Applied Research in UMass History

Innovation, Collaboration, and Education in Three Case Studies

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EXECUTIVE SUMMARY

This essay is the product of a request to the University of Massachusetts Amherst Department of History by Vice Chancellor for Research and Engagement Michael Malone, Ph.D. for a report on the history of applied research at UMass. It documents ways in which applied research both shaped and reflected the history of UMass and its relations with industry, government, and society from 1863 to the present.

The History Department's Graduate Program Director, Dr. Marla Miller, charged me with researching and writing this report from January to August 2012. During the first phase of this project, I spoke with over twenty librarians, current and former UMass professors, and other experts, and combed the W.E.B. Du Bois Library University Archives and Special Collections (SCUA) to determine a set of case studies that could illustrate the history of applied research at UMass based upon: 1) their ability to showcase research that contributed strongly to the history of UMass and the world beyond, 2) their ability to highlight different periods of UMass history and different issues in the history of applied research, and 3) the availability of primary sources. I then conducted a lengthy oral history interview with Dr. Richard S. Stein, phone interviews with two former graduate students of Dr. Carl R. Fellers, and further archival research at SCUA, Jones Library (Amherst), and Forbes Library (Northampton), while also surveying secondary texts, newspaper microfilms, electronic newspaper databases, and other materials available online.

My report consolidates this research by analyzing the history of applied research at UMass through case studies of three professors whose research influenced both their respective disciplines and the University: farmer and agricultural scientist Levi Stockbridge (1820-1904), food scientist and technologist Dr. Carl R. Fellers (1893-1960), and polymer scientist Dr. Richard S. Stein (b. 1925). During the 1870s, Stockbridge used his and his colleagues' applied agricultural research to generate public support for Massachusetts Agricultural College (MAC) and to secure funds vital to preventing the institution's financial collapse. One of few professors in the U.S. able to attract industry funding during the Great Depression of the 1930s, Fellers was a forerunner in using applied research to expand graduate education at UMass, utilizing thousands of dollars in external grants to propel the UMass Food Science Department's graduate program into the largest on campus and the top in its field from 1925-1957. Also a forerunner, Stein used the Polymer Research Institute (PRI) he founded in 1961 to generate government and industry grants for basic polymer research used to expand interdisciplinary polymer education at UMass during both the 1960s, when robust government funding fueled a massive expansion of the University, and during the 1980s, when public funding for higher education dwindled.

These scholars' careers demonstrate that cutting-edge university research, combined with diplomatic political networking, can help advance the campus’ academic mission while yielding results directly beneficial to industry, government, and society. The case studies presented here also highlight ways in which UMass, for 150 years, has consistently benefitted the world, the nation, and the Commonwealth of Massachusetts by providing dynamic liberal arts education and ground-breaking research. In addition, however, this study reveals that the university-government-industry relations reflected and shaped by UMass researchers' work changed over time. For instance, UMass administrators and faculty have not always (as they typically do today) viewed the development and marketing of their school's applied research capacities as crucial to the institution's success.

An appendix offers examples of UMass applied research topics for additional study that would further enhance our understanding of the history of applied research on this campus.
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Since the founding of Massachusetts Agricultural College (MAC) in 1863, applied research has been central to the development of what has grown to become the University of Massachusetts Amherst (UMass). Impetus for establishing MAC came from the Morrill Land-Grant Act (1862), which set aside federal funds for the creation of public colleges devoted to educating young Americans in liberal studies, modern farming techniques, and mechanical arts, so as to benefit the nation’s agriculture and industry.¹ In the early years, applied agricultural research conducted by MAC professors played a key role in garnering support for the school among skeptical Massachusetts farmers. Since then, the institution has blossomed from a small school dedicated to agricultural education into New England's premier public research university. Today UMass grants over 200 different degrees, attracts over $140 million per year in external research funding, and boasts internationally recognized graduate programs in a number of fields, including linguistics, kinesiology, food science, and polymer science.²

Externally funded research has helped UMass attain its present stature by funding graduate programs, enhancing the institution's prestige, and providing students with invaluable opportunities for hands-on learning in public, business, and industrial settings. It has also benefited industry and society at large. UMass research has resulted in new industrial plant fertilizers, modern techniques for food preservation, and formulas for understanding polymeric properties that enabled the development of the globe's telecommunications network, to name just a few innovations.

This essay documents ways in which applied research both shaped and reflected the history of UMass and its relations with industry, government, and society. It is far from an exhaustive study,

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¹ Act of July 2, 1862 (Morrill Act), Public Law 37-108, which established land grant colleges, available online at: http://www.ourdocuments.gov/doc.php?flash=true&doc=33. Massachusetts legislators assigned the task of instruction in the “mechanic arts” to the Massachusetts Institute of Technology, while designating MAC for agricultural instruction.

however. Given that a full account would involve examining hundreds of UMass researchers in dozens of fields in the sciences as well as the humanities, and that many of the written records documenting such research no longer survive (or have not yet been preserved archivally), a complete narrative is at this point impossible. Instead, this essay offers case studies of three UMass professors whose research significantly influenced both their respective disciplines and the University: farmer and agricultural scientist Levi Stockbridge (1820-1904), food scientist and technologist Carl R. Fellers (1893-1960), and polymer scientist Richard S. Stein (b. 1925). With a format enabling close study of discrete examples, this essay shines new light on important figures in UMass history while offering historical insight on several issues surrounding applied university research.

The history analyzed in these case studies also provides a backstory to the applied research thriving on the UMass campus today. A scan through links on the UMass Research website shows that projects, programs, and collaborative institutes dedicated to cutting-edge applied research cut across both the sciences and humanities and all eleven of the University’s Schools and Colleges. The Pioneer Valley Life Sciences Institute, for example, brings together researchers and clinicians from UMass and Springfield's Baystate Medical Center to conduct multidisciplinary research on cancer, diabetes, and other diseases. Featured among its programs is the Center for Excellence in Apoptosis Research, which, with the participation of nearly sixty UMass scientists, conducts nationally-recognized research on cell death that will enable the development of “new diagnostic tools and therapeutic interventions” for fighting disease. UMass also hosts the National Science Foundation (NSF)-funded Center for Hierarchical Manufacturing, a national center dedicated to basic and applied research on nanoscale manufacturing, working to make possible the production of “next generation, nanotechnology-enabled

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4 Pioneer Valley Life Sciences Institute website, CEAR page: [http://www.umass.edu/creativeservices/comps/pvlsi/cear.htm](http://www.umass.edu/creativeservices/comps/pvlsi/cear.htm).
devices for electronics, energy conservation, resource conservation, and human health.”

Among the several collaborative research institutes affiliated with the UMass Isenberg School of Management is the Center for International Securities and Derivative Markets, which facilitates global trade through the publication of its Hedge Fund and Commodity Trading Advisor Database and reports sponsored by the Options Industry Council, the Chicago Board Options Exchange, and other companies and trade associations. In addition, UMass is renowned as a leader in research on green energy and sustainability. The University hosts a number of industry and government supported institutes and projects dedicated to developing photovoltaics, wind energy systems, biofuels, and the use of the geobacter bacteria species in bioremediation, bioenergy, bioelectronics, and the conversion of the greenhouse gas carbon dioxide into fuel.

In the social sciences, the NSF-funded National Center for Digital Government coordinates research aimed at using digital communications mediums to facilitate civic engagement and government interaction with the public, while the Center for Educational Assessment “conducts research and provides training in the areas of psychometrics, research methods, and educational statistics to promote fair, useful, and efficient educational assessment practices” in Massachusetts and throughout the world. Using original research to promote “human and ecological well-being,” the Political Economy Research Institute, with close ties to the UMass Economics Department and partnerships with foundations such as the Rockefeller Brothers Fund, is a leading source of “workable

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5 Center for Hierarchical Manufacturing website, Nanomanufacturing Process Research page: http://chm.pse.umass.edu/research.
6 Center for International Securities and Derivatives Markets website: http://www.isenberg.umass.edu/CISDM/.
policy proposals . . . on issues of globalization, unemployment, financial market instability, central bank policy, living wages and decent work, and the economics of peace, development, and the environment.”

In the humanities, faculty and students in the UMass History Department's Public History Program regularly collaborate with museums, historic sites, non-profit organizations, and government agencies such as the Roy Rosenzweig Center for History and New Media, the Pioneer Valley Planning Commission, and the U.S. National Park Service, to “serve audiences for history outside of the University.”

Furthermore, at UMass, even undergraduates conduct valuable applied research. This is best evidenced in the Commonwealth Honors College's new Community-Engaged Research Program, which pairs top seniors with local community organizations to conduct socially beneficial research on topics “ranging from community awareness of wastewater discharge to the value of naps for preschoolers.”

Such expansive research endeavors are possible today thanks to the trailblazers of Umass’s past. The case studies analyzed in this essay trace the histories of three such figures.

The first case study focuses on Levi Stockbridge, Professor of Agriculture during MAC’s early years, when the institution's future hung in the balance, and the notion that the school could eventually become a massive research university was inconceivable to even the College's most stalwart supporters. During the uncertain years of the 1870s, when the U.S. faced an economic downturn and Massachusetts taxpayers widely questioned the benefits of public higher education, Stockbridge played a crucial role in using his and his colleagues' agricultural research to generate public support for MAC and secure funds vital to preventing the institution's absorption by Amherst College. In particular, his donation of royalties from the world famous “Stockbridge Manures” made possible the nation's second

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9 Political Economy Research Institute website, About Us page: http://www.peri.umass.edu/190.
agricultural experimentation station, while his tireless political advocacy, including during his brief tenure as College President from 1880-1882, established a firm foundation for 150 years and counting of excellence in UMass education and research.

The second section deals with Carl R. Fellers, a pioneer in the field of food science and technology who from 1925-1957 propelled the UMass Food Science Department's graduate program into the largest at UMass and the top in its field nationally with the help of thousands of dollars in government and food industry research grants. As one of few professors in the country able to attract substantial industry funding during the Great Depression years of the 1930s and the World War II era (1941-45), Fellers was a forerunner in using external research grants to expand graduate education at UMass. In 1957, however, UMass President Jean Paul Mather forced Fellers into early retirement to sanction his alleged use of university equipment to conduct an unauthorized vitamin D analysis for a private milk company. With this episode occurring during the peak of Mather's tumultuous struggle to garner support for the expansion of UMass from the State Legislature, Fellers' story underscores the unpredictable political climate in which university researchers operated during the first years of the institution's rapid postwar expansion.

Finally, the third case study traces Richard S. Stein's use of government and industry funded research to expand polymer education at UMass. A key figure in the development of the field of polymer science, Stein also led some of the nation's first efforts to organize interdisciplinary graduate education in the study of polymers. Stein coordinated such activity through the Polymer Research Institute (PRI), an organization he set up in 1961 to fund polymer education through external grants for polymer research useful to government, industry, and society. Drawing in millions of dollars in government and industry funding prior to Stein's retirement in 1991, the PRI served as an engine driving the creation and expansion of the Polymer Science and Engineering Department (PSE Department) and several other institutions that established UMass as a global leader in polymer
research and education. Remarkably, Stein's networking skills, and the quality of research conducted by him, his colleagues, and his graduate students, enabled the PRI to expand polymer education at UMass not only through the booming years of government-funded university expansion in the 1960s, but also during the 1980s, when public funding for higher education dwindled, and few programs at American state universities experienced significant growth. With the bulk of his work conducted during the peak years of U.S. government and industry investment in university research, Stein's career also demonstrates how not only applied, but also basic research, can benefit industry and society.

Though their lives collectively spanned the history of UMass and nearly two centuries of unparalleled political, social, and technological change, these three men's careers offer a general lesson that has remained true over the passing of time: cutting-edge university research combined with diplomatic political networking can expand the University's academic mission while yielding results directly beneficial to industry, government, and society. Quality research and social capital are no guarantee of successful institutional growth, however. Such success is always partly a product of contingent factors related to timing, location, and chance. The UMass PSE Department may never have come into existence, for example, if not for the fact that the Chemistry Department happened to be hiring in late 1949 at the same time that Richard Stein was looking for a job and the Monsanto plastics plant in Springfield was expanding its operations. Moreover, relationships like those existing between universities, government, and industry are always shaped by the larger political, economic, social, and cultural contexts in which they occur. And such contexts continually change over time as a result of individual action. This study demonstrates this latter point by revealing ways in which UMass researchers both responded and contributed to changes in university, government, and industry relations, as well as changes in prevailing beliefs regarding the value of applied versus basic research, during key periods of the institution's 150 year history.

From 1867-1882, Levi Stockbridge (1820-1904) was an ardent spokesperson for Massachusetts Agricultural College (MAC) and the societal benefits of applied research conducted on its campus. During Stockbridge's tenure on the MAC faculty, the College faced an uncertain future. Throughout the 1870s, MAC President William S. Clark (1826-1886) endured opposition from Massachusetts farmers skeptical of “book learning” and state legislators who insisted the College move away from reliance on state funding and become financially self-sufficient. As MAC confronted mounting debt, Clark and his small cohort of faculty struggled to prevent the institution's financial collapse. The institution may not have survived its first fifteen years of existence if not for the work of Stockbridge. Through his tireless championing of MAC agricultural research and his investment of funds earned through the sale of plant fertilizers bearing the mark of his famous “Stockbridge formulas,” Stockbridge played a crucial role in ensuring the school's preservation for future generations.

Born and raised in neighboring Hadley, Massachusetts, Stockbridge joined MAC as farm superintendent and agricultural instructor in 1867, just in time to teach the college’s “pioneer class” of fifty-six young men. He earned a promotion to Professor of Agriculture in 1871. Along with MAC's other “big four” professors—William S. Clark (botany and horticulture), Henry H. Goodell (modern languages), and Charles A. Goessmann (chemistry)—he endeavored throughout the 1870s, despite meager pay and the College's primitive infrastructure, to teach his students through a curriculum based on hands-on agricultural research. Having no college degree, Stockbridge was an unlikely professorial candidate. But the Commonwealth’s federal mandate under the Morrill Act had created a job opening for which he was uniquely suited.

13 William Henry Bowker, speech read at the fortieth anniversary of Massachusetts Agricultural College, October 2, 1907, excerpt printed as “Sketches: the Big Four,” one page leaflet distributed compliments of James E. Mulcahy, life insurance broker, Springfield, MA, 1970, Levi Stockbridge Papers, Box 3, Folder 52, Special Collections and University Archives, University of Massachusetts Amherst (henceforth referred to as SCUA). Cary, 39.
The younger of two sons, Levi assumed management of his family's farm as a teenager in the 1840s, while his father, Deacon Jason Stockbridge, sent older brother Henry to study at Amherst College.\textsuperscript{14} Exhibiting a keen interest in learning, Levi often sat in on his older brother’s chemistry classes. He also developed a curriculum for independent study based on his brother's school materials and readings recommended by Amherst College President Edward Hitchcock (1793-1864), who became a mentor to the young Stockbridge, and granted him free access to the college laboratory. Nights reading the works of Justus von Liebig and other agricultural chemistry pioneers, his practical experience on the family farm, and time spent conducting experiments in the Amherst College lab, convinced Stockbridge that the emerging discipline of agricultural science held the promise of immense benefit for the farmers of the Pioneer Valley and the world.\textsuperscript{15} He even dreamed of the Pioneer Valley as a future home to an agricultural college similar to those that had so immensely contributed to Germany's recent agricultural progress.\textsuperscript{16}

Taking after his father, Levi Stockbridge was also a community leader and respected advocate for Pioneer Valley farmers. He was elected to the Massachusetts House of Representatives in 1855, helped found both the North Hadley Farmer’s Club and the Massachusetts Board of Agriculture in 1856, served in the State Senate from 1865-1866, returned to the State House of Representatives in 1870, and made an unsuccessful gubernatorial run on the Greenback ticket in 1880 before returning once again to the House from 1883-1884.\textsuperscript{17} His determined advocacy and political connections were essential to the Commonwealth’s choice of Amherst as the site of its new agricultural college in 1863,

\textsuperscript{14} Anna Stockbridge Tuttle, “Reminiscences of Levi Stockbridge by his Daughter,” unpublished paper (undated), 5, Levi Stockbridge Papers, Box 3, Folder 54, SCUA.
\textsuperscript{16} Tuttle, 12-13.
as MAC became one of the nation's first colleges founded under the Morrill Act.\footnote{Cary, 27.}

Once under the employment of MAC, Stockbridge also labored vigorously to promote the College among the people of Massachusetts. Speaking regularly before meetings of county agricultural societies, Amherst political leaders, and the Massachusetts General Court, he constantly extolled the benefits of College’s applied research upon the state’s farming industry. In an 1876 talk before Massachusetts Board of Agriculture, for example, Stockbridge spent four hours explaining his Mass Ag experiments with chemical fertilizers and their benefits to farmers around the country, as part of a request for state aid to establish an agricultural experimentation station on campus that would generate further research useful to the state's agricultural industry.\footnote{Massachusetts Board of Agriculture, Annual Report for 1876, 142-185. Clipping available in Levi Stockbridge Papers, Box 1, Folder 36, SCUA.} Indeed, Stockbridge was unmatched among his colleagues in his faith that MAC’s development of applicable technical knowledge would eventually ensure its prosperity. Before the institution landed on a secure financial footing, Stockbridge frequently visited downtown Amherst to personally endorse loans from the local bank to cover the institution’s payroll. Stockbridge expressed similar generosity in his frequent cash loans to students, who looked to him not only as an inspiring teacher, but also as “a father confessor and ever present help in time of trouble.”\footnote{William H. Bowker, “Dedication of Stockbridge Hall at the Massachusetts Agricultural College, Friday, October 29, 1915,” pamphlet (1915), 10-12, Levi Stockbridge Papers, Box 3, Folder 53, SCUA. Stockbridge also held the “limited individualist” belief that society’s greater good would best be served by the state’s limiting individual wealth to one million dollars in order to preclude the existence of an inherited plutocracy. Such ideas were consistent with his membership in the pro-labor, pro-farmer, anti-monopolist Greenback Party. In his 1904 eulogy, Bowker speculated that had Stockbridge been born in the twentieth century, “he would have become, in the best sense of the word, a socialist.”}

While Stockbridge’s banknotes enabled Mass Ag’s short-term survival, his harnessing of applied research put the university on a firm footing for long-term success. During the 1870s, Stockbridge and his colleagues Professor Charles E. Goessmann and then President William S. Clark conducted experiments in sugar beet, maple sugar, and tobacco production, all of which piqued the
interest of Massachusetts political leaders interested in these crops' commercial potential. Most importantly, Stockbridge gained international repute for his innovation in plant fertilizer. Drawing upon his prior farming experience, Stockbridge conducted experiments at MAC on the novel premise that fertilizers should be custom tailored to the chemical composition of specific plant varieties, rather than spread over fields in a generalized manner, as was then traditional practice. The results were his “Stockbridge formulas” for corn, potato, and dozens of other crop fertilizers published in agricultural bulletins and pamphlets distributed throughout the world. Leading agricultural journals of the day confirmed the benefits of Stockbridge's research. A December 1875 issue of the Scientific Farmer, for example, published results of experiments its researchers conducted testing Stockbridge's formulas for grass (hay), oats, and potato fertilizer. They demonstrated enormous increases in productivity: fertilized grass yields doubled the harvest in an adjoining unmanured plot, while the oats harvest quadrupled, and the potato harvest nearly doubled.

As a result of his contribution to such agricultural advances, Stockbridge became a household name in rural communities for his role in “transforming farming into a modern science” and “revolutionizing” the fertilizer industry.

On a cold, grey afternoon in December 1875, William H. Bowker (class of 1871) ascended the creaky steps to Stockbridge's cluttered office above the woodshed abutting his house to discuss the “Stockbridge Formulas” with his former professor.


22 “Prof. Stockbridge's Experiments in Crop Feeding” reprinted in The Stockbridge Fertilizers and Formulas from W. W. Bowker & Co., pamphlet and catalog printed by W. A. Brooks & Co., Boston, 1876, 17-18, Levi Stockbridge Papers Box 1, Folder 30, SCUA.


24 Known today as the “Stockbridge House,” this building is now home to the University Club. Constructed in 1728 by settlers Samuel and Hannah Boltwood, it was Amherst's first European-style house, and remains the town's oldest standing building. The addition, which featured horse stables, a woodshed, and Stockbridge's office, no longer exists, however. See, “Stockbridge House,” YouMass Wiki.
Stockbridge for the rights to manufacture fertilizers under his name, but the twenty-five-year-old Bowker hoped that Stockbridge would instead take a chance with his recently formed Bowker Fertilizer Company. Always one to support the Mass Ag community, the professor readily agreed to a deal. “I know you,” Stockbridge remarked, as he was about to sign the agreement. “You have been one of my boys and one of our College family, and I think I’ll take my chances with you.”\textsuperscript{25}

As he had distributed them globally for free, seeking only the gratification of helping his fellow farmers, Stockbridge had not hitherto earned income from the fertilizer formulas bearing his name. But Bowker’s sale of the “Stockbridge Manures” quickly generated profit. Remaining true to his generous ideals and faith in the social value of academic research, in 1878 Stockbridge donated the first $1,000 in royalties he received from Bowker to establish the Massachusetts Agricultural Experimentation Station he had long lobbied for in the state legislature.\textsuperscript{26} He did so knowing that the Station would serve as a center for practical agricultural research that would increase public support for MAC. This donation won the Trustees' authorization of the Station, which was the second of its kind in the country, and the first one affiliated with an agricultural college.\textsuperscript{27} With Stockbridge, Clark, and Goessmann assigned to a committee charged with managing the operation, the professors proceeded with new research.\textsuperscript{28} In the Station's first report printed in January 1879, Goessmann outlined his experiments ruling out sorghum as a lucrative Massachusetts cash crop, while Stockbridge explained the results of his experiments with a new lysimeter (a device used for measuring the percolation of rain upon soil) demonstrating the impact of moisture upon soil temperature.\textsuperscript{29} These reports added to the dozens of

\textsuperscript{25} William H. Bowker, “A Tribute to Levi Stockbridge,” pamphlet (1904), 7, Levi Stockbridge Papers, Box 3, Folder 52, SCUA.

\textsuperscript{26} Bowker (1904), 7-8. In his history of UMass, Cary mistakenly wrote that this money was royalties from Stockbridge's fertilizer “patents,” but such patents did not exist. Bowker's testimony clearly indicates that these funds were the proceeds of a copyright agreement allowing the Bowker Fertilizer company to sell fertilizer under Stockbridge's name.

\textsuperscript{27} Ibid. The first agricultural experimentation station was located in New Haven and operated by the State of Connecticut.

\textsuperscript{28} MAC Annual Report for 1878, 15.

\textsuperscript{29} C. A. Goessmann, “Report to the Directors of the Massachusetts Experimental Station,” and Levi Stockbridge, “Report
useful studies recently completed in MAC faculty, including investigations on the agricultural value of South Carolina phosphates (as fertilizer), the convertibility of Massachusetts’s salt marshes into farmlands, and the influence of different feeds upon the quality of cow's milk.\textsuperscript{30}

Recognizing the importance of such research for both Massachusetts industry and the nation's agriculture, President Clark expressed in the 1879 MAC Annual Report his hope “in the interests of scientific agriculture, that the liberality and enterprise of Professor Stockbridge in thus starting the Massachusetts Experimental Station will be followed up by the appropriation or gift of means for its continuance.”\textsuperscript{31}

Stockbridge's business deal took place at crucial time for MAC. With its endowment shrinking steadily, by 1877 the College had increased its debt by $5,000 to $8,000 per year, and public criticism of the institution had become widespread.\textsuperscript{32} Two years later, internal disagreements split the Board of Trustees, and articles in the \textit{Springfield Republican}, \textit{Boston Post}, and \textit{Boston Globe} attacked the administration as “negligent and unintelligent” for supposedly wasting public funds through poor management.\textsuperscript{33} In the midst of this turbulent period, Stockbridge’s investment in MAC’s mission reaffirmed to the school's Trustees that he was a key leader of the College community. They called upon the Professor of Agriculture in the spring of 1880 when the College faced its worst crisis to date, as President Clark submitted his resignation amid frustrations with the Legislature’s stubborn refusal to provide the institution with adequate state funding. Stockbridge accepted the president’s chair reluctantly, after withdrawing his own resignation from the College faculty. But in two short years he

\textsuperscript{30} MAC Annual Report for 1880, 14-15.
\textsuperscript{31} MAC Annual Report for 1878, 16.
\textsuperscript{32} Cary, 53.
\textsuperscript{33} \textit{Springfield Republican}, January 4, 1879, quoted in Cary, 58. See Cary for quotes from the other papers listed here.
succeeded in saving the College from collapse.\textsuperscript{34}

Immediately after assuming the presidency, Stockbridge organized a special town meeting in Amherst to respond to Governor Thomas Talbot’s plan to hand MAC over to Amherst College. The petition generated by this meeting, bolstered by a Bureau of Agriculture report favoring Stockbridge’s proposal for a Massachusetts Agricultural Experimentation Station, and a letter by Stockbridge asserting that the College had “done more for the advancement of agricultural science” since its founding “than the combined Departmental Schools of the nation,” convinced the Governor to abort his plan.\textsuperscript{35} Stockbridge then went about balancing the College’s $24,000 budget by dramatically cutting faculty pay; expenditures for salaries dropped from $17,461 in 1879 to less than $10,000 in 1882.\textsuperscript{36} He also continued lobbying for adequate state financial support. In June 1881 he organized a convention at MAC bringing together the governor and his Executive Council, the Board of Agriculture, and the Board of Trustees to discuss the needs of the College, and hear Trustee Daniel Needham’s fervent request for a budget appropriation guaranteeing free tuition and other essentials needed to fulfill Massachusetts’ contract under the Morrill Act.\textsuperscript{37}

Stockbridge’s appeals to the legislature remained unfulfilled when he resigned from his post in January 1882, shortly after filing his last Annual Report. But his efforts to salvage MAC had established the momentum needed to garner the state government’s lasting support for the Agricultural College. A few months later, the legislature made its first appropriation for the experiment station; $15,000 allotted through the federal Hatch Act of 1887 allowed for the construction of new laboratory buildings, now known as West Experiment Station (1887) and East Experiment Station (1880).\textsuperscript{38} The next few years also brought funds for the construction of several other new buildings on campus,

\begin{footnotesize}
\begin{enumerate}
\item Cary, 60.
\item Levi Stockbridge letter to the Senate and House of Representatives of the Commonwealth of Massachusetts (undated), Levi Stockbridge Papers, Box 1, Folder 32, SCUA. Cary, 60-61.
\item Cary, 63.
\item MAC Annual Report for 1881, 14-21.
\item Cary, 72.
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including a new president’s house—no longer would a woodshed serve as the Mass Ag president’s office. Most importantly, a $10,000 scholarship appropriation attracted an 1883 entering class numbering fifty, the largest since 1878, when President Clark had obtained a one-time round of scholarships for incoming students. As Harold Whiting Cary explained in his centennial history of UMass, Stockbridge's successors “would not have to face another threat to bring the institution to an end.”

Following his retirement from MAC in 1882, Stockbridge continued his work in agriculture and politics, and as a board member of the Bowker Fertilizer Company, until his death in 1904. In a eulogy for Stockbridge read at MAC's 1904 commencement, William H. Bowker lauded the accomplishments of his revered professor, friend, and business partner. Bowker implored the MAC community to remember Stockbridge as not only an inspiring teacher, but also as someone skilled in applying scientific research to farmers' practical problems. “As good practice and good science must agree in the end,” he wrote, “so I believe the scientific world is coming to agree with the practical farmer that the system and method of application for which Stockbridge stood and labored is as truly scientific as it is thoroughly practical, and to accord him a high place among the workers for the advancement of scientific as well as practical husbandry.” In other words, an important aspect of Stockbridge's legacy was his advancement of applied research beneficial to farmers, the plant fertilizer industry, and UMass.

Over a century since his passing, Stockbridge’s influence continues to be felt. It lives on in Stockbridge Hall, home of the Stockbridge School of Agriculture, whose faculty and students conduct cutting edge research on hydroponics, athletic turf design, organic farming techniques, and permaculture, the latter having recently gained recognition by winning the White House’s prestigious

39 Ibid, 64.
40 Ibid.
41 Bowker (1904), 15.
“Campus Champions of Change Challenge.”\(^{42}\) Now in its 125\(^{th}\) year of operation, the Massachusetts Agricultural Station (now part of the Center for Agriculture) also continues to positively impact the people of Massachusetts and the beyond, particularly in the areas of global food security, hunger and farm systems, climate change, sustainable energy, and food safety and functionality.\(^{43}\) Stockbridge's work also continues to influence farmers and fertilizer companies everywhere, who now take for granted the professor’s faith in the advantages of agricultural chemistry. Finally, Stockbridge’s legacy persists in benefitting the thousands of members of the UMass community, whose educations and careers, whether they realize it or not, would not have been possible without the field investigation and unflagging dedication of this tenacious Hadley farmer.

**Carl R. Fellers: UMass's Forgotten Food Science Pioneer**

During his tenure in the Department of Food Technology from 1925 to 1957, Professor Carl R. Fellers (1893-1960) was UMass's most important generator of externally funded applied research. A pioneer in the field of food science and technology, he founded his department's graduate program in 1930, and quickly propelled it into the largest at UMass and the top in its field with the aid of thousands of dollars in research funds provided by food companies and the federal government. In doing so, Fellers was a forerunner for other UMass professors (including chemist and polymer scientist, Richard S. Stein) who used external funding to expand graduate education. His accomplishments were especially remarkable during the Great Depression years of the 1930s and the World War II era (1941-45), when few other American university researchers managed to attract industry funding.

Prior to World War II, most corporations conducted research in their own laboratories, and the


\(^{43}\) UMass Amherst College of Sciences, Center for Agriculture website, “Issues We Focus On”: http://www.ag.umass.edu/index.php/research/issues.
majority of external funding for university research came from philanthropists. A number of major universities also hosted laboratories and graduate programs organized in conjunction with industry partners, particularly during the 1920s, but such cooperative ventures declined during the Great Depression. At MAC, however, Fellers was the first researcher to attract a significant amount of external research funding.

Yet Fellers and his work have been largely omitted from UMass’s historical record. In particular, Harold Whiting Cary’s *The University of Massachusetts: A History of One Hundred Years* (1962), generally considered the authoritative study of the institution during its first century of existence, neglects Fellers entirely and makes only passing reference to the Department of Horticultural Manufactures (as the Department of Food Technology was known prior to 1946).

How could it be that Cary, a UMass history professor hired in 1933, managed to overlook the contributions of one of his most renowned colleagues, the University's greatest source of external funding and, beginning in 1941, head of the department with the most important graduate program on campus? Since Cary did not leave a written explanation, it is impossible to say for sure. In all

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45 Cary, 138. As a result of Cary’s omission, succeeding scholarship has included similar lapses. For example, Richard M. Freeland’s exhaustive study, *Academia’s Golden Age: Universities in Massachusetts, 1945-1970* (New York: Oxford University Press, 1992), which draws heavily from Cary in its fifty-page chapter on UMass, does not mention Fellers either. The name of the Department of Food Technology was changed to the Department of Food Science and Technology in 1962. In 1972 the named changed to the Department of Food Science and Nutrition, and in 1990 it became the Department of Food Science.

46 Obituary of Harold W. Cary, *Springfield Union-News*, May 13, 1994, 24. Cary was certainly aware of Fellers. Besides the fact of Fellers’ towering stature on what remained in the 1950s a small campus, Cary communicated directly with the Food Technology department while researching his book. On April 7, 1961, acting Department Head Arthur S. Levine send Cary a memorandum in response to an apparent request for information on the department's history. As a contribution to the history of the University for the Centennial, he enclosed a six-page departmental history written by former Head W.W. Chenoweth, which credited Fellers for “develop[ing] a research department which ranks second to none in this country.” Levine also stressed, “this Department has enjoyed for over 30 years a world-wide reputation for its contributions to food research and education. This recognition has reflected creditably on the University abroad as at home.” Memorandum from Arthur S. Levine to Harold W. Cary, Subject: “Centennial History,” April 7, 1961, and W.W. Chenoweth, “Dedication Address,” text from a speech given at the dedication of the Chenoweth Laboratories,
likelihood, however, his omission of Fellers was no accident. In 1957, Fellers was forced into early retirement after University President Jean Paul Mather alleged that he and his Food Technology colleague, Leonard R. Parkinson, had used University equipment to conduct unauthorized vitamin D analyses for a private milk company.\textsuperscript{47} Fellers’ supposed transgression infuriated Mathers at a time when the President was immersed in an intense lobbying campaign to secure state funding for the University.\textsuperscript{48} Completing his centennial history of UMass only five years after Fellers’ retirement, Cary likely judged the contentious vitamin D incident as one best avoided, and decided to ignore the former Food Technology Head altogether.

In disregarding Fellers, however, Cary passed over an important story about applied research. Fellers’ story is not only about an innovative scientist and teacher beloved by his students and colleagues; it is also about how well-cultivated university-industry relations propelled a university researcher’s career and department to stunning success, and how conflict over such relationships, occurring in the midst of larger political disputes surrounding a rapidly expanding state university's uncertain future, resulted in the abrupt termination of this esteemed scholar's employment.

UMass was a leader in food science before Fellers. Indeed, the discipline was born at MAC in 1913, when Horticulture Department Chair Frank A. Waugh asked pomology instructor William W. Chenoweth to present a paper on horticultural manufactures to a meeting on campus of the Massachusetts Fruit Growers Association, whose members had been struggling for years with the question of what to do with their low-grade fruit.\textsuperscript{49} Waugh was convinced that with new canning,


\textsuperscript{48} Powers, 53-54; Freeland, 309-313.

\textsuperscript{49} The MFGA meeting was part of a larger conference of New England farmers held at MAC that spring. W.W. Chenoweth, “The Birth of a New Science” in \textit{Phi Kappa Phi Journal} (December 1945), 158-160, copy in Horticulture
preserving, and food processing technology, farmers could transform lower grade produce normally destined for the compost heap into tasty and profitable food products. Chenoweth was initially reluctant to accept his Chair’s request, believing that he “knew absolutely nothing about the subject.” But Waugh was insistent. “Your ignorance on the subject is all in your favor,” he maintained, “because you won’t have any prejudices to overcome.”

It wasn’t long before Chenoweth had embraced his colleague’s vision. The fruit growers attending “the first lecture ever given on the subject of horticultural manufactures” responded with enthusiasm—so inspired was Charles Miller that he decided to open a canning factory in South Amherst using the professor’s principles. The lecture convinced Chenoweth that a vast “unexplored field” with huge implications for the betterment of society was ripe for investigation. With a gas plate, some pots and pans, and a few “hydrometers for measuring salt and sugar solutions,” he set up a laboratory in a Wilder Hall basement storage room where he spent “every spare hour” of the following year developing techniques and formulas for home canning procedures. These formulas became the basis for the courses in horticultural manufactures Chenoweth began teaching in the fall of 1914, and for the first textbook on horticultural manufactures, which he published in 1930. During the World War I years of 1916-1917, Chenoweth also oversaw a hugely successful series of MAC-sponsored public lectures and workshops designed to train the people of Massachusetts in food preservation. During the summer of 1917 alone, over 9,200 people registered for his two-day programs, while

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50 Ibid, 158-159.
51 Ibid. Writing in 1945, Chenoweth remarked that Miller’s “plant has been operating continuously for a period of almost thirty years.” In W.W. Chenoweth, “History of the Department of Horticultural Manufactures,” undated document in Horticulture Division, 15/11, SCUA UMass, 1, Chenoweth indicates that this factory was located in South Amherst. I have been unable to find further documentation on Miller’s canning factory.
52 Ibid (1945), 158.
53 Ibid.
eighty-five attended his four-day sessions.\textsuperscript{55} Chenoweth became Head of the new Department of Horticultural Manufactures in 1918 with the enthusiastic support of President Kenyon Butterfield, who, in the context of the era's food shortages, believed that the future of MAC depended upon its ability to develop as a “food college.”\textsuperscript{56}

Upon joining the Department of Horticultural Manufactures in 1925 with the help of funds provided by the Purnell Act, Fellers helped transform an already path-breaking department into one equipped to lead the “scientific age of the industrialization of food manufacturing.”\textsuperscript{57} A native of Hastings, New York, and a graduate of Cornell University (A.B., 1915) and Rutgers University (M.S., 1916; Ph.D., 1918), Fellers brought to MAC his experience as a bacteriologist with the U.S. Food and Drug Administration’s Bureau of Chemistry in San Francisco from 1919-1920, as research bacteriologist on seafood and canned foods with the National Canners Association in Seattle from 1921-1923, and as professor of food preservation at the University of Washington from 1924-1925.\textsuperscript{58} In these capacities, Fellers honed his skills as a researcher and developed social capital through his personal connections with professionals in academia, the federal government, and the growing food industry. Such connections proved crucial to his success in attracting external funding for food science research at UMass. Chenoweth later recalled that Fellers' ability to “draw large sums of money to be expended in research” came from his “commanding reputation among business concerns and scientific

\textsuperscript{55} Chenoweth (1945), 161.
\textsuperscript{56} Cary, 138. For more on Chenoweth, see F. John Francis, “Walter Chenoweth, the Teacher,” in \textit{Pioneers in Food Science}, 117-120. On Chenoweth’s successful efforts to improve nutrition among the people of Newfoundland by teaching methods for canning salmon and other foods during the summers of 1929 and 1930, see F. John Francis, “The Grenfell Adventure,” in \textit{Pioneers in Food Science}, 121-128.
\textsuperscript{57} Chenoweth (1945), 162. “History of UMass Food Science Department,” narrated slideshow produced by the UMass Food Science Department available online at: http://www.umass.edu/foodsci/clydesdale-center/Fergus%20Clydesdale%20Health%20and%20Wellness.mov. President Calvin Coolidge signed the Purnell Act in 1925, in the wake of World War I-era food shortages, to promote national agricultural productivity through applied research conducted at agricultural experiment stations on land-grant colleges. For more on the Purnell Act, see Joel P. Kunze, “The Purnell Act and Agricultural Economics,” \textit{Agricultural History} 62:2 (1988), 131-149.
Because the contracts Fellers signed with various companies no longer survive, it is impossible to know exactly how much revenue he brought to his department. A list of industry and government funded fellowships acquired by the Food Technology Department from 1929 to 1943 available in the University Archives, however, demonstrates that external funding amounted to approximately $65,550 during this period. Today such a sum would be worth two to four million dollars. In a 1944 letter to President Hugh P. Baker accompanying this list, Acting Head of Department Francis P. Griffiths credited Fellers as the main figure responsible for attracting this support so crucial to “research of value to the entire state and nation.” The Department spent most of these funds on graduate student fellowships, while also purchasing equipment for Chenoweth Laboratories, built in 1933.

Among the largest donors was the New York-based American Cranberry Exchange, which provided roughly $11,000 between 1930 and 1942 for research Fellers led on the nutritional value of various cranberry products. The Hills Brothers Company of New York also granted at least $3,200 for research on fig and date preservation beginning in 1929, which resulted in Fellers' patents on methods for pasteurizing Dromedary dates, and provided several years of graduate student fellowships. Birdseye Laboratories of Gloucester, Massachusetts, provided over $1,100 for nutritive

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59 Chenoweth (1945), 163.
60 “Cooperative Fellowships – Department of Horticultural Manufactures,” typed list of industry and government grants to the Massachusetts State College Department of Horticultural Manufactures. An accompanying memorandum from Acting Head of Department Francis P. Griffiths to President Hugh P. Baker, January 14, 1944, indicates that Professor William Esselen authored the latter document. Both documents are available in Horticulture Division, 15/11, SCUA UMass. This figure may be a conservative estimate, however, since Esselen's list omits funding from the American Potash Export Company and the Massachusetts Fruit Growers Association cited in Chenoweth (1933) and Massachusetts Agricultural Experiment Station, Annual Report for the fiscal year ending November 30, 1931 (Amherst, MA: Agricultural Experiment Station, February 1932), 47. I henceforth cite these reports as MAES, Annual Report.
61 I arrived at these figures by comparing the value of $65,000,000 in 1940 to its value in 2012 using the Purchasing Power Calculator provided at MeasuringWorth.com: http://www.measuringworth.com/uscompare/relativevalue.php.
62 Griffiths memorandum to Baker.
63 Ibid. Chenoweth (1933).
64 “Cooperative Fellowships”; MAES Annual Report for 1930, 267.
65 Powers, 46; Chenoweth (1933), 25-26; “Cooperative Fellowships.”
studies of blueberries and other foods throughout the 1930s. In addition, the Springfield, Ohio-based K-R-O Company and the USDA Bureau of Biological Survey funded nearly $5,000 of research on the use of red squill as rat bait during this period. In the World War II years of 1939-1943, the Glass Container Association of New York granted $20,000 for research on industrial canning of food in glass jars. Other funders included Quaker Oats, General Foods, Campbell's Soup, and the Massachusetts Fruit Grower's Association (who had benefitted greatly from Chenoweth's work), while Fellers conducted further research on white fish, Atlantic tuna, apples, onions, asparagus, tomatoes, peas, coconut, mushrooms, and other foods.

Furthermore, Fellers patented path-breaking processes for canning and freezing shellfish to avoid discoloration and the accumulation of gritty particles that had previously limited the mass production of processed shrimp. Cited by a shrimp-packing spokesperson as “the greatest technical advance in 25 years,” these inventions benefitted the seafood industry as a whole, including the South Carolina-based Blue Channel Corporation, of whose board of directors Fellers was a member. Fellers conducted basic research valuable to industry as well. For example, his and his colleagues' articles on the antioxidant qualities of ascorbic acid, funded in part by the Hoffman – La Roche Company, helped revolutionize the processed food industry by providing knowledge about a naturally occurring substance that has been widely used as a preservative for fruits, vegetables, and meats since 1943.

With industry funding, Fellers attracted graduate students from around the world, making his department's program the top in its field. His former student Frederick J. Francis later recalled that as a
food chemistry instructor at the University of Toronto interested in pursuing a Ph.D., Carl Fellers was “the only [researcher in the field] I heard about. I would have gone to Timbuktu if he was there. He had that kind of a reputation in Canada in the middle 1940s.”73 Others of Fellers’ approximately forty graduate students came from around the U.S., and from countries as far-flung as Chile, Egypt, Norway, India, and Singapore.74 Many of “Doc Fellers' boys” went on to found and direct food science departments at other universities, or to take prestigious positions in the United States Department of Agriculture (USDA), Agriculture Canada, or top food companies such as CPC International, General Foods, and the Thomas J. Lipton Company.75 During Fellers' tenure, the Food Technology Department also hosted the largest graduate program at UMass, regularly producing over half of its doctoral graduates. Of the 140 Ph.D. degrees awarded by the University between 1945 and 1960, 75 were in food technology.76

Two elements were crucial to Fellers' success in attracting the large amounts of research funding that sustained his department and career: his authoritative knowledge of an emerging field useful to a burgeoning industry, and his skill in utilizing a vast network of professional contacts. Fellers' mastery of the field he helped create was world renowned due to the above achievements, his authoring or co-authoring of over 200 scientific and technical articles, and his earning of numerous awards, including the prestigious Babcock Medal.77 As his son-in-law and former graduate student, Dr. Anthony Lopez, recalls, food industry executives took Fellers seriously because whenever asked a

73 Francis quoted in Powers, 15. Francis later became a professor in the UMass Food Science and Technology Department, serving as Head from 1971-1977.
74 Powers, 11-21, 55-71; “Food Technology Department,” typed list of department faculty and graduate students, March 1, 1953, 2 pages, Department of Food Science and Nutrition Papers, Box 25/F5, Folder 1, SCUA. The Department also hosted students from Greece, Burma, Iraq, Formosa, Brazil, Thailand, and Israel, among others.
75 Powers, 11-21, 55-71. Fellers also advised at least two female students, Mary E. Lyons (Ph.D., 1939), and Georgia Markakis (M.S., 1952).
76 F. J. Francis, “The Department of Food Science Historical Development,” in “Seventy-Five Years of Food Science,” 2.
77 “Two Resign from UMass Food Tech Department,” *Amherst Journal Record*; “Dr. Fellers to Receive Food Award,” *Amherst Journal Record*, April 5, 1950. See Powers, 73-78, for a partial listing of Fellers' publications.
question in the area of food science and technology, “he had an answer for it, a correct answer.”

Widely adored by his students, colleagues, and business associates, Fellers also possessed a magnetic character that was key to his successful networking. While business partners have not left written records recalling their dealings with him, the piles of letters that the professor's former students sent to Mrs. Josephine Fellers following her husband's death in 1960 speak to the respect and adoration his personality commanded. Former students remembered “Doc” as an immensely kind, generous, and enthusiastic teacher who “took a close personal interest I every one of his students,” often (with the help of his wife, Josephine) feeding and housing students in his family's home and lending money to those in financial need. Fellers also garnered an enormous amount of respect for his service in World War II, during which he rose to the rank of Lieutenant Colonel and oversaw the construction of 33 dehydration plants in Australia used to feed allied troops in the Pacific Theater, an effort that earned him a Bronze Star.

Given his vast accomplishments and esteemed reputation, news of Fellers’ forced retirement, announced by President Mather in March 1957, surely came as a shock to those who knew him. Unfortunately, there remains little evidence documenting the chain of events leading up to this announcement. The mystery surrounding Fellers’ forced retirement, however, points to the state of university-industry-government relations in the late 1950s.

The only surviving documentation on Mathers' decision is a pair of articles from the *Amherst Journal Record* and *Daily Hampshire Gazette*. Both pieces quote a statement President Mather provided for the media on March 12, 1957, but the original transcript of this announcement is not available in the University Archives. In the portions of his statement quoted in the press, Mather,

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78 Anthony Lopez, phone interview with author, May 9, 2012.
79 Kenneth E. Benson, M.S., 1939, quoted in Powers, 57.
80 Powers, 39-45.
81 “UMass Professors Engaged in Professional ‘Lab’ Work; Will Leave, Says President,” *Daily Hampshire Gazette*; “Two Resign from UMass Food Tech Department,” *Amherst Journal Record*. 

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without providing specifics, charges that Fellers and his colleague Leonard Perkinson “were engaged in professional laboratory work which they could not reconcile with [the University's] current administrative policies,” and that, “as a basic principle and policy of any tax supported program, no public institution can permit the unauthorized use of facilities and equipment for personal gain or in flagrant competition with private industry.”

Adding a bit more information to the story, Fellers' former graduate student John J. Powers asserts in his book *Pioneers in Food Science* (presumably based upon his personal memories, since he cites no source) that in 1954 President Mather “appointed a committee” to evaluate charges from a private milk company that Fellers had used UMass lab equipment to conduct vitamin D assays for a rival milk company without proper University authorization.

In the March 1957 *Gazette* article, however, Trustee Chair Joseph Bartlett denied rumors that the Board had carried out a formal investigation of Fellers. Furthermore, neither the papers of President Mather nor the Board of Trustee minutes from 1954-1957 housed in the University Archives contain records of an investigation of Fellers, though this does not rule out the possibility that such an investigation did exist.

The above sources suggest that Fellers conducted laboratory tests with University equipment, probably for a milk company, without proper administrative approval. However, since Fellers used most “money collected for incidental, miscellaneous services” to provide students or their wives with odd-jobs caring for laboratories and research animals, his associates at the time doubted that Fellers conducted unauthorized vitamin D analyses for a milk company for personal profit, or aimed to compete with private industry (as his critics implied).

Moreover, since Massachusetts Agricultural Experiment Station Annual Reports for 1948-49 and 1949-1950 note Parkinson and Fellers as working

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82 *Daily Hampshire Gazette*, “UMass Professors Engaged in Professional ‘Lab’ Work; Will Leave, Says President”; *Amherst Journal Record*, “Two Resign from UMass Food Tech Department.”

83 Powers, 52.

84 *Daily Hampshire Gazette*, “UMass Professors Engaged in Professional ‘Lab’ Work; Will Leave, Says President.”

85 Powers, 53.
on a “Vitamin D Bioassay Research” assignment, it could be that they simply neglected to have the project re-authorized.\textsuperscript{86} The sanctions against Fellers may also be surprising to those familiar with research services today provided by UMass Research Equipment, Facilities and Service (REFS), which regularly coordinates similar services for interested industry partners.\textsuperscript{87}

So why exactly did President Mather force Fellers into retirement? Revoking the job of one of the University's most renowned researchers was a harsh penalty for any infraction, especially at a time when many officials at major American universities coveted nearly any opportunity for industry funding.\textsuperscript{88} In all likelihood, Mather's punishment of Fellers was a response to conflicts much larger than a dispute over a vitamin D assay. During his brief tenure as President from 1954 to 1960, Mather devoted much of his time and energy to promoting UMass, and its potential for undergraduate education, among the citizens and political leaders of Massachusetts. Having set out in his inaugural speech to expand undergraduate enrollment from 4,000 to 10,000 within a decade in order to accommodate the “tidal wave” of Massachusetts youth projected to apply for admission in coming years, he lobbied the State House, met with newspaper editors to secure supportive editorials, and held speaking engagements throughout the Commonwealth endeavoring to secure the state funding and political autonomy necessary to reach his goal.\textsuperscript{89} Benefiting from the support of Governor Christian Herter, Mather enjoyed a fair amount of success early in his term. During his first three years in office the State Legislature appropriated over twelve million dollars for construction at UMass, a sum that exceeded by over two million dollars the total of all of the University's previous capital budgets.\textsuperscript{90}

After making over 300 speeches in nine months, Mather also won passage of the “Freedom Bill” in July 1956, which transferred control over faculty hiring, promotion, and compensation from the

\textsuperscript{86} Ibid, 52.
\textsuperscript{87} UMass Research, Equipment, Facilities and Services website: \url{http://www.umass.edu/umassrefs/}.
\textsuperscript{88} Roger L. Geiger, Research and Relevant Knowledge: American Research Universities Since World War II (New York: Oxford University Press, 1993), 158.
\textsuperscript{89} Freeland, 306.
\textsuperscript{90} Ibid, 309.
Legislature's Division of Personnel and Standardization to the UMass provost, and earned him an outpouring of praise from colleagues and associates.\textsuperscript{91}

The latter bill passed only narrowly, however, as President Mather, frustrated by the Legislature's slowness in responding to the University's needs, offended many of its members during a speech widely quoted in newspapers in which he sarcastically quipped that the Division of Personnel's “knowledge of higher education would crowd a cufflink.”\textsuperscript{92} Described by one legislative leader as “dead right” on the issues but “lack[ing] any sense of diplomacy,” Mather faced consistent resistance on Beacon Hill following the Freedom Bill's passage, especially among representatives of Boston's Catholic elites who regarded the University as provincial backwater.\textsuperscript{93} In the context of intense statewide political negotiations over UMass's future, charges of misconduct by a University professor were likely the last thing Mather wanted publicized in Massachusetts newspapers. Furthermore, state funding for expansion of liberal arts education was much more of a priority for Mathers than food technology research. These could explain the University President's quiet but strict response to Fellers' vitamin D incident.

Mather also demonstrated his anger toward Fellers by refusing to allow a portrait of the professor commissioned by his former students to hang in Chenoweth Laboratory in 1957. Only in 1960, after Mather resigned from his position to protest the Legislature's refusal to approve a bill to increase UMass faculty salaries, and after Fellers died of a stroke in Quebec on his way to teach a class at Laval University, did the University's new President, John W. Lederle, agree to permit the portrait's hanging.\textsuperscript{94} With Mather gone, and Fellers deceased, it was Lederle who built upon the legacies of both

\textsuperscript{91} Ibid, 310. Ian Menzies, "He Put UMass on the Map," \textit{Boston Globe}, December 4, 1984, 21. Mather's papers in the University Archives contain a folder of letters from UMass faculty, Massachusetts political leaders (including Senator John F. Kennedy), and administrators from universities around the country congratulating him on the passage of this legislation. See Jean Paul Mather Papers, SCUA.
\textsuperscript{92} Freeland, 310.
\textsuperscript{93} Ibid, 311; Menzies.
\textsuperscript{94} Freeland, 311; Powers, 53-54. Mather's resignation played a key role securing political support for UMass on Beacon
men by leading UMass through its greatest period of expansion in the “dynamic decade” of the 1960s, during which the Department of Food Science and Technology (as it became known in 1966) remaining a leading source of teaching and innovation.95

Fellers' portrait, which still hangs in Chenoweth Laboratory, remains UMass's sole memorial to a researcher whose career fell casualty to the growing pains of a state institution embarking on a period of unprecedented growth. During this time, enlargement of undergraduate education was President Mathers' primary concern, and government- and industry-supported university research had not yet begun the campus-wide expansion that would take place in the 1960s under Lederle.96 But although few at UMass remember the professor who blazed their school's path towards becoming a world-class research university, Fellers remains a legend in the field of food science and technology. For example, the field’s most prestigious prize is the Carl R. Fellers Award, which the Institute for Food Technologists annually grants to one of the discipline’s top scholars. In addition, the profession's honor society, Phi Tau Sigma, regularly includes in its newsletters a “Memories of Dr. Carl R. Fellers” column, featuring “Doc” Fellers’ aging graduate students’ testimonials on their appreciation for the professor and his profound positive impact upon their lives, educations, and careers.97 And Fellers' legacy continues to benefit UMass, despite the fact that few have heard of him. A 2011 report by the National Research Council recognized the Department of Food Science as one of four UMass research-

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96 The main other UMass researcher attracting major external grants at the time of Fellers' retirement was Richard S. Stein, discussed in the next section. Expansion of research at UMass in the 1960s was a result not only of Lederle's effective leadership, but also of an enormous increase in availability of U.S. government funding for university research following the Soviet Union's launching the world's first satellite, Sputnik, into space on October 4, 1957. See Geiger (1993), 161-166.

97 Phi Tau Sigma newsletters are available online at: http://www.phitausigma.org. The newsletter's editor, Dr. Kathryn L. Kotula, provided the author with a document featuring all of the “Memories of Dr. Carl R. Fellers” columns published to date. For more graduate student accounts of Fellers, see Powers, 55-71.
doctorate programs ranked among the top of their field at any U.S. university, public or private. Because Fellers' work helped make such recognition possible, it cannot be overlooked.

Richard S. Stein: UMass Pathbreaker in Polymer Research and Education

Few have contributed to the development of UMass research in the second half of the 20th century as much as Professor Richard S. Stein (b. 1925), who taught and conducted research in the Chemistry Department from 1950 until his retirement in 1991. Stein used early 1950s grants from the Research Corporation and the Office of Naval Research (ONR) to establish himself as a pioneer in the nascent field of polymer science, the study of small molecules fixed together to form larger molecules, or polymers. He then helped put UMass on the map as the world's premier center of polymer research by earning dozens of prestigious honors and awards, traveling throughout Europe and Asia to share his expertise, and founding and coordinating a series of campus-based government- and industry-supported institutions dedicated to interdisciplinary collaboration: the Polymer Research Institute (1961), the Research Computing Center (1961), the Chemistry Department's Polymer Science and Engineering Program (1964), the Polymer Science and Engineering Department (1975), the Center for UMass/Industry Research in Polymers (CUMIRP) (1980), and the Conte National Polymer Research Center (1996). By helping make plastics and other synthetic materials ubiquitous, such institutions

98 Malone, “From the Vice Chancellor.” Also see footnote 1.
99 Stein has received rewards from the American Chemical Society; the American Physical Society; the Rheology Society; the Society of Plastics Engineers; the Society for Polymer Science, Japan; the Materials Research Society, and the University of Massachusetts (Chancellor's Medal, 1978). He was inducted into the National Academy of Science in 1990, and the National Academy of Engineering and the American Academy of Arts and Sciences in 1991. He has held visiting professorships at Kyoto University (Japan; 1968, 1972, 1976, and 1984), Syracuse University (1978), Laval University (Quebec, Canada; 1982), École Supérieure de Chimie (France; 1986), University of Ulm (Germany; 1989), and the University of Akron (1992), and holds honorary doctoral degrees from UMass, Brooklyn Polytechnic University, and University of Ulm. He has published over 400 articles and reviews in scientific publications. In 1977, prior to U.S. recognition of the Peoples' Republic of China, Stein travelled to the country with a small delegate of U.S. scientists. For an overview of these accomplishments, see Richard S. Stein “Polymer Education in the United States,” Macromolecular Symposia 118:1 (1997), 753-760; Richard S. Stein, interview by James J. Bohning, University of Massachusetts Amherst, June 17, 1987 (Philadelphia: Chemical Heritage Foundation, Oral History Transcript #0071); David Adams, “George R. Richason, Jr. and Richard S. Stein – Groundbreakers in UMass Amherst Chemistry,” (paper
contributed to a fundamental technological transformation of our world.

Now 87-years-old (and still inhabiting, with his wife, Judith, their family home of 60 years a block north of campus), Stein has had plenty of time to reflect on his career. When asked what he believes has been his greatest contribution to humanity, he replies, “I think advancing polymer education.” To Stein, the most important outcome of the above accomplishments was the furtherance of humanity's understanding of polymers, whether this be through teaching laypeople that common products from sneaker soles to television screens are the results of molecular innovation, or through creating the interdisciplinary research forums and educational programs that have made such innovation possible.100

Key to Stein's success in advancing polymer education was his skill in transmuting the traditional boundaries of his discipline and department. Stein understood early on that advances in knowledge and technology beneficial to society require cross-pollination of ideas across disciplines like chemistry, physics, and engineering, and across the spheres of academia, industry, and government. Indeed, the history of Stein's career can be understood as a story about how a pathbreaking researcher expanded knowledge related to his field by forging lasting collaborations across such divides. His accomplishments are also distinctive because he used successful research collaborations with external partners to expand polymer education during the booming decades of government-funded university expansion in the 1950s and 60s, as well as after the early 1970s, when public funding began to shrink, and UMass, like most other American public universities, entered several decades of slowed growth.101

In addition, Stein's career demonstrates how basic research—as well as applied research—can

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100 Richard S. Stein, interview by Dan Chard, Amherst, Massachusetts, April 2, 2012. Also see Stein, “Polymer Education in the United States.”
101 Story, 67.
benefit industry and society. The scientific formulas and theories Stein and his colleagues developed during the peak years of U.S. government and industry investment in basic research made possible the development of countless new technologies and commercial applications involving plastics, rubbers, and other synthetic materials. While experiencing American industry's move away from investment in long-range research and development initiatives in the past thirty-five years, Stein has warned his fellow citizens of the future perils portended by this trend.

Few people had heard of polymer science when a twenty-five-year-old Stein began his career at UMass in 1950 after having just completed his Ph.D. in physical chemistry at Princeton (1948) and a post-doctoral research position at Cambridge (1948-1949). It wasn't long after arriving, however, before Stein began making a name for both himself and his emerging field. Stein's summer 1951 ONR grant to fund his light and particle scattering experiments on the structure-property relationships of polymers was one of the University's first large government research grants outside the Food Science Department. Over the course of the next decade, Stein helped attract over $300,000 in industry and government grants for research on plastics, using most of it to fund graduate student research in the Chemistry and Chemical Engineering Departments. During the latter period, Stein's research group published over 50 scientific articles and presented at over 30 conferences, four of them overseas. A large portion of these articles documented findings on the physical structures and chemical properties

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102 Stein had previously received an ONR grant at Princeton. He conducted his experiments in the basement of Goessmann Hall using an apparatus constructed with materials gathered from local hardware stores and an auto garage. His ONR grant prompted a major overhaul of the process through which University researchers received external grant money, since the laws of Massachusetts required that all external funds coming into UMass first pass through the State Treasury in Boston, forcing Stein to begin his summer research without pay. Dean of Science Charles Alexander intervened by using his political connections to get the State Legislature to pass a special appropriation enabling Stein to conduct his research, and later initiated a bill directing external research money into a University-controlled trust fund. By assigning University control over external funds, the latter act greatly improved research possibilities at UMass and remains the mechanism used to coordinate research funding today. Stein interview by Bohnning, 33. Adams (2004), 6.


104 Ibid.
of polymers discovered through Stein's pathbreaking light-scattering experiments, research that was essential for further applied research on plastics, rubbers, and other synthetic materials.\textsuperscript{105} According to former Dean Fred Byron, through this work Stein “helped define and bring into existence the whole field of polymer science.”\textsuperscript{106} Similarly, former Chemistry Department Head Louis Quin attests that Stein “performed such pioneering research in the chemistry of polymers that he is now recognized as one of the outstanding scientists in our nation.”\textsuperscript{107} During the 1950s Stein also expanded polymer education at UMass by opening his evening polymer science course to employees from Monsanto's large plastics plant in Springfield and the General Electric plant in Pittsfield.\textsuperscript{108}

In 1960, the Chemistry Department acknowledged Stein's early achievements by awarding him its most distinguished honor: the Charles Goessmann Commonwealth Professorship.\textsuperscript{109} Such accomplishments also equipped Stein with the prestige and personal connections needed to found the Polymer Research Institute (PRI) at UMass in 1961, which he led as director until his retirement.\textsuperscript{110} Located in a new, $2.5 million addition to Goessmann Chemistry Laboratory, supported entirely by grants from the ONR, the National Science Foundation (NSF), and several corporate funders, and overseen by an Advisory Board composed of UMass faculty and industry leaders, the PRI served as an internationally renowned center for “graduate and post-graduate education and fundamental research in polymer science . . . under local, governmental, and industrial sponsorship.”\textsuperscript{111} It also served as the

\textsuperscript{105} Takeji Hoshimoto, Robert E. Prud'homme, Garth L. Wilkes, and Do Y. Yoon, “In Honor of Richard S. Stein on his 75th Birthday,” \textit{Polymer} 42:21 (2001), 8923-8924.
\textsuperscript{106} Byron quoted in \textit{Campus Chronicle}, “Richard Stein to Be Honored at Dec. 17 Retire Reception,” December 13, 1991, clipping available in Richard S. Stein faculty file, 40/11, SCUA.
\textsuperscript{107} Quin quoted in ibid.
\textsuperscript{108} Stein interview by Bohning, 36; Stein (1997), 754.
\textsuperscript{109} Adams (2004), 9.
\textsuperscript{110} In 1961, Stein also introduced the first computer to UMass, founding with Bob Rowell the Computer Research Center in the Chemistry Department library with an IBM punch-tape computer leased at approximately $30,000 per month. The same year, Stein also recommended the University initiate and computer science department, a vision that became realized in 1965. See Stein interview by Bohning, 41-43. For more on the history of the Computer Science Department, see the UMass Computer Science Department website, history page: http://www.cs.umass.edu/about/history-department.
\textsuperscript{111} Polymer Research Institute booklet, 1962, 5. Other PRI funders included the Air Force Office of Scientific Research, the Petroleum Research Fund of the American Chemical Society, the Research Corporation, General Electric Co., the
engine powering the expansion of polymer education at UMass for the following four decades.

Stein's first step in founding the PRI was simple and inexpensive: he created a letterhead, which he then used to solicit grants. According to Stein, the PRI helped attract external funds because "it developed some coherence and an image that would not have been possible had it been just a departmental effort." Stein borrowed the idea from Dr. Herman Mark, a senior professor at the Polytechnic Institute of Brooklyn, where Stein completed his B.S. in chemistry in 1945. An Austrian chemist of Jewish heritage renowned for his studies of the internal structure of cellulose, Mark founded a similar institute at Brooklyn Polytechnic in 1946 inspired by chemistry collaboratives he had worked with in Berlin and Vienna prior to fleeing Nazi rule. The idea behind the PRI was to create an institution that could facilitate interdisciplinary collaboration while attracting external grants for research useful to government, industry, and society at large. It was also an attempt to secure funding for basic polymer research, which Stein believed was being overlooked as the U.S. government pumped resources into applied military research on university campuses in response to the Soviet Union's launching of its Sputnik satellite in 1957. Coming at a time when a number of experts warned of future financial dangers associated with the reliance of many American university research programs upon federal funds, Stein's adaptation of his advisor's model was propitious. The PRI's industry collaborations would prove essential after the mid-1970s, when federal funding for university research began to decline.

UMass's new President, John W. Lederle, ardently supported Stein's efforts. He enthusiastically

112 Stein interview by Bohning, 14.
113 Ibid, 40.
114 Stein, interview by Chard.
116 Stein interview by Bohning, 39; Geiger (1993), 161-166.
backed establishment of the PRI in a July 1961 letter to the Board of Trustees that outlined the proposed Institute's purposes and organizational structure. Citing the PRI as an organization that could stimulate the Massachusetts polymer industry while enhancing the University's reputation and attracting quality faculty and graduate students, Lederle viewed the Institute as a component of his larger effort to transform UMass into an expansive, world-class public research university and “center for excellence in higher education” on par with those in Berkeley, Madison, and Ann Arbor. Indeed, the PRI’s expansion and success during the “dynamic decade” of the 1960s mirrored the unprecedented growth of the University as a whole. Under Lederle's leadership, and with the help of dramatic increases in state and federal funding, UMass's undergraduate population skyrocketed from 6,300 in 1960 to 23,000 in 1972, while the graduate student population grew to 4,000, the faculty population multiplied from 336 to over 1,000, and the number of buildings on campus expanded by 70 percent to 300. During the 1960s the PRI attracted thousands of dollars in grants; hosted dozens of preeminent seminar speakers, post-doctoral scholars, and visiting scientists from around the world; and organized several large conferences attended by the world's top polymer scientists, including the Second Interdisciplinary Conference on Electromagnetic Scattering in June 1965, an Education in Polymer Science conference in February 1966, and the American Chemical Society Biennial Polymer Symposium in June 1968. It also gained international esteem among industry leaders like the General Tire and Rubber Company's S.L. Aggarwal, who credited the Institute for “bring[ing] into

118 John W. Lederle letter to UMass Board of Trustees, Subject: “Establishment of Polymer Research Institute,” July 28, 1961, Polymer Research Institute papers, RG 9/8, SCUA. Story, 62; Freeland, 320.
119 Increased government spending on higher education during this period came about as a result of a booming economy, Cold War efforts to improve American scientific advancement, and the Civil Rights movements' demands for broadened access to higher education. Faculty pay also increased by ninety percent during this period, largely as a result of State Legislature's supporting Lederle's efforts to gain fiscal autonomy for the university in 1962. Lederle also oversaw the establishment of the UMass Medical School in Worcester in 1962 and UMass Boston in 1964. Lederle retired in 1970, but UMass's growth spurt continued through 1972, during the first few years of Richard C. Wood's term as President (1971-1977). See Story, 62-63; Freeland, 315-316, and John W. Lederle, YouMass wiki entry: http://www.library.umass.edu/spcoll/youmass/doku.php?id=people:l.lederle_john_w&st[]=john&s[]==lederle.
120 Polymer Science and Engineering Program, University of Massachusetts Amherst, undated informational booklet ca. 1968, Polymer Science and Engineering Program papers, 25/P7/1, SCUA, 12-16.
focus the excellence and diversity of graduate polymer research facilities available at the University of Massachusetts,” and the Monsanto Company's Robert N. Crozier, who cited its “stature among polymer people everywhere.”

A key element of the PRI's expansion was the new Polymer Science and Engineering Program (PSE) inaugurated by Stein in 1966 after several years of effort. While the Chemistry and Chemical Engineering Departments awarded the PSE Program's M.S. and Ph.D. degrees, the PRI coordinated its coursework and funded graduate students through external research grants. Stein helped found the program at a crucial time, when the plastics and chemical industries were burgeoning and hungry for bright young professionals. So popular was the Program that in its first two years of existence, its enrollment surpassed the number targeted in its initial five-year plan. In just five years graduate student enrollment mushroomed from two in 1966 to forty-two in 1970. To keep up with student demand, the PRI hired five professors to teach exclusively in the PRE Program, complimenting the work of Stein and five others who reported to the Chemistry and Chemical Engineering Departments. By 1970, the PSE Program also hosted one of the most active seminar programs on campus (with over fifty speakers per year), and housed some of the period's most cutting-edge polymer research technology, including apparatuses used for x-ray diffraction, birefringence, light scattering, photomicroscopy, rheology, gel permeation, osmometry, and differential scanning calorimetry. Additionally, the PSE Program was a crucial impetus behind the construction of the massive Lederle

122 Richard S. Stein letter to PRI Advisory Board, April 5, 1968, private papers of Richard S. Stein.
123 Polymer Science and Engineering Advanced Degree Program and Activities of the Polymer Research Institute, Annual Report, 6/1/70 – 5/30/71, 1, Polymer Science and Engineering Program papers, 25/P7/1, SCUA.
124 Ibid. The faculty members working exclusively for the PSE Program (administered by the Graduate School) were: Prof. Roger S. Porter (Head, PSE), Prof. Frank E. Karasz, Adjunct Associate Prof. Seymour Newman, Prof. Fraser P. Price, and Prof. Otto Vogl. Those reporting to the Department of Chemistry (in the College of Arts and Sciences) were: Stein, Associate Prof. William J. MacKnight, and Prof. James C. W. Chien. Those reporting to the Department of Chemical Engineering (in the School of Engineering) were: Prof. Robert W. Lenz (Associate Head, PSE), Associate Prof. Robert L. Laurence, and Prof. Stanley Middleman.
Graduate Research Center (GRC); it moved into two floors of the GRC's seventeen-story Tower A following its completion in 1972. A year later, the Program gained a boost in graduate student funding with the establishment of the NSF-funded Materials Research Laboratory (MRL) devoted to polymeric research. In 1976, PSE became its own Department within the College of Natural Sciences and Mathematics.

Because the UMass PSE Program was the first of its kind in the country, Stein's peers recognize his “pioneering role in the development of graduate education in polymer science.” In the introduction to a 2001 issue of the journal Polymer dedicated to Stein's intellectual legacy on his seventy-fifth birthday, his former graduate students, Takeji Hoshimoto (Ph.D. 1971), Robert E. Prud'homme (Ph.D. Chemistry 1973), Garth L. Wilkes (Ph.D. 1969), and Do Y. Yoon (Ph.D. 1973) also celebrated their former professor as “an enlightening teacher and formidable researcher who not only inspired us during our years of study but also continues to inspire us in our work today.” These four scientists had good reasons to appreciate Stein. Being among the first of the over 150 doctoral and postdoctoral students from more than twenty different countries who studied under him, they were some of the earliest beneficiaries of the PRI and the PSE Program. They were also among Stein's many graduates who went on to lead polymer education efforts in other parts of the world. Hoshimoto, for example, went on to head the Department of Polymer Chemistry at Japan's prestigious Kyoto University. Similarly, Prud'homme, Wilkes, and Yoon led polymer education efforts at Quebec's Laval University, the Virginia Polytechnic Institute, and Korea's Seoul National University, respectively. Other notable early PSE graduates who studied under Stein include the Program's first Ph.D. graduate, Tisato Kajiyama (1969), who later became President of Japan's Kyushu University, and

126 Polymer Science and Engineering Program booklet (ca. 1968), 3.
127 Stein (1997), 754.
128 Hoshimoto, et al., 8923.
129 Ibid.
130 Ibid.
131 Ibid.
Ashok Misra (Ph.D. 1974), who served as President of the Indian Institute of Technology Bombay.¹³²

Stein and the PRI led expansive polymer education programming at UMass not only during the boom years of the 1950s, 60s, and early 70s, but also during the 1980s, when government funding for higher education plummeted, enrollment plateaued, and campus construction projects ground to a halt.¹³³ As prevailing political beliefs moved away from supporting direct government investment in university research, during the 1980s the federal government established a series of programs designed to promote industry-academia relations, including the NSF’s Industry/University Cooperative Research Centers (I/UCRC). Stein and his colleague Otto Vogl established the first of these centers at UMass in 1980, calling it the Center for UMass/Industry Research on Polymers (CUMIRP).¹³⁴ They did so by drawing upon the success of polymer research conducted at UMass over the past three decades and their existing relationships with industry leaders established through the PRI. Stein and Vogl initiated CUMIRP with a five-year NSF grant of $1,043,000 and annual contributions of $30,000 each from seventeen companies, including Dow, DuPont, Exxon, General Electric, IBM, and Westinghouse.

Within its first five years of operation, the Center met its goal of moving from reliance on NSF funding for half of its expenses to operating completely on industry grants.¹³⁵ Building successful private-sector partnerships enabled CUMIRP to drive expansion of polymer education at UMass during a time when dried up government funding forced other programs to scale back their activities.

Stein and Vogl formed the Center with the aim of “further[ing] research on polymers in areas of interest both to industry and UMass faculty, stimulat[ing] industrial innovation, and expand[ing]...”

¹³³ Story, 67.
¹³⁵ “Report of Activities: Polymer Research Institute, The Polymer Science and Engineering Department, Materials Research Laboratory, Center for UMass/Industry Research on Polymers, University of Massachusetts at Amherst,” April 1983 through September 1984, pamphlet, Polymer Science and Engineering Program papers, 25/P7/1, SCUA; Stein (1997), 754.
polymer research at UMass resulting in a better supply of industry-oriented, highly-trained polymer scientists.”

Through consulting with an Advisory Committee composed of representatives from each participating company, an NSF program manager, and UMass administrators, CUMIRP researchers developed “in-house research and development” programs for industry partners, which resulted in the publication of a slew of papers elucidating new findings on the physical, chemical, electrical, and optical properties of polymers. Though CUMIRP initially focused on fundamental research projects yielding new knowledge useful for the long-term development of commercially viable applications, the Center moved towards a greater focus on applied research over the course of the 1980s and 1990s as corporate culture moved towards interest in quicker profits for their investments.

In 1994, for example, CUMIRP redefined its structure to adapt to changing industry needs, by enabling smaller companies to sponsor research and development projects. Meanwhile, expansion of CUMIRP through the PRI led to further opportunities for funded PSE graduate student research and experience working with industry partners, experiences that often translated into employment after graduation.

From 1991 to 1993, for example, the PSE Department graduated an awarded an average of sixteen PhD degrees per year (double the average of a decade earlier), with graduates entering jobs in academia or industry with such companies as General Electric, Proctor & Gamble, and 3M immediately following graduation.

Under leadership of Stein and the PRI, the expansion of CUMIRP and the PSE Department over the course of the 1980s prompted federal and state support for the construction of the Silvio O. Conte National Center for Polymer Research, a state-of-the art, 100,000 square foot polymer research facility.

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136 “Activities of the Polymer Research Institute, the Polymer Science and Engineering Department, Material Research Laboratory, and the Center for UMass – Industry Research on Polymers of the University of Massachusetts,” April 1, 1980 – March 31, 1981, pamphlet, Polymer Science and Engineering Program papers, 25/P7/1, SCUA UMass, 8.
138 Stein (1997), 759.
140 “Graduate Programs in Polymer Science and Engineering, University of Massachusetts Amherst,” PSE informational booklet, 1993, 40-43, Polymer Science and Engineering Program papers, 25/P7/1, SCUA UMass.
education and research facility completed in 1996 with the aid of $56 million in state and federal funds. The growth of the PSE Department relative to other UMass programs during the 1980s is well illustrated by the fact that the Conte Center was the first building constructed on campus since the completion of the University Library (now W.E.B. Du Bois Library) in 1973.

Since 1967, the UMass PSE Department has graduated over 500 Ph.D. students who have gone on to careers in academia, government, and industry in all corners of the world. While over 150 of these students studied directly with Richard Stein, the rest owe him a debt of gratitude as well, since their educations and careers would not have been possible without Stein's pioneering efforts in expanding polymer education with the help of inter-departmental collaboration and creative partnerships with government and industry. A 2007 *Journal of Higher Education* article examining the UMass PSE Department as a case study in “Academic Capitalism and Student Socialization” demonstrated that fifteen years after Stein's retirement, PSE graduate students continued to personally benefit from the Department's close ties with industry through CUMIRP (which remains active today with over 40 industrial partners). As one student interviewed for the study explained, “The relationship with industry is very beneficial for both sides: It provides cheap labor for companies and gives students . . . great experiences such as learning [what] future jobs would be like.” Another attested, “Projects with industry have an overlap with each other and with the literature. They are published in journals. Even students who have been sponsored basically by industry, their training has had sufficient basic research and basic science.” Meanwhile, countless others besides graduate students have benefitted from Stein's additional polymer education efforts over the years, which

141 The federal government provided $20 million of these funds, while the rest came from the state of Massachusetts. “Excellence at UMass,” *Boston Globe*, April 12, 1996, 26.
142 UMass Polymer Science and Engineering Department website, History page: [http://www.pse.umass.edu/about/history.html](http://www.pse.umass.edu/about/history.html).
144 Ibid, 84.
included distance learning courses offered on VHS tapes and CD-ROMS, workshops for high school science teachers, and direct consulting with various major companies, including Monsanto, General Electric, and Johnson & Johnson.145

While externally funded research benefitted students and faculty associated with Stein's polymer education efforts, its results also rewarded corporate investors. Stein is particularly proud of a 1999 letter sent to him by former Bell Labs CEO W. O. Baker illustrating this point. According to Baker, Stein's principles on microcrystalline/amorphous interfaces were key to Bell Laboratories' development of its global telecommunications and computer networks. Baker affirmed that such engineering developments had in their first few years of operation “earned for the Bell Telephone System almost exactly the total cost of Bell Labs operations in the period 1950-1960.”146 To Stein, Baker's affirmation underscores the rewards basic research can reap for industry.147

In recent decades, Stein has written and spoken publicly to stress the importance of basic research out of concern that industry's trend since the 1990s towards investing in short-term product commercialization over long-range research and development “may be 'eating our seed corn' for which we shall pay a price in the future.”148 After all, he explains, “what we do in the future with applied research is going to depend upon basic research that's done today.”149

Since his retirement, Stein has also moved away from his earlier focus on polymer research and education to concentrate on what he considers his second major contribution to humanity: working to advance solutions to global climate change.150 In addition to a variety of public education efforts, including appearances on public television and powerpoint enhanced discussions at the Amherst Senior Center, this endeavor has involved contributions to the scientific and commercial development of

145 Stein interview by Bohning. 38.
147 Stein interview by Chard.
148 Stein (1997), 759.
149 Stein interview by Chard.
150 Ibid.
biochar, a charcoal-based soil amendment proven to boost agricultural productivity while helping to mitigate climate change by producing negative carbon emissions (a process known as carbon sequestration).\textsuperscript{151} Conversing for several morning hours at his home on Berkshire Terrace in April 2012, Stein spoke at length about his concerns that political leaders are not taking seriously the threat of rising sea levels, which may displace millions living on America's coastlines in approaching decades. As he said in a recent meeting with state officials, “mother nature understands thermodynamics even if you don't.”\textsuperscript{152}

At 87, Stein continues to exude a warm character and expansive knowledge of things scientific and political. He moves more slowly than he did in the 1980s, when one colleague affectionately quipped, “Stein's metabolism continually works overtime . . . I don't think he sleeps more than four hours a night.”\textsuperscript{153} But he has not let up on the learning, teaching, networking, and researching that were crucial to the development of the UMass PSE Department. Meanwhile, two blocks from his house, on the edge of North Campus, stands the glistening steel and plate glass of the Silvio O. Conte National Center for Polymer Research. The Center today houses the PSE Department, over 200 faculty, post-doc, and grad student researchers, and CUMIRP, which now includes over forty industrial collaborators. There, thanks to Stein's foundational efforts, UMass polymer research and education continues to thrive.\textsuperscript{154}

**EPILOGUE: UMass and Applied Research into the 21st Century**

Today most administrators and faculty of major American state universities take as common sense the notion that their school's success relies, in part, on the development and marketing of its applied

\textsuperscript{151} Ibid. Also see Stein's video addresses on his Vimeo webpage: http://vimeo.com/user1488303/videos.
\textsuperscript{152} Stein interview by Chard.
\textsuperscript{154} CUMIRP website: http://www.pse.umass.edu/cumirp/.
research capacities. But this was not always so. The history of research at UMass accounted here illustrates how the shape and fortune of applied research were closely tied to changes in university-government-industry relations, as well as larger social and cultural currents that determined the value placed on applied versus basic research, the liberal arts versus vocational training and the sciences, and other issues affecting higher education.

Carl Fellers' generation of industry research grants was certainly central to the development of the world-renowned UMass Food Science Department. And in using external funding to expand graduate education, Fellers and Food Science were undoubtedly forerunners to Richard Stein and the PSE Department, as well as other UMass graduate programs, from Computer Science to Mechanical and Industrial Engineering. But in the 1930s, applied research was not the focus of the institution's administrators. In 1931, the year MAC became Massachusetts State College (MSC), for example, the College's new President Hugh Baker did not mention applied research, Fellers, or the Food Science Department (then the Department of Horticultural Manufactures) in his annual “Report of the President to the Board of Trustees,” despite the fact that agricultural education and the Experiment Station remained two of the institution's key functions. Instead, Baker justified his requests for funds to double the size of the library and expand the admissions building on the grounds that such projects would enhance the MSC's new mandate to extend liberal arts education to a greater number of the Commonwealth's young people. Baker's priorities came in response to pressure from a number of constituencies, including students, younger alumni, and a powerful state labor movement demanding an expansion of opportunities for liberal arts education, at a time when the College faced record numbers

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of applications for undergraduate admission, particularly from young women.\textsuperscript{157}

MSC’s liberal arts emphasis in the 1930s helps explain why the College was one of the nation's leading sources of graduate students during the second quarter of the 20\textsuperscript{th} century. A 1951 study published in the preeminent journal *Science* found that between 1924 and 1934, MAC/MSC ranked sixth in the nation among institutions whose undergraduates went on to complete graduate degrees. With the majority of the fifty top institutions named in the article being small liberal arts colleges, the study concluded that liberal arts education was essential to the training of American scientists.\textsuperscript{158}

Additionally, emphasis on the societal value of liberal education during the 1930s paralleled renewed interest among university administrators and faculty in promoting basic research vis-à-vis applied research. For example, at Massachusetts' other land-grant college, the Massachusetts Institute of Technology (which was one of the nation's first universities to develop institutions dedicated to industry-sponsored applied research), a number of prominent figures, including President Karl Compton, sought to bolster their institution's reputation and financial stability by developing its capacities for education and research in basic science, as the Great Depression prompted a number of companies to withdraw funding for applied research institutes established during the first three decades of the twentieth century.\textsuperscript{159}

Popular demand for liberal education also took center stage during the 1950s, when the GI Bill and the baby boom fueled President Mather's quest to expand the school following its official designation as the University of Massachusetts in 1947. Indeed, Mather's driving determination to obtain state funding for expanding the University's undergraduate education capacities may help explain his willingness in 1957 to sacrifice the career of Fellers, the campus's biggest source of external funding for applied research.

\textsuperscript{157} Ibid, 3; Cary, 155.
\textsuperscript{159} Servos, 546; Owens, 804.
The 1950s and 1960s was also the period in which U.S. government and industry, prompted in part by Cold War competition with the Soviet Union, invested more in basic research on university campuses than at any other time in history. During this era of unprecedented university growth, President John Lederle viewed expansion of both basic and applied research as vital to his larger mission of transforming UMass into New England's premier center of public higher education. Stein's PRI, after all, which Lederle supported enthusiastically, primarily conducted basic research. The PRI forged eager partnerships with Monsanto, General Electric, and other industrial giants of the day, who recognized Stein's polymer research as essential for the future development of profitable commercial applications, while also attracting large grants from the ONR, NSF, and other federal agencies. The fact that the PRI, through CUMIRP, continued attracting industry investment in basic research during the 1980s, when government funding for university research drastically dissipated and few other American university researchers managed to do so, is testament primarily to the ability of Stein and his colleagues to build upon their track records as some of the world's top polymer researchers and their existing personal connections with key figures in government and industry. But even this couldn't last forever. Finally compelled to adapt to the changing global economy and a concomitant shift in American corporate culture, CUMIRP restructured a few years after Stein's retirement to accommodate industry desires for investment in shorter-term applied research projects.

In some ways, UMass today resembles MAC in the 1870s. Today's sprawling campus and vast online list of course offerings would, of course, be unrecognizable to Levi Stockbridge and his contemporaries. The University is also well established and respected—it is in no danger of financial collapse or being absorbed by neighboring Amherst College. But the current culture of university, government, and industry relations, like that dominant in Stockbridge's day, is one in which prevailing

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160 Indeed, UMass partners with Amherst College as a fellow member of the Five College Consortium, which since 1965 has facilitated cooperation between these schools as well as Mount Holyoke College, Smith College, and, since 1970, Hampshire College. See Five College Consortium website: https://www.fivecolleges.edu/.
political attitudes demand that in exchange for support from government and industry, the institution must “prove” its value.

With much of the 1870s public dubious about the notion that basic research or liberal arts education held any “practical” worth, Stockbridge successfully garnered popular support for MAC by traveling throughout Massachusetts via steam train and horse and buggy to promote the benefits of its applied research among farmers, businessmen, and political leaders. Today the advantages of public higher education are more widely acknowledged. Since government spending on public universities began declining in the mid-1970s, however, UMass administrators, like their counterparts at other American state universities, have become increasingly moved to run the institution on a business model, reliant upon entrepreneurship, industrial partnerships, branding the UMass image, and creatively marketing the university's academic offerings, sports programs, alumni achievements, and applied research innovations. In this context, a key element today in maintaining UMass's reputation as a top public research university is the Office for Research and Engagement, which provides services designed to “foster collaborative research, innovation, technology commercialization and entrepreneurship.”¹⁶¹ As was the case in Stockbridge's day, promotion of applied research is key to UMass's reputation and prosperity.

The truth is that for 150 years, UMass has consistently benefited the Commonwealth, the nation, and the world by providing dynamic liberal arts education and an array of both basic and applied research. The conditions under which it has done so, however, have changed over time, and will continue to do so in the future. Meanwhile, UMass researchers will do what they have always done: adapt, innovate, and lead in developing solutions to the challenges facing our world. They are certainly doing so today. In all corners of campus, UMass faculty and students continue to conduct

¹⁶¹ UMass Research and Engagement website, About Us page: http://www.umass.edu/research/about-us. UMass Research and Engagement promotes both basic and applied research, though its promotional materials often emphasize the latter.
research that fulfills the 1862 Morrill Land-Grant Act's mandate for institutions of higher learning in service of American industry, government, and society. Indeed, the success and breadth of UMass applied research today far surpasses Levi Stockbridge's most fantastic nineteenth century dreams.
APPENDIX

Topics and Sources for Further Study

Frank A. Waugh (1869-1943), Landscape Architecture Pioneer
A MAC Horticulture Department Head, Waugh helped create the applied discipline of landscape architecture. He produced dozens of publications aimed at both academic and popular audiences, and promoted teaching of agriculture, pomology, practical horticulture, and landscape design. He also founded an undergraduate program in “landscape gardening” (the second in the nation) at MAC in 1903. Prior to his retirement in the late 1930s, Waugh helped design several National Parks, university campuses (Kansas and Oklahoma), and trained many students who influenced his field.

- Annaliese Bischoff, “A Look at the Etchings of Frank A. Waugh,” online exhibit of Waugh's etchings featuring links to further information on the professor: http://people.umass.edu/abischof/frankwaugh/

Lorian P. Jefferson and Agricultural Economics, 1912-1935
With a B.L. from Lawrence College (1892) and an M.A. from the University of Wisconsin (1907), Jefferson joined the faculty of the MAC Division of Social Science in 1912, where she rose to the rank of Professor of Agricultural Economics. One of the first female professors at MAC engaged in applied research, Jefferson worked for the Massachusetts Agricultural Experiment Station, publishing numerous articles in the Station's bulletins and in scholarly publications such as the Journal of Farm Economics and Rural New Yorker. She published her studies on topics such as the economics of apple production and Massachusetts farm ownership in the hopes of offering useful research findings to the Commonwealth's farmers and businesses.

- Lorian P. Jefferson papers. FS 072, SCUA.

School of Public Health, 1940-Present
Building upon the infrastructure of a student infirmary established in response to a scarlet fever outbreak at MAC in 1912, the first public health department, the Department of Bacteriology, was founded at MSC in 1940, followed by the Department of Nursing and other departments that merged into the School of Health Sciences in 1973, which split into the School of Nursing and School of Public Health in 1989. During the 1950s, faculty in these schools collaborated with the State Department in offering courses on clinical lab methods for civilian defense work and blood transfusions, and with the U.S. Public Health Service in teaching courses on environmental sanitation. Over the years, the faculty in the School have established “several centers and institutes that foster transdisciplinary research, teaching and service that spans the basic and applied sciences and public health, clinical practice and community applications,” including the Center for Research and Education in Women's Health, the Institute for Global Health, the Biostatistics Consulting Center, and the Northeast Regional
School of Management, 1947-Present
The Board of Trustees established the School of Business Administration in 1947 in response to student demand for business courses that had been growing since the beginning of the twentieth century. Applied research was integral to its initial conception. As Dean Kirshen wrote Oswald Tippo on 23 July 1964: “The new bldg was designed, as you know, for a Center for Research. … I think the need for such a Center is a must for our School and for the University. I cannot conceive of a School of Business Administration apart from its engaging in both applied and basic research of a scholarly nature. I cannot conceive of a School of Business Administration being placed in a different category than the Sciences, even if funds are more easily obtained for the latter than for us” (Academic Affairs/Tippo/Box 3 f 5, SCUA). The school was renamed the Eugene M. Isenberg School of Management in 1998. During the 1950s, the School's faculty collaborated with area businesses in producing reports on the Connecticut Valley's potential for industrial development.

In the early 1970s wind energy research began at UMass under the leadership of the Civil Engineering Department's Professor William E. Heronemus, known by many in his field as “the father of American wind energy.” Following several testimonies before Congress on the importance of renewable energy, Heronemus received major grants from the National Science Foundation in 1972 and 1975, which funded the creation of the Renewable Energy Research Laboratory (now the Wind Energy Center) and the construction of an experimental WF-1 wind turbine and “Solar Habitat” house on Orchard Hill. At the time, the WF-1 was the largest wind turbine in the U.S., and it became a prototype for turbines in use today. When very few others were studying this, Heronemus and other Mechanical Engineering faculty developed numerous innovations in wind energy technology, optimizing the design of wind turbines for electrical production, demonstrating offshore wind energy potential, and calculating ocean thermal energy conversion. Today many of these concepts are widely accepted, and have been picked up by companies such as US Windpower, Zond Systems, Enron Wind, General Electric Wind, and a variety of northern European companies. Many of Heronemus's grad students have also become leaders in the wind energy industry. In 2004, the WF-1 was dismantled and shipped to a storage facility at the Smithsonian.
• Jon McGowan, interview on Bill Heronemus by Dan Chard, University of Massachusetts, April 3, 2012, SCUA (in process).
• William Heronemus papers, FS 068 SCUA.

Public History Program, 1979 to Present
Originally conceived as a program in “applied history,” the History Department's Public History Program officially began in 1989 when new hire David Glassberg began teaching the first graduate Introduction to Public History course. Work towards developing such a program began as early as 1979, however, when History Department Chair Paul S. Boyer began discussing the idea of expanding graduate course offerings to prepare students for careers outside of academia, in places such as historical societies, museums, governmental agencies, and private businesses. Over the past twenty-five years, the Public History Program has gained recognition as one of the best in the country, due to the huge influence of its faculty and students upon the field. UMass Public History faculty and graduate students have undertaken dozens of applied research projects in collaboration with museums and historical societies in New England and beyond, as well as with government agencies such as the National Park Service.

• “Public History at the University of Massachusetts Amherst: 25 Years,” unpublished document available from Marla Miller, mmiller@history.umass.edu.

Derek Lovely and Geobacter, 1987-Present
Derek Lovely's microbiology research breakthrough occurred in 1987, when he discovered the bacterial species geobacter metallireducens in sediment of the Potomac River in Washington D.C. Since then, Lovely has gained international recognition and millions of dollars in grants for his research demonstrating geobacter's potential for a number of socially beneficial applications in the areas of bioremediation, bioelectronics, bioenergy, and removal of the greenhouse gas carbon dioxide from the atmosphere.

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Lopez, Anthony, May 9, 2012, phone interview.

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**Books and Articles**


