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After years of distrust, **ACADEMIA AND INDUSTRY** are forming alliances for chemical research

RICK MULLIN, C&EN NORTHEAST NEWS BUREAU

PRESIDENT DWIGHT D. Eisenhower's farewell address to the nation, delivered on Jan. 17, 1961, warned against the undue influence of a wealthy government-backed arms industry, the so-called military-industrial complex. In that speech, he also warned that the high cost of university science made U.S. campuses prone to the dangerous influence of money, corporations, and government.

"The free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research," he said. "The prospect of domination of the nation's scholars by federal employment, project allocations, and the power of money is ever present and is gravely to be regarded."

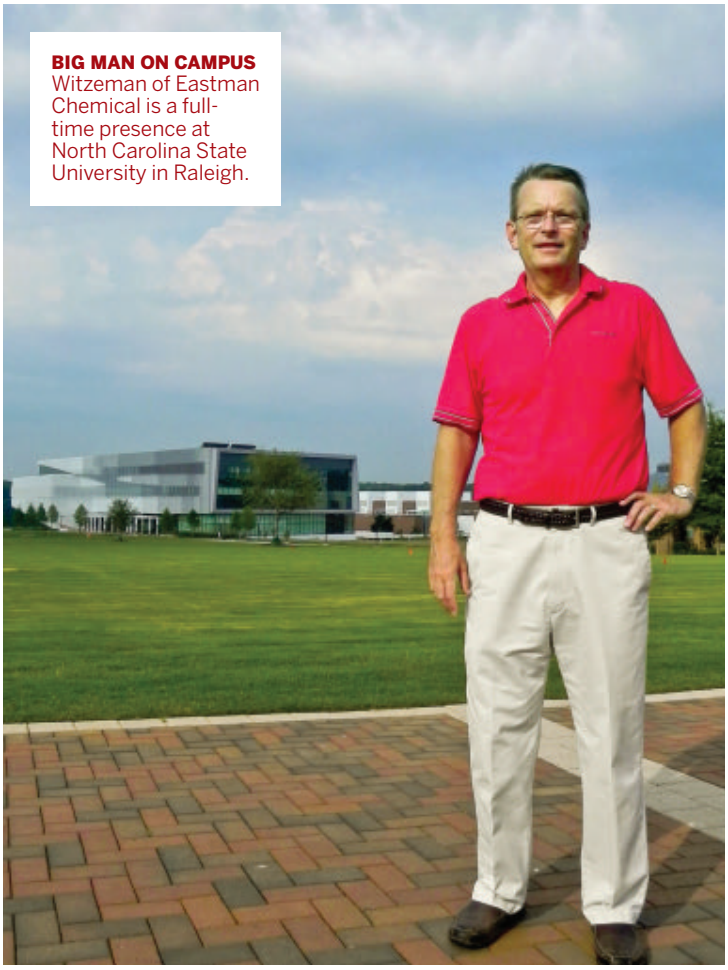
Eisenhower's words were taken to heart by the counterculture movement of the 1960s, which saw in the conflation of government and industry a threatening technocracy. Students and faculty across the country, from Columbia University to the University of California, Berkeley, protested against military and corporate presence.

Fast-forward half a century to a weatherworn picnic table on the campus of Harvard University, where James N. Wilking, a postdoctoral researcher, is discussing the benefits of being part of a collaboration between Harvard and BASF—the world's largest chemical company—in a nearby laboratory. "Before I came to Harvard, I knew nothing about bacterial biofilms," Wilking says. "Everything I've learned about biofilms, I've learned through these weekly meetings that we have on Tuesday nights for BASF," he adds.

The knowledge paid off with a job. Wilking has accepted an assistant professorship at Montana State University, in Bozeman, that focuses on biofilms. "So the whole experience here has been really important," he says. Graduate students and postdocs at other schools tell similar stories.

The past five years have seen a proliferation of collaborative agreements. In addition to the BASF project in Massachusetts, schools including North Carolina State University, Pennsylvania State University, and Georgia Institute of Technology have set up industry researchers in their labs to work directly with academic scientists. Colleges have been attracted to these partnerships because the cost of research keeps rising and the portion of that cost covered by budget-poor state and federal agencies keeps dwindling. For industry, the deals bring access to fundamental research capabilities, which have eroded at many companies since the 1980s.

But rather than subverting intellectual curiosity, many participants say, the industry-academic hookups are responsible for new courses in areas such as polymer engineering and green chemistry, where industrial research partners have brought money and expertise to cash-strapped labs. The partnerships have reinvigorated basic chemistry and chemical engineering departments and are improving the skills of scientists entering the workforce, they say.



BIG MAN ON CAMPUS Witzeman of Eastman Chemical is a full-time presence at North Carolina State University in Raleigh.

EASTMAN CHEMICAL

THERE ARE surprisingly few critics of a development that has seen corporations pour millions of dollars into universities and become directly involved not only in research but also in curriculum development. Faculty concerns about conflicts of interest have been raised at UC Berkeley and other campuses. But "I think people going forward realize that the world has changed," says Michael F. Malone, vice chancellor for research and engagement at the University of Massachusetts, Amherst. Malone is more concerned with the need to promote scientific innovation in the U.S. and the advantage industry provides to that effort. "It's impossible to underestimate global competition. A lot of it is driven by globalization

and the rise of the Asia-Pacific region."

UMass Amherst and Massachusetts Institute of Technology recently signed on with BASF when the German firm renewed its five-year pact with Harvard. The expanded partnership is called the North American Center for Research on Advanced Materials. Like MIT, UMass Amherst is a land-grant school, Malone notes, and the work done at the UMass Innovation Institute (UMII), an industrial research partnership program started 2011, is in keeping with the school's mission of developing technologies for the public good.

"I don't think this is a real revolution," Malone says. "This is old wine in new bottles. This is what land-grant universities were founded to do."

James D. Capistran, executive director of UMII, however, says that public universities have not always done a good job fulfilling their obligation to advance public well-being. "We needed to do a lot better engaging with industry and finding that intersection where engagement doesn't hurt, but helps, our educational purpose," he says.

UMII is doing its part, Capistran says, having generated $14.3 million in industrial research awards in its first year of operation.

The institute, which seeks partnerships in fields such as astronomy to veterinary science, has set a target of $30 million in annual industry-supported research in the next five years. In support of this effort, UMass Amherst has invested $157 million in a new life sciences center, one wing of which will house laboratories available for use by industrial partners.

UMII has its roots in the Center for UMass/Industry Research on Polymers, an industry engagement program that was established by the National Science Foundation in 1980 and turned over to the university in the early 1990s. Gregory N. Tew, a professor in the department of polymer science and engineering, says polymer research still drives much of the industry alliance activity at the university.

"If you look at the major effort put in place for the new life sciences investment from the state, two of the three major thrust areas are driven by polymers—bioactive delivery and personalized medicine," Tew says.

Industry's needs have changed dramatically since those first academic-industry alliances were forged, notes David A. Weitz, a physics professor who codirects the BASF Advanced Research Initiative at Harvard. He points to the dismantling of AT&T in the early 1980s, and how its storied Bell Laboratories became the research arm of a smaller telecommunications spin-off, as a starting point in the disappearance of the large corporate R&D center.

"In my mind, it was a national treasure," says Weitz about Bell Labs. Although it was arguably a government lab operated by a company, it was also a template for large corporate laboratories dedicated to basic research. "Many companies modeled themselves after Bell Labs, and most of these corporate research labs ultimately failed," he says.

UMASS AMHERST

SPACE AVAILABLE University of Massachusetts, Amherst's Capistran welcomes industry researchers to the campus' new life sciences laboratories.

LABS RUN BY the likes of RCA, Westinghouse, Xerox, AlliedSignal, and Eastman-Kodak—research centers that engaged thousands of people in discovery-oriented science—were significantly downsized in the 1980s and 1990s, while others disappeared along with the companies that owned them. Weitz himself worked at Exxon in New Jersey for 18 years until 1996. He was there on the day in 1985 when the company cut its corporate research staff in half.

The effect of the loss of the big labs has been twofold, Weitz says. The traditional career path from university to industry changed drastically with the disappearance of thousands of jobs and the emergence of research positions requiring more entrepreneurial skills. At the same time, industry realized that it must pursue basic research through partnerships. The stage was set for a dramatic shift in academic-industry relations.

BASF initiated the project in biofilms by giving Harvard freedom to explore—"to learn and educate ourselves," Weitz says. "Then, rightfully, they said we had to start to produce something." Although the first five years did not result in a commercialized product, some of the work done in the lab has been transferred to BASF for development.

Discovering materials that are passed to a corporate lab for development is vital science, says Weitz, who can remember when such a thing was anathema on campus.

"At Harvard in the mid-1970s, you were suspect if you were involved with industry," he says. "I think this is nonsense. And I can turn it around—if you want to do fundamental and no applied science, you are basically saying you want to do boring, irrelevant work. Our research has led to first-rate papers in *Science* and *Nature* and to changes in the way the industry that supports us does its work. There is no question that you can do fundamental work that has direct application."

"Most graduate students don't become academic professors. Most go into industry."

BASF still has a large corporate research center, Weitz points out. "That's one of the pleasures of working with them, but they also recognize that, in this day and age, research is getting broader and broader, and they can't do everything in-house."

From BASF's perspective, working with universities is nothing new—the company has commercialized technology developed in academia for decades. But BASF only began working with labs outside Germany 10 years ago, according to Jens Rieger, senior vice president of advanced materials and systems research. Its first partner was the Institute of Science & Supramolecular Engineering, in Strasbourg, France. The firm then opened its own lab in Singapore where it works with local universities.

The first five years of the Harvard-BASF alliance corresponded to a period of important change in university intellectual property (IP) policy. In 2007, the year the alliance started, UC Berkeley, Lawrence Berkeley National Laboratory, and the University of Illinois, Urbana-Champaign (UIUC), formed their own collaboration with the oil company BP: a $500 million, 10-year project called the Energy Biosciences Institute.

BP was given rights to negotiate for exclusive licenses on IP generated with the partners. It also set a cap of $100,000 per license per year, with some special exceptions. Although some critics considered the cap imprudent, most research managers at universities pointed to the deal as the way forward.

work, and from these only four licenses were obtained, resulting in $80,000 in revenue for the university. Given the cost of generating and maintaining IP, the university was losing money even as it turned away industry-funded research.

UNDER THE NEW POLICY, faculty can request that the university hold the rights to IP on particular projects, "but nine out of 10 say 'no,'" Foley reports. "They just want the funding."

Foley, who left Penn State this summer to become executive vice president of academic affairs for the University of Missouri system, points to recent partnerships at Penn State with Siemens, Corning, and Dow Chemical that he says are likely to

1961 Eisenhower gives farewell address
In an address memorable for the phrase "military-industrial complex," the President warns of undue influence undermining the "free university."

1980 CUMIRP starts up
The Center for UMass/Industry Research on Polymers, a state-funded program to promote university-industry research partnerships, is formed.

1984 Industrial labs close
Recession-related cuts affect Tosco, Diamond Shamrock, and Ashland Chemical. Research departments are downsized steadily into the early 1990s, with cuts fueled by economic cycles and corporate restructuring.

1862 Land-grant system is introduced
The Morrill Act establishes the funding of federal land-grant institutions to promote technical-oriented education and the commitment of scientific advances to the public.

1969 "The Making of a Counter Culture" hits bookstores
Theodore Roszak's book, published within weeks of the Woodstock music festival, defines the 1960s counterculture as a reaction to "technocracy," the encroachment of business and commerce into social institutions.

1984 AT&T breaks up
The breakup of the telephone monopoly signals the dismantling of Bell Laboratories, a template for large, commercial research labs.

Nobel Laureates John Bardeen (left), William Shockley (seated), and Walter Brattain conduct research that leads to the invention of the transistor at Bell Labs in 1947.

ATTITUDE CHANGE **Universities, once wary of industry, have formed more ties with firms, as companies downsized their own labs.**

The next step was to come to the U.S. Rieger says the company was to some extent guided by personal relationships between its researchers in Germany and Weitz and others at Harvard. "We are on the same wavelength," says Rieger, who was on-site at Harvard during the initial five-year project and has since returned to Germany. "And we had come to the conclusion that we needed new insights on medical devices and advanced formulations for drug delivery related to David's experiments in microfluidics."

As for the cultural divide between academic and industrial research, Rieger sees the walls coming down. "Students appreciate the work they do with us because we are dealing with real-world problems," he says.

Last year, Penn State announced a big change to a long-standing policy under which the university retained the rights to all IP generated from sponsored research. In a plan crafted by Henry C. Foley, vice president for research, Penn State said it would consider contracts that grant industrial research partners all IP rights.

Foley had spent a year investigating the economic benefit that the university accrued by insisting on holding IP rights. Between 2000 and 2007, his study found, less than 8% of invention disclosures from the university arose from industry-sponsored

thrive under a less restrictive IP policy. And such deals will also redound to the benefit of industrial partners in need of resources for basic research.

"We have been eating our seed corn for quite a number of years as a society," he says, noting that at many large corporations the engine of innovation was "ground out for efficiency gains in the 1990s and early 2000s." Companies are now looking to academic partners to replace that engine. "I think that is a reasonable goal," Foley says.

Penn State is just one school where Dow, the largest U.S. chemical company, has

& VIDEO ONLINE **To see academia-industry collaborations through the eyes of postdocs, visit http://cenm.ag/collab.**

been stepping up its activities. The firm announced in 2011 that it would spend $250 million over 10 years to support chemical research at 11 universities including Penn State, the University of Michigan, and UC Berkeley. Dow said at the time that it was investing in areas of research such as catalysts, polymers, materials science, and separations that have become "less trendy" as public and private funding has shifted to biorelated areas.

Dow's commitment to UC Berkeley came despite earlier resistance on campus to its involvement with the school in a nonresearch capacity. In 2007, the firm launched a five-year program in which a Dow executive, Tony Kingsbury, worked on-site with the university to develop a course on sustainable chemical products.

The program met with considerable pushback from Michael P. Wilson, director of the Labor Occupational Health Program at Berkeley's School of Public Health, who contends that one of Dow's incentives in setting up on campus was to become involved in the university's policy proposals to the state legislature regarding green chemistry.

According to Wilson, Dow initially offered $10 million as a gift to the Berkeley Center for Green Chemistry, where he is associate director of integrative sciences. The offer came with a request that the center be named for the company and that a Dow executive be placed on its staff, but it was rebuffed, Wilson says.

The company instead gave the money to Berkeley's Haas School of Business, which helped create the green chemistry center. Kingsbury maintained an office at the school for the duration of the five-year partnership, which recently ended without being renewed.

Although Dow has been credited for financing the green chemistry center at a time when state funding of research was being cut back, Wilson says the California Environmental Protection Agency provided "foundational funding" for the center.

"Over five years, we tangled with Tony and struggled with his influence on campus, which was manifold," Wilson says. He objected to a Dow executive teaching seminars and claims that Kingsbury was asked to stop identifying himself as a Berkeley affiliate in his communication with state agencies.

Kingsbury, who now works as a consultant, dismisses Wilson's concerns, telling C&EN that professionals with undergraduate degrees routinely teach seminars in business schools. He denies that he misrepresented himself.

David E. Kepler, Dow's chief sustainability officer, portrays the company's work at Berkeley as part of a multiuniversity push to involve industry in efforts to promote sustainable and green chemistry. "Our fundamental belief is that solving the world's problems will happen at the interface between business, government, and civil society," says Kepler, a Berkeley alumnus who currently sits on the university's board of trustees. "What we were trying to do is work with the university to help them bring interdisciplinary science in and have a curriculum around it."

Richard A. Mathies, outgoing dean of the school's College of Chemistry, says Dow's involvement was quite positive, adding that he has not seen the company exert undue influence on the curriculum. "Over the last five years, we have developed an extensive and mutually successful program with Dow," Mathies says. "They have been a very strong partner for the university at a time when all our other partners are stepping away."

He notes that the university's primary partner, the state of California, has cut its funding of UC Berkeley in half over the past 10 years, now only funding 10% of total operating costs. Meanwhile, Dow's investment catalyzed the green chemistry center and related curricula, Mathies says. "Dow's contribution of funds has allowed us to run the seminars and programs that got our students interested in sustainability."

Dow recently announced a $3.5 million gift to rebuild undergraduate laboratories at Berkeley, and Mathies says $1 million of the money will go toward developing an undergraduate curriculum in green chemistry.

THE COMPANY'S OVERALL investment in research at the 11 universities will consolidate and focus what has been an uncoordinated effort to work with academia, according to David Bem, director of Dow's core R&D division. Bem says he has seen an ebbing in resistance to industry involvement in the academic lab. "There are a lot of things everyone has recognized—one is that most graduate students don't become academic professors. Most go into industry," he

1993 Corporations are reengineered
"Reengineering the Corporation: A Manifesto for Business Revolution," by Michael M. Hammer and James A. Champy, is published. Business process reengineering accelerates R&D downsizing and outsourcing throughout the 1990s.

2007 BP inks deal with UC Berkeley
University of California, Berkeley, signs onto a $500 million research pact with BP that includes a flexible policy on intellectual property rights, forming the Energy Biosciences Institute. The contract becomes a template by which other schools begin allowing industrial partners the right to intellectual property.

2011 University of Massachusetts launches UMass Innovation Institute
UMass Amherst launches a new industrial outreach initiative drawing on a 30-year-old program in polymer engineering.

2003 Pharma comes to Cambridge
Novartis establishes R&D in the former New England Confectionery Co. candy factory, moving its locus of research from Switzerland to the Massachusetts hometown of MIT, Harvard University, and other academic powerhouses. Pfizer and AstraZeneca also ramp up research in the Cambridge/Boston area.

Novartis makes maximum use of open space and architectural forms of nature throughout the Novartis Institutes for BioMedical Research, in Cambridge, Mass.

2013 BASF renews North American Center for Research on Advanced Materials
BASF re-ups its five-year contract with Harvard, expanding the partnership to include UMass Amherst and MIT.

says. "We are not trying to manhandle the curriculum. There are areas where we can absolutely contribute to the curriculum."

COMPANIES HAVE RECOGNIZED change on their side, as well. The big realization at Eastman Chemical in recent years is that "all the smart people in the world don't live in Kingsport, Tenn.," says Gary Luce, technology liaison for the Kingsport-based company, which last year entered a $10 million, six-year collaboration with North Carolina State University. Eastman established a laboratory called the Eastman Innovation Center at the school's Centennial Campus in Raleigh to support joint research.

J. Stewart Witzeman, director of the center, argues that the kind of technology and science that industry needs can be found at the interface of research disciplines. He notes, for example, that Eastman has several cellulose products that can benefit from research at NC State's department of forest biomaterials. "And industry can make a contribution by adding insight at these interfaces," he says.

UC Berkeley's Mathies, who will continue as a professor in the chemistry department, concentrating on developing relationships with industry, claims that he is quite familiar with Eisenhower's warning about the threat to open inquiry at universities. He notes that Berkeley, as part of its deal with BP, convened a meeting of the University of California Academic Senate to set down guidelines for what is and isn't appropriate in industry engagement and for how funding opportunities have to be reviewed. Academia, he warns, will have to continue reviewing such proposals.

Cary Nelson, immediate past-president of the American Association of University Professors and an English professor at UIUC, has coauthored an AAUP guideline for academic-industry collaborations. Prompted largely by an increase in cases of academics found to have conflicts of interest when authoring reports supportive of drug and energy companies, the guidelines, due out this year, attempt to establish an ethical framework for relationships.

"We are saying that these collaborations are inevitable, and often good, but that they have to be done in the right way," Nelson says, adding that the association sees nothing intrinsically wrong with relationships such as BASF's in Massachusetts. Among AAUP's recommendations, he says, is a requirement that information is shared among multiple universities working on the same project in an industrial partnership, that no confidential research is done on campus, and that faculty members not be selected by recipients of funds from an industrial contract. AAUP is encouraging schools to develop their own guidelines, he says.

Managers of research partnerships with chemical companies acknowledge the risks, but they are focused mostly on the practical benefits of melding their labs with those of industry. According to UMass Amherst's Capistran, developing partnerships is a matter of pragmatic relationship building, with an eye toward mutual benefit for the university and its industrial partners. "Our motto," Capistran says, "is 'Let's do what makes sense.'" ■