Industry now provides more than $9 million of CMU's $40 million a year research budget, and some large deals are in the offing.

The Robotics Institute is the centerpiece of this activity. Established in December 1979, it has 17 full-time research scientists and draws on faculty from several different departments, especially computer science and mechanical engineering. Its budget is now about $5 million a year, two-thirds of which comes from industry and one-third from the federal government.

Westinghouse and DEC, together with the Office of Naval Research, are the primary sponsors of the institute. Additional support is provided by 17 companies that have joined an affiliates program. For annual dues of $10,000 to $50,000, affiliates receive periodic reports of work in progress at the institute and can attend briefing sessions at CMU. Funds from the affiliates are used for general research support, and the sponsoring companies get nonexclusive licenses to any technology that results.

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process of trying to break into the front ranks of engineering schools in the United States. A multidisciplinary Center for Excellence in Engineering is being established on campus, and over the next 5 years, ASU expects to add 68 people to its engineering faculty, which currently numbers about 100. New research laboratories are under construction, the core of which will be a state-of-the-art microelectronics and computer science facility.

Although the state government is providing the bulk of the funds, industry is expected to contribute about $9 million, according to Charles Backus, the center's director. Already, hard commitments of $8.3 million and verbal commitments amounting to another $2 million have been made. Industry, in fact, played a key role in getting the whole venture off the ground.

In the late 1970's, university officials began hatching plans for a major expansion of engineering research and education at ASU. Like their counterparts at Stanford, they realized that in order to get what they wanted, they would have to look further than the government for support, so they sounded out local industry executives. An industrial advisory committee, two-thirds of whose members were chief executive officers of major high-technology companies in the Phoenix area, was formed and it became the key to ASU's fortunes.

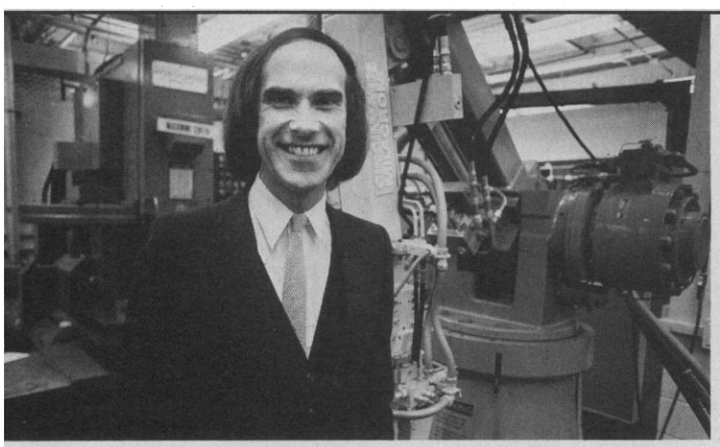
The committee surveyed the engineering manpower needs of firms in the area and concluded that 1500 to 2000 engineers would have to be hired each year. ASU obviously could not meet the demand, and so the committee went to Governor Bruce Babbitt and the state legislature to argue that unless engineering education and research at the university were given a major boost, economic growth in the region would be seriously constrained. "The growth of Arizona was tied to growth at ASU, and the politicians got behind the idea of the center," says Backus. Babbitt, in particular, enthusiastically supports the plan, and last year the center was one of only two items in the state budget to receive an increase in funds. The other was the prison system. Construction of the new facility started recently, and it is scheduled for completion next summer.

State governments in California, Minnesota, and North Carolina have also invested substantial sums in the development of electronics centers at state universities, and in each case, corporations are putting up a significant fraction of the initial funds.

These corporate funds are flowing into the universities largely to build and equip research facilities. But will industry step up its support for research once the facilities are built? People on both sides of the academic-industrial complex believe that it will, although firm arrangements for continuing support are still being worked out at most of the centers.

Traditional project support from individual companies is expected to increase, but universities are also exploring various industrial affiliates programs as a way of bringing in more flexible funding. A possible model is the highly successful Silicon Structures Project (SSP) at California Institute of Technology (Caltech).

Corporations pay Caltech $100,000 to



Paul Wright

A challenging but "risky" project for Westinghouse

The decision to assign patents to major sponsors "cleared a roadblock" to getting Westinghouse's participation, says Todd Simonds, the institute's assistant director for industrial relations. The general philosophy guiding industrial research at the institute, according to acting director Arthur Sanderson, is to limit the work to multiyear, substantial programs. "We wanted to avoid the situation of making short-term commitments to industry for short-term deliverables," he said. As the relationships with sponsors have evolved, however, there has been debate over how much the institute should be drawn into work on projects that are specific to a particular sponsor's needs. Wright's project illustrates some of those strains.

It is the only project in which CMU researchers are working alongside industry scientists in an industrial setting. The other projects mostly involve laboratory work at CMU that is transferred by the company to its plants. Wright acknowledges that there has been debate about his project and that it is "risky for my university career." The arrangement, he says, has resulted in "a lot of time spent in custom-specific work that is nonscholarly." A graduate student, for example, spent 3 months building special grippers for a robot, a project that is not Ph.D.-level work. Nevertheless, Wright argues, the research is exciting and has many ground-breaking dimensions.

"A university is generally responsible for developing a model that is held together with sealing wax and string, which impresses besuited businessmen but falls apart the next day," he says. It is an intellectual challenge, he argues, to carry the process one step further and see whether the system actually works in practice.

The success of the Robotics Institute in attracting industrial support has not been lost on other researchers at CMU. A proposal has just been drawn up by Mark Kryder, a specialist in magnet technology, for a magnetics center at CMU. The university is now seeking $10 million in industrial support for the center. Kryder is confident that the money will be forthcoming. So, apparently, is the university: approval has recently been given to establish a major new magnetics research facility on campus.

Finally, the university has also recently floated a proposal to raise $3 million, in individual corporate contributions of $150,000, for research on the social impacts of advances in robotics and other advanced information systems.

Cyert sees mutual interest in these expanding links. "There is greater recognition in industry of the need for more research if we are going to maintain our premier industrial position, and most firms recognize that they can't hire the talent they need," he says. The universities, which have the talent, can help them out, he believes.

—C.N.

send a staff scientist to the university to work for a year in the general area of computer-aided design of integrated circuits. They get exposure to one of the largest groups working on such problems in the United States, and Caltech gets the benefit of their industrial experience—as well as some welcome cash. Twelve firms are now participating, bringing Caltech a cool $1.2 million a year, and several others are on a waiting list, according to George Lewicki, SSP's director.

Both university researchers and corporate executives say they want to see links of this type encouraged. Meindl, for example, says that the industrial scientists working at CIS will be "one of our principal assets." Lewis Branscomb, chief scientist at IBM, says that "if a company just goes out and contracts some work at MIT instead of doing it itself, it would not be good for the company or for MIT." Instead, he says he would prefer to see an interchange of personnel. "There are a lot of bright people out there," he notes.

In addition, another potentially important source of corporate research funds is about to open up. A Semiconductor Research Cooperative (SRC) has recently been established to generate a pool of funds from electronics companies that will be used to support basic research at universities. The idea for SRC was originally proposed by executives of IBM, but it has now been established as an independent body and has gained at least verbal support from virtually every major manufacturer and user of semiconductors in the United States. It is expected to disburse $6 million this year, $10 million to $15 million next, and as much as $30 million to $35 million by 1985—about three times the amount that NSF currently spends on microelectronics and computer science.

Corporations that join SRC will contribute amounts based on their worldwide sales or purchases of semiconductors. In return, they will receive progress reports on the work SRC sponsors and, although patent policies have yet to be worked out in detail, they will almost certainly get royalty-free licenses to use patented processes that arise from SRC projects. This arrangement means that every member company will have access to the entire pool of SRC-sponsored research, and small companies will pay less than large ones for that access.

Research funds will be disbursed to universities in three different ways, according to Larry Sumney, SRC's executive director. Major grants of $1 million to $4 million per year will be made for general research support at "centers of excellence" in priority fields such as computer-aided design and semiconductor materials. It is expected that staff scientists from at least two SRC member companies will work at the centers receiving these grants. Second, SRC intends to solicit proposals from university

John Linvill

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scientists for research in specific areas. And third, it expects to fund some unsolicited proposals. It will not be short of takers. Sumney says he has been "besieged" by inquiries.

Unlike the commercialization of biotechnology, this growing corporate role in engineering schools has so far been accompanied by little controversy or academic soul-searching. Concerns about academic freedom and the role of the university are seldom voiced in discussions of these new developments, for example, and questions about ownership of intellectual property do not seem as troublesome as they do to researchers in biotechnology.

One reason may be that electrical engineers and computer scientists have long had close relationships with industry. "We know how to work with each other," says Steckl. Another is that the microelectronics centers are supported by many sponsors and will be working mostly on generic problems. Issues of ownership of proprietary information are thus less likely to arise. It may also be, as Linvill put it, that "we lost our virginity a long time ago, and the biologists are now in the process of losing theirs."

Nevertheless, these burgeoning corporate connections do raise some difficult issues. The first is a practical one. With virtually every electrical engineering and computer science department in the country already looking for new faculty and finding it tough to compete with industry for good people, who is going to work in these new centers? Researchers in the elite engineering schools tend to scoff at the idea that large numbers of good people will be attracted to as yet unproved centers. So far, however, ASU, which has the most ambitious recruitment plan, has not had great difficulties in hiring, says Backus, who acknowledges that this will be a key to ASU's success. "We are looking forward to competing with the likes of Stanford, Berkeley, and MIT," he says.

A less tangible issue is whether this surge of industrial funding will change patterns of research in the universities in a way that undermines academic values in general and graduate education in particular. Among the concerns that have arisen in biotechnology, for example, is that corporate funding may reduce cooperation among researchers, shift the center of gravity of academic research programs toward projects likely to have commercial payoff and away from more basic studies, and that graduate programs sponsored by industrial funds will be too narrowly drawn.

To the extent that the microelectronics centers continue to receive unrestricted support from multiple donors, such concerns will be minimized. But if there is a substantial increase in specific project support by individual companies, problems could arise. There has, for example, already been some discussion at Carnegie-Mellon University of the conflicts posed by a corporate sponsor's interest in relatively short-term research and the university's responsibility to provide more fundamental graduate education (see box on p. 512).

One thing that is certain is that these emerging corporate connections will significantly broaden the base of support for many university engineering departments. The chief source of funds for computer science, for example, has been the Department of Defense, and its investments have fundamentally shaped the structure of computer science research at the universities. DARPA, for example, has poured huge sums into facilities at three universities—MIT, Stanford, and Carnegie-Mellon—and they are consequently by far the strongest universities in this area in the country. The advent of corporate support is beginning to change the pattern, however. "Nobody is dictating which are going to be the strong schools," says Branscomb of IBM. "I don't know that a committee sitting in Washington would have picked RPI," he notes, but it is well on the way to becoming a major center.

People in the universities share this notion. "Industrial support in this area will have as profound an impact as government support has had in the past," predicts Linvill.—COLIN NORMAN