

Frank Spedding and the Ames Laboratory: The Development of a Science Manager

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FRANK SPEDDING, the first director of the Ames Laboratory, was a strong personality who had a lasting impact on the character and culture of the laboratory. He was one of only a few scientists who managed to leverage their expertise to build institutions that supported their interests. This new breed of scientist—a science manager—first emerged in the 1930s and 1940s. Historians Dominique Pestre and John Krige proposed that these science managers could be identified by a set of shared traits: physicist, conceiver, and entrepreneur. As physicists, they were trained in the “evolution of the discipline and its key theoretical and experimental issues.” As conceiver, they were resourceful, particularly with regard to acquiring the necessary skills, techniques, and equipment required to execute their research programs. As entrepreneurs, they served their laboratory by raising capital, assuaging external agencies, and maintaining internal harmony among their staff.¹

1. Dominique Pestre and John Krige, “Some Thoughts on the Early History of CERN,” in *Big Science: The Growth of Large-Scale Research*, ed. Peter Galison and Bruce Hevly (Stanford, CA, 1992), 93; and Catherine Westfall and Lillian Hoddeson, “Thinking Small in Big Science: The Founding of Fermilab, 1960–1972,” *Technology and Culture* 37 (1996), 457–92.



Frank H. Spedding, 1948. All photographs courtesy of the Department of Energy's Ames Laboratory.

Frank Spedding fits the profile described by Pestre and Krige, albeit with one important difference—he was a chemist. His undergraduate degree in chemical engineering, M.S. in analytical chemistry, Ph.D. in physical chemistry, and postdoctoral work with theoretical physicists provided him with an extraordinary breadth of knowledge in his own and related disciplines. A creative and energetic spirit complemented his formal training, enabling him to acquire the technical skills, staff, and equipment required for his research program and the establishment of “his” laboratory. He was an entrepreneur who deliberately crafted an empire that fused Iowa State College (ISC) and the Ames Laboratory in a way that confirmed and maintained his authority, interests, and control. Spedding used his personal drive, aptitude, and professional experience to pursue his agenda, satisfy his ambition, and capitalize on his accomplishments. Deeper insight into Spedding’s development provides greater understanding of the Ames Laboratory and its unique place in the network of postwar national laboratories.

After World War II, the U.S. government established several national laboratories through which it supported science pro-

grams ostensibly in the federal interest. The directors of several of those laboratories became science managers who personally influenced the laboratory as they defined its programs, protocol, character, and culture. Ernest Lawrence was one of the earliest and perhaps the most celebrated of this genre. His personal ambition, creativity, and determination drove him to build his cyclotron center at the University of California Berkeley. His success might have inspired those around him, for his Berkeley Laboratory spawned several scientists who became science managers. Lawrence's student Robert Wilson, for example, would later direct Fermilab as physicist, conceiver, and entrepreneur.² Frank Spedding, though not Lawrence's student, was a student of a close colleague and collaborator of Lawrence and he apparently adopted the Berkeley model of management as well.

The character, culture, and agenda of the Ames Laboratory, like that of Lawrence's Berkeley Laboratory, must be attributed to its first director. Much has been written about the vision and tireless pace of Ernest Lawrence; relatively little has been written about the enduring legacy that Frank Spedding bestowed on the Ames Laboratory.³ This article aims to correct that oversight.

THE AMES LABORATORY is one of several national laboratories created by the Atomic Energy Commission after World War II. Today, these laboratories come under the auspices of the Department of Energy (DOE). In some ways the Ames Laboratory is much like the other laboratories, particularly in administrative structure, function, and, broadly speaking, mission. Each of the laboratories is government owned but operated by a university, corporation, or conglomeration of the two types of insti-

2. Catherine Westfall, "A Tale of Two More Laboratories: Ready for Research at Fermilab and Jefferson Laboratory," *Historical Studies in the Physical and Biological Sciences* 32 (2002), 369-407.

3. Herbert Childs, *An American Genius: The Life of Ernest Orlando Lawrence* (New York, 1968); J. L. Heilbron and Robert W. Seidel, *Lawrence and His Laboratory: A History of the Lawrence Berkeley Laboratory* (Berkeley, CA, 1989); Joanne Abel Goldman, "National Science in the Nation's Heartland: The Ames Laboratory and Iowa State University, 1942-1965," *Technology and Culture* 41 (2000), 435-59; idem, "Mobilizing Science in the Heartland: Iowa State College, the State University of Iowa, and National Science during World War II," *Annals of Iowa* 59 (2000), 435-59.

tutions.⁴ The federal government owns the Ames Laboratory, yet Iowa State University operates it. Its purpose, as with each of the laboratories, is to promote and produce science that fits an agenda the federal government defines. Initially, that was to promote and pursue atomic science. Today, the mission is broader: its pursuit of solutions to energy-related problems is central.⁵

Notwithstanding these characteristics that the Ames Laboratory shares with the other DOE laboratories, some differences – most notably its size, interdisciplinary approach to science, and symbiotic relationship with its contracting institution – set the Ames Laboratory apart from other national laboratories. Its operating budget is by far the smallest of all the DOE laboratories. For fiscal year 2006, the DOE funded \$26 million of its \$28 million in operational costs.⁶ The smaller budget of the Ames Laboratory supports a smaller facility, and its staff of 315 full-time equivalent employees pales in comparison to Brookhaven Laboratory's 2,607 full-time employees.

In addition to the size and scale of the Ames Laboratory, its exceptional relationship with its contractor, Iowa State University, distinguishes it from the other DOE laboratories. Physically, the Ames Laboratory is completely integrated within the Iowa State campus. There are no fences separating the laboratory from the campus, and they share buildings and facilities. The laboratory's scientists use the roads, library, cafeteria, and sewage system of Iowa State University. The laboratory maintains a relatively small security force but does not operate its own fire department. Perhaps most important, the laboratory and the university staffs link these two institutions in an extraordinary way. Many of the scientists at the Ames Laboratory hold joint ap-

4. The National Energy Technology Laboratory is an exception to this pattern. See its Web site at www.NETL.DOE.gov (accessed 10/30/2006).

5. See Ames Laboratory's mission statement at www.ameslab.gov (accessed 10/30/2006).

6. U.S. Department of Energy, "The U.S. Department of Energy's Office of Science: Steward of 10 World-Class National Laboratories," www.sc.doe.gov/National_Laboratories/Draft_Labs%20Booklet.Pdf (accessed 10/30/2006). The balance is derived from a range of non-DOE "Work for Others" contracts. The Princeton Plasma Physics Laboratory, with an operations budget nearly three times that of Ames Lab, is the next smallest DOE laboratory. The most expensive DOE laboratory is Oak Ridge National Laboratory with a budget of \$902 million, of which the DOE contributes \$712 million.

pointments in associated departments of the university. Those joint appointments provide a relatively stable base of funding for both institutions' research programs and, thus, an attractive package for recruiting high-quality faculty and staff. The shared labor force (faculty, postdoctoral staff, and students) and facilities dramatically increase the "purchasing power" of both institutions. Over the past 60 years, nearly 3,000 graduate students have completed degrees at Iowa State University within the Ames Laboratory. Those students have provided the requisite workforce for the scientific groups and, in turn, have benefited from a close mentoring relationship with senior scientists. Along with the shared infrastructure, this joint staffing defines the symbiotic relationship between Iowa State University and the Ames Laboratory.⁷

The Ames Laboratory carries out a varied program of scientific research. In this sense, it is an anomaly in the national laboratory system.⁸ Although its program is not quite as diverse as those in "multiprogram" laboratories, such as Brookhaven and Argonne, it does embody a broad scope of interest and funding in energy sciences. Its scientific focus, however—with its relatively large programs in condensed matter physics, materials and engineering physics, and materials chemistry—has always been rooted in the realm of materials science. Those programs account for approximately 60 percent of its annual operating budget.⁹ One of the hallmarks of these efforts and an important legacy of the laboratory's founding director, Frank Spedding, is the interdisciplinary approach to science—crossing the boundaries of physics, chemistry, and materials engineering—that was fundamental to his personal intellectual development.

7. Goldman, "National Science," 448–52.

8. National laboratory historian Peter Westwick recognized characteristics that set Frank Spedding and the Ames Laboratory apart from the other national laboratories. Specifically, sometimes the Atomic Energy Commission included the Ames Lab in its listing of multiprogram labs and Spedding was included in the exclusive "Lab Director's Club," whose membership was usually limited to the directors of the large multipurpose laboratories. Peter J. Westwick, *The National Labs: Science in an American System, 1947–1974* (Cambridge, MA, 2003), 9–10.

9. Ames Laboratory, Budget FY 2005–2006, Ames Laboratory Archives, Ames. The balance of the budget supports research in the chemical and biological sciences, advanced scientific computing, and energy research.

FRANK SPEDDING was a highly intelligent, curious, and ambitious student. During his formative years, he complemented those innate qualities with opportunities that came about both deliberately and fortuitously. As an undergraduate and graduate student, he took advantage of good fortune, emulated talented mentors, and built significant professional networks, all of which shaped his development.

He was born on October 22, 1902, in Hamilton, Ontario, Canada, to Howard L. Spedding, a photographer, and Mary Anne Elizabeth Marshall, the daughter of the mayor of Dummville, Ontario. While Frank was still a boy, the family moved to Illinois, where he attended grade school and began high school. In 1921 he graduated from high school in Ann Arbor, Michigan, and spent the twenties completing his education. After receiving his bachelor's and master's degrees at the University of Michigan in 1925 and 1926, he followed the advice of his undergraduate mentor, Moses Gomberg, and moved to Berkeley, where he earned his Ph.D. in 1929 under the guidance of G. N. Lewis.

Spedding's mentors at the University of Michigan and at University of California Berkeley provided him with a scientific and professional foundation that channeled and focused his interest in chemistry and fostered his analytical approach to problem solving. At Michigan he worked with Moses Gomberg and H. H. Willard. According to Spedding himself, Gomberg had a particularly important influence, inspiring his student to think critically and analytically. When Spedding questioned the validity of theories taught in class, Gomberg encouraged the young undergraduate's curiosity. Years later, in a letter to Gomberg upon his retirement, Spedding recalled the incident to his mentor: "Your attitude I shall always consider a model in such situations. You listened carefully, pointed out certain weaknesses in my theory which would have to be overcome, told me of sources of information which were unknown to me and encouraged me to go on with the problem."¹⁰ That, Spedding claims, lit the fire within him to pursue basic research.

The influence of G. N. Lewis and the Berkeley environment on Spedding cannot be overstated. Lewis became a strong role

10. Spedding to Gomberg, 1/11/1935, Spedding Papers, Iowa State University (ISU) Archives.

model for his student, in terms of both academics and ambition.¹¹ Lewis had already built an impressive resumé by 1912, when Berkeley recruited him from the Massachusetts Institute of Technology (MIT) to become professor and chair of the chemistry department and dean of the College of Chemistry. While recruiting new faculty and reshaping the chemistry department, he remained active in research. He had published 39 articles by the time he arrived at Berkeley; between 1912 and the time Spedding graduated in 1929, he published an additional 64 articles.¹² In addition to his personal research program, Lewis's charge at Berkeley included building and shaping the chemistry program. In this he succeeded fabulously. Nobel laureate Glenn T. Seaborg recalled that a veritable who's who of scientists attracted him to Berkeley for his graduate training with Lewis just a few years after Spedding's arrival. These included the "legendaries" who wrote the textbooks that he had used at UCLA. "There were names such as Joel H. Hildebrand, Wendell M. Latimer, William C. Bray, C. Walter Porter, Gerald E. K. Branch, . . . and the rising young nuclear physicist Ernest O. Lawrence."¹³

The Berkeley chemists and physicists were not only accomplished but they also maintained strong, pioneering research programs that relied on talented students for their execution. Spedding became acquainted with a cadre of faculty and graduate students, many of whom he continued to associate with long after his student years through formal and informal

11. In 1915 the California Board of Regents created the Board of Research to provide support for faculty research projects. The notion of supplemental funding for research was a relatively new concept. In 1917 G. N. Lewis received \$1,000 to equip his low-temperature laboratory, the largest award granted to date. Lewis's ambitions in this regard provided a model for the entrepreneurial spirit that grew at Berkeley during the 1920s. See Verne A. Stadtman, *The University of California, 1868-1968* (New York, 1970), 212-13.

12. "Scientific Publications of Gilbert N. Lewis," in *In Honor of Gilbert Newton Lewis on his Seventieth Birthday* (Berkeley, CA, 1945), 9-19.

13. Glenn T. Seaborg, "Glenn T. Seaborg," in *There Was Light: Autobiography of a University, Berkeley: 1868-1968*, ed. Irving Stone (New York, 1970), 52. The chemists Seaborg cited were already there and well established when Spedding entered the program in 1927, seven years before Seaborg. Hildebrand and Bray began at Berkeley in 1912, Branch in 1915, and Porter and Latimer in 1917. Randall coauthored the classic textbook *Thermodynamics and the Free Energy of Chemical Substances* with G. N. Lewis in 1923.



Frank Spedding reunited with his mentor, Ernest O. Lawrence, ca. 1955.

networks. Perhaps most important, there were regular interactions between the graduate students and Berkeley's scientific superstars within disciplines and across disciplinary boundaries. Lewis himself collaborated with E. O. Lawrence so regularly that visiting physicist Emilio Segrè referred to Lewis as a chemico-physicist.¹⁴ Although Glenn Seaborg did his graduate work under Lewis, he continued his postdoctoral work in Lawrence's laboratory.¹⁵ Spedding's Ph.D. "sub-committee in charge" also reflected a cross-disciplinary approach. Lewis chaired the committee, with chemists Joel Henry Hildebrand and Rhorfin Rusten Hogness, physicist Raymond Thayer Birge, and botanist Sumner Cushing Brooks attending.¹⁶ Therefore, although his

14. Emilio Segrè, *A Mind Always in Motion: The Autobiography of Emilio Segrè* (Berkeley, CA, 1993), 168. In 1936 the relationship between Lewis and Lawrence apparently soured after failed experiments and scientific disagreements. Heilbron and Seidel, *Lawrence and His Laboratory*, 181–82.

15. In 1937 Lewis's former student Glenn Seaborg became Lawrence's "most productive chemist." Heilbron and Seidel, *Lawrence and His Laboratory*, 259.

16. Department of Chemistry, University of California Berkeley, *Ph.D. Programme – F. H. Spedding, 1929*, "Sub-Committee in Charge," Spedding Papers.

degree was in chemistry, Spedding's exposure to Lewis's interdisciplinary approach allowed him to work comfortably and frequently with scientists in other disciplines. That is apparent during Spedding's postdoctoral experiences and, later, in the programs he directed at the Ames Laboratory. By the time Spedding retired from Iowa State University in 1968, he held faculty positions jointly in the departments of chemistry, physics, and metallurgy.

At Berkeley, both during his graduate years and after taking his degree, Spedding used spectroscopic techniques to study the structure and symmetry of atomic and molecular arrangement in materials, particularly the rare earth compounds. Scientists suspected that understanding the relationship between the properties of those metals and their electronic structures would be important, and Spedding's spectroscopic research furthered that understanding.¹⁷ His early experiences in this field influenced his lifelong research program as well as that of the Ames Laboratory, the laboratory that Spedding would build and direct on the Iowa State campus. Ames Laboratory later became synonymous with the production and study of high-purity rare earth metals and compounds.

Although Spedding earned a graduate degree from a highly respected institution under the direction of an accomplished mentor, the year was 1929 and jobs were hard to find. Fortunately, his expertise and perseverance did attract soft money.

17. Although rare earths were so named because many believed that they were rare, in fact, they exist in significant quantities. Because of their close chemical similarity, however, the separation of one rare earth metal from another was an arduous task, and so they remained generally neglected. Separating the elements with any significant degree of purity required as many as 40,000 distinct operations. In fact, some scientists spent their entire professional lives refining a rare earth to 99 percent purity. Rare earths were first identified in 1787, but little work was done with them because of difficulties identifying them. In 1913–1914 Niels Bohr and H. G. J. Mosley demonstrated that 15 rare earths existed, but only 14 had been identified. During the 1920s a search for the missing elements ensued. See Frank H. Spedding et al., "Production of Pure Rare Earth Metals," in *Industrial and Engineering Chemistry* 44 (1952), 553; Frank Spedding, "The Significance of the Research Publications of Dr. F. H. Spedding over the Past Fifty Years," Spedding Papers; idem, "Progress in Rare Earth Chemistry," Spedding Papers; idem, "The Rare Earths," *Scientific American* 184 (Nov. 1951), 26–30; and Karl A. Gschneidner Jr., *Rare Earths: The Fraternal Fifteen* (Washington, DC, 1964), 1–11.

For the next seven years, Spedding was able to patch together a number of short-term, albeit low-paid, appointments that allowed him to continue his pathbreaking research into the rare earths and expand his network of professional contacts beyond the boundaries of Berkeley. In 1930 he received a National Research Council (NRC) Fellowship, followed by a Guggenheim Fellowship, and finally a Baker Fellowship from Cornell University. The NRC Fellowship provided the resources for Spedding to continue his research at Berkeley for two years. By incorporating the relatively new methods of quantum mechanics into his spectroscopic studies, he refined the means to determine the structure and symmetry of rare earth compounds by identifying and interpreting the spectra of their molecules.¹⁸ Spedding recalled how he first acquired these "difficult" materials: "I practically went down on my knees to Dr. Hopkins [of the University of Illinois]."¹⁹ His groveling paid off handsomely; his work on rare earth spectroscopy earned him the Langmuir Award in 1933, an award for outstanding work by a chemist under the age of 31.²⁰ The award prize of \$1,000, together with a modest stipend from Lewis, allowed him to remain at Berkeley for another year.

The American Chemical Society presented the Langmuir Award to Spedding in Chicago at the World's Fair, where a chance meeting profoundly influenced the course of Spedding's career. There, an old man, "a short fellow, like Santa Claus," approached Spedding and offered to send the young chemist several pounds of samarium and europium, "the rarest of the rare earths." Spedding accepted, but doubted the character's sincerity. To his surprise the rare earths arrived soon after he returned to California. Spedding later learned that the stranger was retired University of Chicago professor Herbert McCoy, who held the position of chief chemist at Lindsey Light and Chemical Company, the largest producer of rare earths at the

18. F. H. Spedding, "Instructions for Biographical Data," 2, Spedding Papers.

19. John D. Corbett, "Frank Harold Spedding," *Biographical Memoirs*, accessible at www.nap.edu/html/biomems/fspedding.html (accessed 12/27/2005).

20. This was the third time the award was offered. Linus Pauling and Oscar Rice received the first and second awards.

time. His gifts to Spedding facilitated the young chemist's study of the materials over the next decade.²¹

For the next year, 1934-35, however, Spedding's rare earth research program idled as a Guggenheim Fellowship provided the opportunity to travel extensively throughout Europe. Just a few years earlier, Frank had married Ethel Annie McFarlane, formerly of Victoria, British Columbia, and the two now looked forward to this adventure abroad. In a pattern that characterized much of Spedding's career, he made much of this opportunity in terms of both his personal intellectual growth and the development of his professional network. On the trip, the skills and traits of the entrepreneur and scientist were further molded.

The Speddings spent the bulk of their time in England as Frank worked at the Cavendish Laboratory. There, he conferred with the prominent physicists Ralph Fowler and John E. Lennard-Jones, attended lectures by the future physics Nobel Prize laureate Max Born, and worked with German physicist Francis Simon, who had just fled Hitler's Germany for England. In addition to his time at the Cavendish Laboratory, he traveled to visit other European facilities, including Kamerlingh Onne's low-temperature laboratory in the Netherlands and research laboratories in France, Germany, and Latvia. He found Nobel laureate Neils Bohr particularly warm and "brilliant" during his visit to his laboratory in Copenhagen. He spent a month there working with Bohr and passed "profitable" afternoons with another Nobel Prize recipient, James Franck, another Jewish scientist who had recently left Germany. Years earlier, Spedding had met Franck at Berkeley, and he took the opportunity in Copenhagen to renew the professional contact. At Berkeley he had also had the opportunity to work with Abram Joffe of the Physico-Technical Institute of Leningrad. Joffe, hearing of the young chemist's visit to Europe, invited the Speddings to visit the Soviet Union and lecture, with all expenses paid by his government.²²

21. Spedding, "Instructions for Biographical Data," 4-5. McCoy explained that he provided these rare earths to chemists, physicists, and astronomers "each of whom has his own special field of work" but none of whom were intending to work along the lines of the research for which Spedding won the Langmuir Award. See McCoy to Spedding, 2/8/1937, Spedding Papers.

22. Spedding, "Instructions for Biographical Data," 6-7.



Frank Spedding reunited with Neils Bohr in 1958.

When the Guggenheim Fellowship ended in July 1935, the Speddings returned to his parents' home in Michigan, with life-long memories, stimulating experiences, numerous contacts, but still no job. Fortunately, soon after arriving back in the States, Cornell University offered Spedding its first George Fisher Baker Fellowship, a one-year appointment with a chance for renewal. Initially, Spedding was reluctant to accept the position because Cornell "lacked a first-rate reputation."²³ Furthermore, still ignited with a passion for research on rare earths, he desired the freedom to pursue his own research interests. At the urging of G. N. Lewis, he did finally accept the offer.²⁴ Apparently, he convinced Cornell to relax any prescribed research program, for he later reported to Lewis that the position prom-

23. Letter Draft, Spedding to Lewis (n.d.), Spedding Papers.

24. Telegram, Lewis to Spedding, 7/17/1935, Spedding Papers.

ised “complete freedom of research.” In addition, his supervisor, Jacob Papish, professor and chair of the chemistry department, promised extensive institutional and laboratory support.²⁵

At Cornell, he continued his spectroscopic research of rare earths, now also considering the effect of magnetic fields on the energy levels that gave rise to the transitions measured in absorption experiments. He also extended his professional network. He continued to collaborate with Berkeley graduate students George Nutting and Richard Bear. Although officially both Bear and Nutting were students of Lewis, graduating in 1933 and 1934, Spedding refers to Nutting as his first graduate student and lists both of them on his Ph.D. family tree.²⁶ Spedding continued to support their development even after they graduated. After earning his doctorate, Nutting remained at Berkeley and continued to work for Lewis. Apparently, at some point, Lewis complained to Spedding about their former student, for Spedding attempted to calm Lewis’s concerns over Nutting’s slow rate of publication. He also counseled his former student to hasten the pace.²⁷ In addition to maintaining his relationships with Berkeley colleagues, while at Cornell Spedding successfully collaborated with future Nobel laureate Hans Bethe.²⁸ He also began a lifelong friendship and collaboration with Harvey Diehl, whom he would recruit to Iowa State during the war years and who would remain there, as a close colleague, for decades.

As his research and collaborations apparently brought Spedding professional satisfaction, his relationship with his supervisor, Professor Papish, deteriorated soon after Spedding’s arrival, much to his personal frustration. Although tensions between the two appear to have continued, Spedding and Papish did extend the fellowship for another year.²⁹ After that second

25. Spedding to Lewis, 8/13/1935, and R. C. Gibbs to Spedding, 8/17/1935, Spedding Papers.

26. Located in the Harley A. Wilhelm Papers, Ames Laboratory Archives.

27. Spedding to Lewis, 9/23/1936, Spedding Papers.

28. See F. H. Spedding and H. A. Bethe, “Absorption Spectrum of $Tm_2(SO_4)_3 \cdot 8H_2O$,” *Physical Review* 52 (1937), 454–55.

29. See Spedding’s note on Jack Kirkwood, “We both left Cornell disgusted with Dr. Papish in 1937,” and Harvey Diehl to Spedding, 10/2/1937, Spedding Papers.

year, however, it was time to move on. By the end of 1937 Spedding had published 33 articles, with eight in 1937 alone. His productivity, together with his fellowships, awards, and strong reputation as a spectroscopist and rare earth chemist presumably strengthened his marketability. He headed west to interview at Ohio State University, hoping for a permanent faculty position. Looking forward to settling down at last, Frank and Ethel drove to Columbus only to face disappointment. By the time the young couple arrived, the head of chemistry, W. L. Evans, had already filled the physical chemistry position for which Spedding had applied. Evans recommended that the unemployed chemist travel on to ISC to seek a position there. He knew that his friend and counterpart at ISC, Winfred Coover, was looking to replace a lost faculty member.

Spedding interviewed for the faculty position at ISC, and Coover, the head of the chemistry department, offered him an assistant professorship on a tenure track. Spedding, nearly 35 years old and tired of uncertainty, held out for a position with tenure. Coover, however, could not make such an offer without the approval of the Iowa State Board of Education, so he had to let Spedding walk—and walk he did. Some weeks later, while hiking in Yellowstone National Park, Spedding came upon a note from Coover that a local ranger had posted on the park bulletin board. The offer now included tenure.³⁰ Spedding's appointment as associate professor was unusual inasmuch as he had not previously held a faculty position and had no teaching experience. In terms of research, however, he had built an impressive resumé that presumably impressed Coover.³¹

BY THE TIME Spedding arrived at ISC in 1937, his inimitable personality had emerged. Spedding knew he was smart. After all, he had a Ph.D. from the University of California Berkeley, one of the pre-eminent universities for chemistry at the time. There he had worked with America's finest scientists. After that,

30. Corbett, "Frank Harold Spedding."

31. There is little indication that the appointment reflected any new initiative or policy change for the department. It did not usher in a period of sustained growth for the department, which was and remained the moderate size of 15 to 17 faculty members between 1934–35 and 1940–41.

he traveled the world, spending time in the company of premier scientists in England. He had been invited to visit the Soviet Union and studied under Nobel laureates in Copenhagen. Those experiences cultivated a self-confidence that provided the grounds for insisting on tenure at ISC. There his self-assurance matured further into the entrepreneurial spirit of a science manager.

Although Spedding was excited about the prospect of finally settling down at ISC, he was disenchanted with the caliber of the institution. He apparently expected ISC to be just the first step toward a home institution with more prestige. "I wouldn't normally have chosen the place, but I was desperate. I thought: I can go there and build up physical chemistry and when jobs really open up I can go to another school."³² Until then, however, Spedding cast his new job in a most favorable light. In correspondence, he usually depicted the physical chemistry group as a relatively sizeable, substantial, and independent department with adequate resources and a supportive infrastructure.³³

The reality differed significantly. In 1940 the physical chemistry group that he directed consisted of two faculty members, including himself. The department was under-equipped and underfunded, as compared to the laboratories that he had worked in at Berkeley and Cornell.³⁴ Moreover, neither the chemistry department nor ISC offered to improve the situation. Undeterred, he used creativity and ingenuity to equip his laboratory. In one instance, Spedding needed glass dewars of the sort that he had used in California, so he learned glass-blowing techniques to form them himself.³⁵ In 1940 Spedding received a spectrograph that lacked the peripheral equipment required for his research.

32. This statement was reportedly made to Harry Svec. "Obituary of Frank Spedding," Spedding Papers. It is also noteworthy that Spedding filed a civil service application with the U.S. government in 1938 for a position as principal chemist for the U.S. Department of Agriculture, a further indication of his lack of satisfaction. See Civil Service Application, Spedding Papers.

33. The university catalog lists two physical chemists, although Spedding cites three, and he lists eight students, three of whom worked directly under him. See for example, Spedding to Bethe, 9/29/1937, Spedding Papers; Spedding to Harold C. Urey (former student of Lewis), 10/1/1937, *ibid.*; and Spedding to Mr. Moe of the Guggenheim Award, 11/6/1941, *ibid.*

34. Spedding, "Instructions for Biographical Data," 8, Spedding Papers.

35. Miscellaneous note in Spedding Papers.

The problem was solved by collaborating with Professor R. M. Hixon from plant chemistry, a program with more discretionary money than physical chemistry. They acquired the resources to equip the spectrograph for the project, which, not so coincidentally, also served Spedding's personal research agenda.³⁶

While Spedding continued his spectroscopic studies, however, the pace of the work on rare earths slowed because the elements remained difficult to obtain. His old benefactor, Herbert McCoy, continued to provide europium, but he could not provide those rare earths with higher atomic weights.³⁷ Recalling that a supply, albeit modest, remained at Berkeley, he appealed to his former adviser to loan him their thulium salt, and Lewis obliged.³⁸ Spedding's persistence paid off, and he resumed publishing. During his first five years at ISC, he authored or co-authored nine articles. In 1942 he published the last of his collaborative work with plant chemistry, and for the next five years he published nothing at all.³⁹ He was otherwise engaged.

IN EARLY 1942 Arthur H. Compton recruited Frank Spedding to join the federal initiative that he was organizing in Chicago to determine the feasibility of building an atomic bomb. That branch of the Manhattan Project sought to understand the properties of fissionable materials, assess the possibility of creating a self-sustaining chain reaction, and examine the possibility of manufacturing plutonium by means of nuclear chain reactions. As Compton assembled his Metallurgical Laboratory, he realized that he needed a rare earth specialist and a chemistry group to complement the group of physicists he had gathered in Chicago. He chose Spedding to provide that expertise and organize the Chemistry Laboratory.

Why Spedding? In Spedding's own words, "Look at the Periodic Table. . . . The uranium group is a second group of rare earths, and at the time almost no one in the country had much

36. Spedding, "Instructions for Biographical Data," 8, Spedding Papers.

37. McCoy to Spedding, 11/29/1937, Spedding Papers.

38. Spedding to Lewis, 1/13/1940, Spedding Papers; Lewis to Spedding, 1/29/1940, *ibid.*

39. "Bibliography of Articles by F. H. Spedding," Spedding Papers.

experience with them.”⁴⁰ There is a natural association of the lanthanide elements—the rare earths—with the actinide elements, such as uranium, that undergo nuclear fission. In the natural ore, rare earths are commonly found along with the actinides. The Metallurgical Laboratory required the actinides in an extremely pure form, so the lanthanide “contaminants” had to be removed. And when uranium and plutonium undergo nuclear fission, rare earths are generally found among the fission products. Finally, there are basic chemical similarities between the lanthanides and actinides, so that an understanding of the former might accelerate an understanding of the latter. Spedding’s formal training and experience encompassed an unusual breadth of knowledge. The host of awards, fellowships, and collaborations that complemented his training further enhanced his reputation. And, of course, when Compton turned to his former University of Chicago colleague Herbert McCoy for a recommendation of a rare earth chemist to join the laboratory, McCoy enthusiastically suggested his longtime beneficiary, Frank Spedding.

Spedding agreed to join the Metallurgical Laboratory in Chicago, and Compton appointed him to head the chemistry division. His first task was to organize the division itself. He recruited fellow Berkeley alumnus Glenn Seaborg to head the plutonium program. That appointment was an obvious choice as Seaborg had discovered plutonium in E. O. Lawrence’s laboratory just a year earlier. Seaborg accepted the post and brought some of his Berkeley research associates with him to Chicago in April 1942. UCLA chemist Charles Coryell agreed to head the fission product chemistry section; New York University chemist Milton Burton directed the radiation and radiation damage divisions; and the University of Chicago’s own George Boyd supervised the inorganic and analytical section.⁴¹

Assembling a laboratory took time, so, in the interest of moving the project along as expeditiously as possible, Spedding suggested to Compton that work begin in Ames on the ISC

40. Spedding, “Instructions for Biographical Data,” 8, Spedding Papers.

41. “Significance of [Spedding’s] Research Publications”; Carolyn Stilts Payne, “The Ames Project: Administering Classified Research as a Part of the Manhattan Project at Iowa State College, 1942–45” (Ph.D. diss., Iowa State University, 1992), 45–46.

campus, where equipment and talent already existed. Compton concurred, and in February 1942 ISC agreed to carry a federal contract for Spedding's new research program. That decision proved critical because the laboratory that Spedding assembled on the ISC campus would later become the foundation for the Ames Laboratory. He hired new scientists but also recruited ISC professors to work on this annex of the Manhattan Project. While these recruits agreed to devote considerable energy to the project, they remained ISC faculty as well.⁴² Similarly, he acquired new instrumentation but also used ISC's resources. He distributed the research effort among laboratories and buildings around the campus that were modified to suit the needs of the project. In these ways and so many others, he capitalized on ISC's infrastructure to execute the demands of the Manhattan Project and to sow the seeds of his laboratory.

In Ames, Spedding set up an organization that would encompass areas of study parallel to those of the Metallurgical Laboratory in Chicago: a plutonium chemistry group, a fission products research group, a metallurgical group, and an analytical chemistry group. Spedding's direction of both sites facilitated communication between the laboratories, coordinated the lines of research, and kept duplication of effort to a minimum.⁴³

He invited ISC colleagues Harley A. Wilhelm and Iral B. Johns to become associate directors of the laboratory, heading its two main divisions, metallurgy and the plutonium effort, respectively. Neither scientist was new to ISC. After a stint as a high school teacher, Wilhelm had enrolled in ISC's Ph.D. program in chemistry in 1927, inherited a spectrograph, and became an expert in spectrochemistry.⁴⁴ He graduated in December 1931 but remained at ISC for the next nine years as a non-tenure-track instructor. Inasmuch as ISC's policy frowned on inbreeding, the administration denied Wilhelm a faculty position, even though there had been exceptions made to the rule in the past.⁴⁵

42. Goldman, "Mobilizing Science in the Heartland," 381.

43. Payne, "The Ames Project," 53, 54.

44. *Ibid.*, 49.

45. W. Bernard King graduated from Iowa State in 1930 and became assistant professor there the next year.

When appropriately motivated, however, the administration proved flexible. In 1940, when Wilhelm threatened to abandon academia for industry, the chair of the chemistry department offered him an assistant professorship. Wilhelm accepted the position with the understanding that his research focus had to change. It had already begun to do so. Although Wilhelm had been at ISC for nearly a decade, Spedding's appointment in 1937 established the Berkeley graduate's seniority. Wilhelm was trained in spectrochemistry, but Spedding became the resident spectrochemist, and Wilhelm turned his attentions to metallurgy. That proved to be fortuitous: Wilhelm's experience in that field made him an obvious choice to head the metallurgical program for the Ames annex of Chicago's Metallurgical Laboratory.⁴⁶

In addition to Wilhelm, Spedding appointed plant chemist I. B. Johns to head the plutonium project at Ames. Another ISC alumnus, he had graduated in 1930, a student of Spedding's former collaborator R. H. Hixon. After several years at Monsanto Chemical in Boston, he returned to his alma mater to assume a faculty position. Presumably, in his case, the years away from ISC offset concerns about inbreeding, and he became an associate professor in 1937, at the same time as Spedding.

With Spedding at the helm and Wilhelm and Johns next in command, a pyramidal structure began to take shape.⁴⁷ During the war years the number of people filling staff positions to execute the scientific research program peaked at more than 90.⁴⁸ The two associate directors managed eight section chiefs who directed numerous chemists and physicists. Junior scientists, research assistants, and junior research assistants supported the senior scientific staff.

The hierarchical model facilitated cooperation and the coordination of work between Ames and Chicago. It defined responsibilities at the laboratory and confirmed the authority of

46. Payne, "The Ames Project," 50.

47. Johns left the Ames program in 1944 to join the group of Manhattan Project scientists in Los Alamos. With his departure, Wilhelm became the second in command and continued in that capacity until his retirement in 1966.

48. This figure does not include clerical or maintenance staff. See "List of Scientific Personnel of the Ames Project under the Manhattan District," Friley Papers, Iowa State University Archives, Ames.

the director, but released him from supervising the daily operations.⁴⁹ Thus Spedding could balance the work of groups at ISC with those at the Metallurgical Laboratory in Chicago with minimum upset to either laboratory. On Sunday mornings, the senior members of the Ames group would meet to review the past week's work and plan the next week's goals.⁵⁰ Spedding maintained that these early "Speddinars," modeled after Lewis's seminars at Berkeley, generated ideas that were not specific to any one individual but were a consequence of the free and spontaneous interchange of knowledge.⁵¹ After the meetings, Spedding would leave for Chicago, and the group leaders would carry out the agreed-upon lines of research.

Although Spedding's frequent trips took him away from the day-to-day activities in Ames, his supervision of the research programs remained clear. Spedding's colleague Harry Svec noted, "The breadth of the work is such that the coworkers were many but the inspiration and drive to do the work was largely due to Spedding's perception of what needed to be done, how it should be done and when it should be accomplished."⁵²

The greatest success at Ames arose from an idea credited to Spedding but executed by Wilhelm and his group at the laboratory. Inasmuch as the "purified" uranium sent to Chicago for study continued to be of disappointing quality and very expensive, a bottleneck to the uranium work resulted. Spedding hypothesized that reducing uranium tetrafluoride, rather than the current process using uranium oxide, might produce a purer and cheaper metal. The idea came to Spedding while at a meeting in Chicago when such a briquette "manufactured for industry" was passed around the table. "So he took a block back to Ames and asked Dr. Wilhelm and [Ames associate] Dr. Keller

49. In the late 1920s and 1930s, Lawrence's laboratory at Berkeley became the prototype of this organizational scheme for academic research. The hierarchical structure defined relationships, responsibility, and authority, presumably increasing the pace and efficiency of directed research. Heilbron and Seidel, *Lawrence and His Laboratory*, 228-29.

50. Frank Spedding, Harley Wilhelm, and Adrian Daane, interview, May 1967, transcript in Spedding Papers.

51. Payne, "The Ames Project," 55.

52. Harry Svec, prologue to *Handbook on the Physics and Chemistry of Rare Earths*, ed. Karl A. Gschneidner Jr. and LeRoy Eyring (New York, 1978), 17.

to try using it in place of the oxide." The experiment worked, and Wilhelm and staff produced enough metal for an eleven-pound ingot.⁵³

Years later, Wilhelm recalled how he took the ingot in his traveling bag to the Ames depot, where he boarded an overnight train to Chicago. He arrived in the morning and went directly to Spedding's office. During the trek his traveling bag had broken, and he arrived at Spedding's office with the uranium ingot clutched under his arm. Spedding and Wilhelm took the ingot to Compton, who "had never seen such a big piece of uranium. . . . Anyway, he looked at it and said, 'I bet there's a hole inside.'" There was not.⁵⁴ The process was successful. By September 1942, Ames scientists routinely extracted uranium metal with a purity averaging 90 percent, and by the end of the year they were sending 100 pounds of uranium to Chicago each week. The price of processing uranium fell from one thousand dollars to about one dollar per pound.⁵⁵

53. Spedding, "Significance of [Spedding's] Research Publications"; H. A. Wilhelm, "A History of Uranium Metal Production in America," December 1947, 7-8, Spedding Papers. The Ames Process or "bomb reduction process" began by heating together uranium tetrafluoride and calcium in a refractory-lined iron capsule to melt the materials. The reaction produced calcium fluoride and uranium metal, which, being denser, sank to the bottom of the bomb. They separated the "slag" of calcium tetrafluoride from the metal and then cast the uranium into ingots. These experiments were modeled on those first attempted in the 1920s. Since then the calcium reduction of uranium tetrafluoride had seemed the most promising technique, but a scarcity of high-quality materials prevented this line of research from advancing. Instead, scientists attempted to reduce uranium oxide to the metal, with little success. During the war, government contracts prompted companies such as Metal Hydride to produce high-quality calcium and spurred the Harshaw and DuPont Corporation to step up production of uranium tetrafluoride from uranium dioxide. The availability of these basic materials allowed the Ames group to return to the abandoned research effort. J. C. Goggins and others at the University of New Hampshire had carried out uranium tetrafluoride reduction experiments that showed promise. See Richard G. Hewlett and Oscar E. Anderson, *A History of the United States Atomic Energy Commission*, vol. 1, *The New World, 1939-1946* (Berkeley, CA, 1990), 87-88; and Payne, "The Ames Project," 69-70.

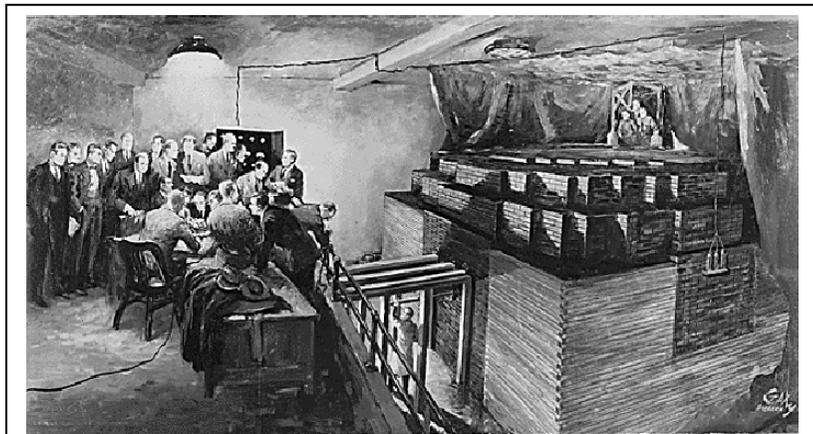
54. Harley Wilhelm, interview with author, 9/29/1990, Ames.

55. Ames *Daily Tribune*, 2/17/1962; "History of Iowa State College Contract W 7406 eng-7," Department of Energy Archives, Washington, DC; F. H. Spedding, "The Operation and Scope of the Ames Laboratory of the Atomic Energy Commission," Spedding Papers.



Fritz Hemness uses a bomb hoist to place uranium reduction bomb 399 in a gas-fired furnace in the "Little Ankeny" building on the ISC campus, ca. 1942-1945.

On December 2, 1942, a successfully controlled chain reaction in Chicago, using Ames purified uranium metal, confirmed the promise of fission and the potential of an atomic bomb. In his capacity as director of chemistry of the Metallurgical Laboratory in Chicago, Spedding witnessed the successful chain reaction. Soon afterwards he stepped down as director of the chemistry division, and James Franck, his former colleague at Berkeley and Copenhagen, assumed the role. That shift of responsibility allowed Spedding to concentrate on executing the scientific program in Ames, as ISC continued to receive government contracts for its wartime research program. Spedding continued to coordinate the work in Ames with that in Chicago and remained an associate of the Metallurgical Laboratory as well as director of the laboratory in Ames.



An artist's depiction of the first controlled chain reaction in Chicago in 1942.

In the immediate aftermath of the war, the U.S. government continued to let contracts to ISC to fund research in Spedding's laboratory. Those contracts called for continued metals production and purification, with an increased emphasis on the rare earths, those metals that had initially brought Spedding to Compton's attention. In 1946 the government created the Atomic Energy Commission (AEC) to organize and implement a program of atomic energy research.⁵⁶ The following year, the AEC established the Ames Laboratory as one of its laboratories to execute its national science program.

Spedding was proud of the work he directed at the Metallurgical Laboratory. He recognized that he had contributed to ending the war, and he thought the peaceful uses for atomic energy would be revolutionary.⁵⁷ From every indication, science rather than international politics drove his work. Publicly, he made few comments about the war, the peace, or the politics of science. The only political issue that appears to have riled him was the secrecy of the atomic program, and on that he was

56. Gilman G. Udell, comp., *Atomic Energy Act of 1946 and Amendments* (Washington, DC, 1971), 1.

57. See F. H. Spedding, "A Chemist's View of Some Aspects of the Atomic Energy Problem," speech to be delivered at the Presentation of the Iowa Medal of the American Chemical Society in Iowa City, 12/3/1948, Spedding Papers; idem, "Atomic Energy – A Review of Fundamentals," n.d., *ibid.*

rather vocal.⁵⁸ He served on the national committee headed by Manhattan Project scientist Richard C. Tolman that developed the postwar declassification policy, and he continued to lobby independently for increased accessibility to atomic research. However, on the major issues of the day, such as the Oppenheimer security hearings or the growing tensions of the Cold War, Spedding had nothing to say, at least publicly. Professionally, although his work with the Chicago group continued during the last years of the war, Spedding's energies primarily focused on building up the laboratory and management infrastructure that would house the Ames Laboratory.

ON MAY 17, 1947, the AEC awarded the contract to manage the Ames Laboratory to ISC, and Frank Spedding was appointed the director of the Ames Laboratory.⁵⁹ In spirit, the program and protocol of the new laboratory remained similar to those adopted by Spedding's group during the war. The laboratory remained on the ISC campus. ISC faculty and graduate students constituted much of the scientific staff, and Spedding controlled the contracted research program. The laboratory continued its

58. See, for example, F. H. Spedding, "What is the Atomic Secret? Iowa Scientist Analyzes Problem" (newspaper clipping, 1949), Spedding Papers; and idem, "Chemical Aspects of the Atomic Energy Problem," *Bulletin of Atomic Scientists* 5 (Feb. 1949), 48-50.

59. According to Spedding, the AEC designated the Ames Laboratory as one of its federally funded facilities in recognition of the work done there under Spedding's leadership during the war and in the interest of continuing such research for the foreseeable future. See, for example, F. H. Spedding, "A Chemist's View," 28. Another factor may help explain the designation of the laboratory in Ames: In January 1947 Iowa's U.S. Senator Bourke B. Hickenlooper was selected to chair the Joint Congressional Committee on Atomic Energy. Hickenlooper had earned his undergraduate degree from Iowa State College, although he graduated from the law school at the University of Iowa. In addition to his personal associations with the two Iowa institutions, he genuinely admired Spedding. See his praise for Spedding in Bourke B. Hickenlooper, "A Look at the Past and a Plan for the Future," in "Ninetieth Anniversary Celebration of the Iowa State College," March 22, 1948, Spedding Papers. This formal but warm relationship continued. In 1960 Spedding invited Hickenlooper, still U.S. senator from Iowa, to visit the new Metals Development Building of the Ames Laboratory that had been constructed with congressional funds. See Spedding to Hickenlooper, 9/26/1960, in Hickenlooper Papers, Herbert Hoover Presidential Library, West Branch.

research program focused on materials, including developmental work with materials such as thorium and beryllium. That work involved "studies in metallurgy, radio-chemistry, chemical engineering, physics, chemistry, etc."⁶⁰ Although its organizational chart distinguished the metallurgy, chemistry, physics, and engineering "sections," strong interdisciplinary efforts became the hallmark of the Ames Laboratory, in accord with Spedding's experience and preference.⁶¹

This interdisciplinary nature as well as the quality of the work in Ames reflected Spedding's strong leadership skills. But Spedding's brilliance extended beyond science. A year and a half before the Atomic Energy Commission established the Ames Laboratory, Spedding began to establish an ingenious managerial infrastructure, the Institute of Atomic Research (IAR), to manage the flow of outside resources to ISC. On November 1, 1945, the Iowa State Board of Education established the IAR and named Spedding its director. The IAR became a clearinghouse for nuclear research on campus; a public resource for atomic energy consultation; a liaison between ISC, Argonne National Laboratory, and its "associated 25 midwestern universities"; a mecca for graduate students; and an administrative hub for processing federal and private funds as they became available.⁶² In addition, ISC delegated the responsibility for administering the contract for the Ames Laboratory to the IAR. Furthermore, the federal government paid overhead costs to ISC to compensate the university for indirect costs that it bore administering its contracts. Those resources provided the bulk of the

60. Contract #W-7405-eng-82 between ISC and the Atomic Energy Commission, 7/1/1948, Friley Papers. Thorium was of prime interest because once it was understood that "the element could extend the available sources of fissionable material," basic knowledge of the properties of the element became a priority. Beryllium, with its high melting point, became a useful "refractory vessel" that held the "bombs." See E. I. Fulmer, "History of the Ames Project under the Manhattan District to December 31, 1946," Iowa State College, 12/9/1947, 25, 38, Friley Papers.

61. This strong tradition continues to the present. For example, an interdisciplinary team of chemists, physicists, and materials scientists was awarded the DOE Outstanding Accomplishment in Materials Chemistry in 1998 for its research on quasicrystal surfaces.

62. Goldman, "National Science," 447.

IAR's operating expenses as well as discretionary money for Spedding's use.⁶³

As director of both the IAR and the Ames Laboratory, Spedding's authority was extensive. As a new administrative mechanism, the IAR challenged the traditional mode of academic governance, and its "science manager" defined new roles for and relationships among faculty. Inasmuch as the IAR administered all research that involved atomic energy throughout the campus, including programs in the departments of engineering, agriculture, and veterinary medicine in addition to those in the physical sciences, its programs crossed departmental boundaries. Moreover, in Spedding's capacity as director of both the IAR and the Ames Laboratory, he approved the scientific staff appointments and had some influence over the AEC-related research agenda of these departments.

Within the physical sciences, an especially close bond between the academic departments and the laboratory divisions was forged. In fact, until 1970, the heads of each laboratory division also chaired the corresponding academic departments. Department chairs thus found themselves under the administrative umbrella of the IAR and the authority of Spedding as well as the university. Interestingly, despite the clear potential for conflict, both the academic departments and the laboratory divisions appear to have flourished. Particularly during the laboratory's first decade, as Spedding's authority solidified, the associated science departments enjoyed a period of significant growth, and the scientists he recruited shared his interests, respected his accomplishments, and recognized his authority.⁶⁴

63. In 1957, for example, the federal government paid \$79,678 in overhead costs to ISC, which in turn reapportioned \$75,000 to the institute. In 1964 the university realized an overhead of \$255,750, of which about \$115,000 provided the institute's budget. See Goldman, "National Science," 447-48.

64. Consider that many of the employees of the Ames Laboratory were attracted to the laboratory because they shared Spedding's interests. See Goldman, "National Science," 450-51. It is also important to realize that several of these new appointees were former students of Spedding and Wilhelm or newly minted Ph.D.s handpicked by Spedding. For example, David Peterson, Adrian Daane, Paul Porter, James Wright, and Jack Powell were Spedding's students who were hired upon graduation. Velmer Fassel was Wilhelm's student. Spedding recruited Harvey Diehl from Cornell—they were colleagues before Spedding went to ISC. Richard Bear had been a student of Lewis and



The Institute for Atomic Research, also known as The Link, was built to house the IAR's administrative offices, which physically connected the chemistry and physics departments.

That may account for the relative calm in light of newly defined lines of authority.

Generous funding, steady growth, and shared interests helped enable Spedding to create positive relations with the directors of the other federally supported laboratories that were created in the wake of World War II. The directors of the Ames Laboratory, Argonne, Oak Ridge, Brookhaven, Berkeley, Los Alamos, Hanford, and the Knoll Atomic Power Laboratory in Schenectady and Sandia formed the "Directors Club" and met annually in the years after the war.⁶⁵ Like the Ames Laboratory, most of the other laboratories had their roots in the Manhattan Project. Spedding credited that shared memory for the good will that at least the first generation of directors enjoyed. Their annual

had collaborated with Spedding while the latter was at Cornell. Spedding recruited Adolf Voigt in 1942 and Dan Zaffarano in 1949. It is important to recall that Spedding preceded the laboratory and built it to capitalize on his interests, which during his tenure were largely shared by the federal government. Those whom he recruited shared his interests, and many remained at the Ames Laboratory for the remainder of their careers. Of those scientists mentioned above, Wilhelm, Peterson, Powell, Fassel, and Diehl retired from the laboratory after long and distinguished careers.

65. See, for example, letters sent from Spedding to the directors of each of those laboratories inviting them to Ames for such a meeting, 8/31/1959, Spedding Papers.

meetings provided opportunities for the scientists to have open discussions without bureaucratic oversight. In addition, they promoted unity that empowered the laboratories to call for change when the directors were dissatisfied with AEC policies.⁶⁶

Spedding's amicable relationships with the directors of the other national laboratories were indicative of his support for the growth of the whole national science initiative. He set up the IAR to facilitate cooperation between the laboratories and ISC, and he enthusiastically endorsed the proposed, though never realized, Midwest Universities Research Association laboratory that was to be built in Madison, Wisconsin.⁶⁷ Notwithstanding such support, occasionally tensions did rise and turf battles did surface, such as in 1945 when the government decided to transfer the uranium turning and casting program from Ames to the Hanford Engineering Works.⁶⁸ However, such tensions appear to be the exception rather than the rule, most likely because Spedding's research program was secured. The separation and study of the rare earths took center stage by the mid-1950s, and in that realm Spedding had little competition. Rather, cooperation and consultation with other laboratories, both within and outside of the national system, seem to have prevailed.⁶⁹

FRANK SPEDDING secured the future of the Ames Laboratory and his authority over its research agenda by virtue of his talents as a science manager—the new sort of scientist that

66. Leland J. Haworth (director, Brookhaven) to Spedding, 12/13/1957 and January 1958, including draft report, "Relationships between the Atomic Energy Commission and the National Laboratories," Spedding Papers.

67. F. H. Spedding, "The History and Purposes of the Iowa State College Institute for Atomic Research," an address given at the dedication ceremony of the Iowa State College Institute for Atomic Research, 5/17/1947, p. 7, Friley Papers; Spedding to D. J. Zaffarano, 7/19/1963, Spedding Papers; Spedding to Dr. George A. Kolstad (AEC), 7/24/1963, *ibid.*

68. Contract No. W-7405 eng-7, 6/25/1945, Friley Papers.

69. Both Spedding and Wilhelm, for example, worked with scientists at Clarendon Laboratory, Philips Petroleum Laboratories, Westinghouse Electric Corporation, and Hanford throughout the 1950s. Spedding to Dr. F. Simon (Clarendon Laboratory), 8/17/1948, 9/19/1950, Spedding Papers; Spedding to R. L. Doan (Philips Petroleum Laboratory), 3/7/1955, *ibid.*; Spedding to William W. Mullins (Westinghouse), 7/5/1955, *ibid.*; "Outline of Research Problems to be Investigated in Support of the Hanford Fuels Development Operation," 9/2/1958, *ibid.*

emerged in the United States during the 1930s and 1940s—a scientist, a conceiver, and an entrepreneur. First and foremost, Spedding was an accomplished scientist as attested to by the plethora of awards and fellowships bestowed on him during his career.⁷⁰ His innovative Ames Process furthered his scientific reputation and very likely earned him the Ames Laboratory. It appears that the laboratory, which was conceived and built on his interests and under his direction, satisfied his entrepreneurial ambitions.

After the war, materials development related to the national interest in atomic energy continued to take center stage at the laboratory.⁷¹ Over the course of the next two decades, however, research increasingly turned to the purification and study of rare earths metals and compounds because of their relevance to the field of atomic energy as well as their industrial applications.⁷² In the 1950s interest in the study of rare earths rose because they can absorb neutrons and thus control the rate of fission. In addition, rare earths also found early application in the optical industry for camera lenses, color television tubes, and lasers, as well as batteries. For all of these reasons, scientists sought to increase their understanding of the properties of rare earths. In 1945 Spedding and other members of his group de-

70. His awards are numerous. In addition to those already mentioned, they include LL.D., Drake University, 1946; Iowa Medal of the American Chemical Society, 1948; D.Sc., University of Michigan, 1949; Nichols Medal of the New York Section of the American Chemical Society, 1952; election to the National Academy of Science, 1952; D.Sc., Case Institute of Technology, 1956; Distinguished Professor of Science, Iowa State University, 1957; Honorary Member, Verein Osterreichischer Chemiker, 1958; James Douglas Gold Medal of American Institute of Mining, Metallurgical and Petroleum Engineers, 1961; Distinguished Citizen Award of the State of Iowa, 1961; Faculty Citation by the Alumni Association of Iowa State University, 1964; Honorary Member, Phi Lambda Upsilon, 1966; Atomic Energy Commission Citation Award for meritorious contributions to the nation's atomic energy program, 1967; American Chemical Society Midwest Award, 1967; Honorary Member, Applied Spectrographic Society, 1969; Honorary Member, Applied Spectrographic Society, 1969; Francis J. Clamer Medal of the Franklin Institute, 1969; Award of Merit, Iowa Academy of Science, 1974; Distinguished Fellow, Iowa Academy of Science, 1975. See Frank Spedding, "Biographical Data Form," Spedding Papers.

71. For example, the first contract awarded to the Ames Laboratory provided for continued research in thorium and beryllium. Contract #W-7405-eng-82.

72. See Gschneider, *Rare Earths*, 39–42.

veloped a process that isolated rare earth metals at 99.99 percent purity with respect to other rare earth impurities.⁷³

During the period immediately after the war, most of the purified rare earth metals available nationally were separated at ISC. A pilot plant was constructed in 1945 to produce the metals until industry took over production in the 1950s and 1960s. Afterwards, although no longer in the business of production, Ames Laboratory scientists continued their study of the rare earths and even established a loan program to supply materials for basic research to other scientists.⁷⁴ In 1966 the AEC expanded the laboratory's ability to support research into rare earths by authorizing the creation of the Rare-Earth Information Center. And in 1981 the DOE established the Materials Preparation Center (MPC) at the Ames Laboratory. The MPC provides rare earth elements of the highest purity by the so-called "Ames Process" to reduce the oxygen, nitrogen, and carbon content of the metals by a factor of ten beyond what is commercially available. In the decades following the war, the Ames Laboratory gained an international reputation for the study of rare earths.

While Spedding's own interests and experiences found expression within the science programs of the Ames Laboratory, Spedding as a conceiver forged an unusually close union of the Ames Laboratory and its contractor, Iowa State College. The laboratory remained on the Iowa State campus and took full advantage of the university's resources. At the same time, the university benefited from Ames Laboratory resources in terms of both financial windfalls and the personnel it attracted. In 1948 W. W. Waymack of the AEC laid the cornerstone for a new metallurgy building, financed by the government at an estimated cost of \$1.5 million. Another \$350,000 was promised to outfit the laboratories. The purchase of a synchrotron further illustrates the "porous" boundaries between ISC and the Ames Laboratory. The college-owned synchrotron began operation in 1950. Research overhead funds paid for its construction, and the annual rental fee from the AEC provided its operating costs, since the AEC-sponsored research program was the sole user of the ma-

73. E. I. Fulmer, "History of Ames Project," 12/9/1946, 41-42, Spedding Papers.

74. Goldman, "National Science," 451.

chine.⁷⁵ Spedding pointed out the hefty dividends the facility paid for science at ISC: "It is the having of this synchrotron at Iowa State College which makes it possible for us to attract the type of staff and graduate students in Physics which we need to carry out our work."⁷⁶ Likewise, the tradition of joint appointments established during the Manhattan Project continued, effectively reducing costs for both the university and the laboratory while holding great appeal for faculty and students.

Spedding, as an entrepreneur, established the IAR as the managerial mechanism that joined the Ames Laboratory and ISC. It provided Spedding with extraordinary autonomy and authority to direct the Ames Laboratory and to realize his own professional ambitions. Spedding secured the bulk of his resources from overhead generated by the contracts that supported the Ames Laboratory. In addition to discretionary income that, in and of itself, became a source of control, the IAR defined a managerial role for Spedding within the university that enhanced his authority. The IAR created a new tier in university administration and allowed Spedding to expand his role as science manager beyond faculty and administrators associated with the Ames Laboratory to those involved with AEC-related programs outside of the laboratory.

There is little question that Spedding strongly influenced the development of the physical science and engineering programs at Iowa State. The Ames Laboratory itself certainly owes its existence and niche to its founding director. Constantine Stassis, now retired from the laboratory and Iowa State University, recalled that Spedding made it clear that the Ames Laboratory was "Spedding's Laboratory," the scientific programs were *his* scientific program, and his name appeared on virtually all of the laboratory's publications during that era.⁷⁷ Indeed, almost 40 years after Spedding's retirement in 1968, the laboratory still bears the indelible mark of its creator.

75. "Memo on Proposed Expenditures for Institute of Nuclear Physics, in Order of Preference," Friley Papers; Spedding to ISC President Friley, 9/20/1950, *ibid.*; David Saxe, director, Development Contracts Division, COO, USAEC, to Spedding, 8/12/1955, Spedding Papers.

76. Spedding to Friley, 9/20/1950, Friley Papers.

77. Constantine Stassis, conversation with author, Ames, 8/15/1998.