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Introduction

Stephen J. Weininger, Worcester Polytechnic Institute, stevejw@wpi.edu

On July 2, 1862, in the midst of the Civil War, President Abraham Lincoln signed the Land-Grant Colleges Act, commonly known as the Morrill Act after its principal sponsor. It provided for substantial grants of federal land to each state for the purposes of establishing colleges "whose leading object shall be, without excluding other scientific and classical studies … to teach such branches of learning as are related to agriculture and the mechanic arts …." The Act notably prohibited discrimination on the basis of race or sex.

The Act's mission statement ensured that, because of their perceived centrality to agriculture, chemistry and other natural sciences would have a predominant place in the curriculum. That perception, fostered by Justus von Liebig's highly influential writings, would require several decades before becoming reality.

Many voices had been advocating scientifically-based agriculture before the Morrill Act. Among the most ardent and effective was Evan Pugh of Pennsylvania. Kristen Yarmey depicts him as pragmatic, patriotic and moral. His persuasive strategy utilized both demonstration and advocacy. A Göttingen Ph.D. with Friedrich Wöhler, Pugh became principal of the Farmer's High School of Pennsylvania in 1859. Confronted with numerous doubters, skeptics and rivals, Pugh waged tireless publicity campaigns for his institution and his science. The High School became the Agricultural College of Pennsylvania in 1862; in 1863 it shared with Michigan Agricultural College the distinction of being the first institution designated as a land-grant college.

The following five papers, which derive from the ACS Symposium "150 Years of Chemistry at Land Grant Institutions: The Past as Prelude to the Future," explore various consequences of the Morrill Act. Stephen Weininger makes clear that the land-grant institutions (LGIs) had anything but a smooth start. Student numbers were small, their preparation weak, faculty training was variable, state legislatures were stingy and graduation rates were scant. The Act left much to the discretion of the States; individual colleges fashioned different visions for themselves. Weininger tracks their divergent ambitions by focusing on course curricula and catalog rhetoric relating to qualitative and quantitative analysis, bedrock courses for numerous majors that provided students with marketable skills. By 1900 instruction was more uniform, enrollments and support were rising, and the LGIs were poised to fulfill their potential.

Applying chemistry to agriculture was an ambition initially well ahead of the technical means for realizing it. Alan Marcus reports that some early attempts were disastrous. Chemists then settled on a more modest goal—using their analytical skills to aid farmers by doing water, soil and fertilizer analyses. The idea of having a State Chemist began to spread. Nonetheless, chemists' reach exceeded their grasp with respect to fertilizer analysis. They responded to trenchant criticism by organizing, upgrading their skills and enforcing standards. By the 20th century these analytical chemists had spawned a new, respected profession—the agricultural chemist. The transformation served as a template for the conversion of industrial chemists to chemical engineers.

Mark Finlay points out that like many other technical innovations, scientific agriculture was a mixed blessing. The expanded output it engendered caused a crash in farm prices, a problem further exacerbated by the Great Depression. One response advocated taking land out of production. An alternate cure involved further industrializing agriculture by having farmers raise crops intended as chemical industry feedstock, the basis of the *chemurgy* movement. The nation's agricultural colleges formed the arena where these two visions were championed by the Federal farm administration and chemical industry, respectively. While some farmers embraced chemurgy, others were convinced its main beneficiary would be industry. The divergence bespoke wide-ranging political differences, national and international. The chemurgic program gained some traction, but rising demand for farm products after war began blunted its impact. As Finlay perceptively notes, agriculture post-World War II became further industrialized and agricultural research became molecular, but now applied to new ends.

Chemical engineering's close connection to industry throughout its history has had major professional and societal consequences, according to Robert Seidel. MIT's unit operations curriculum, which promoted curricular uniformity during the early 20th century, also highlighted the necessity of students' direct contact with actual plant operations. Only industry was able to afford students such experience, thereby tying the academy closely to it. As with other science-based disciplines, World Wars I and II boosted the growth of chemical engineering. Post-World War II, the discipline metamorphosed into engineering science—highly mathematical and abstract. Process design became increasingly isolated from the public it was meant to serve. The rift became glaring after the tragic chemical accidents at Seveso, Italy, and Bhopal, India.

Weininger's paper had ended by noting the substantial number of female students in the chemistry laboratory. Unfortunately, women graduating with the same skills as male students had great difficulty finding professional employment. That was a major impetus for most science-oriented female students to major in home economics, where many subsequently found work as teachers. Various observers have asserted that home economics consequently hindered the movement of women into science.

Amy Bix tackles this issue head on. While acknowledging that home economics reinforced gender stereotypes, she counters that the field enabled many young women to study college-level science. Furthermore, their numbers "subvert[ed] the notion of women's scientific ignorance and technical incompetence." As home economics expanded its range of topics its emphasis on chemistry increased, creating space for female instructors in chemistry departments. Many home economics graduates found work in food-related fields, including journalism. The large number of women enrolled in science at the LGIs even opened a wedge for women in engineering, which widened considerably after World War II. The war had already spawned a demand for technically trained women, which the federal government strove to satisfy. Bix concludes that although the entry of women into science was slow, it would have been slower yet but for the efforts at many LGIs, including home economics.

As this issue was being prepared, our colleague and friend, Mark Finlay, was killed in an automobile accident. Mark was a dedicated teacher, gifted scholar and committed member of our professional community. He will be deeply missed. This issue is dedicated to his memory. (For more about Mark, please see About the Author at the end of his contribution.)