NATIONAL ACADEMY OF SCIENCES

JULIUS ADAMS STRATTON
1901—1994

A Biographical Memoir by
PAUL E. GRAY

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Biographical Memoir

MIT Museum

JULIUS ADAMS STRATTON

May 18, 1901–June 22, 1994

BY PAUL E. GRAY

JAY, AS HE WAS KNOWN by nearly all who worked with him, served the Massachusetts Institute of Technology, the Radiation Laboratory at MIT, the federal government, the National Academies, and the Ford Foundation during his long and productive life. His work at MIT, as a member of the faculty and subsequently as provost, chancellor, and president, was vital to the development of both research and education during periods of rapid growth and change at MIT.

EARLY YEARS

Stratton was born on May 18, 1901, in Seattle, Washington. His father, Julius A. Stratton, was an attorney who founded a law firm well known and respected throughout the northwest; later he became a judge. His mother, Laura Adams Stratton, was an accomplished pianist. Following his father's retirement in 1906, the family moved to Germany, where young Julius attended school through age nine and became fluent in German. In 1910 the family returned to Seattle, where he completed his public school education.

Stratton came to MIT, with which he was associated for 74 years, as the result of an accident at sea and on the advice of a fellow student. From an early age he was interested in how things worked and in building things, particularly devices that involved electricity. In high school he grew fascinated by radio in the early days of spark-gap transmitters and galena crystal detectors. These interests, combined with the shutdown of amateur radio operations during World War I and the desire to serve the nation, led him to qualify as a commercial radio operator (second grade) and to sign on during summer vacations as a shipboard radio operator.

Stratton had been admitted to Stanford for matriculation in September 1919 when he signed on for the summer right before as radio operator aboard the SS *Western Glen* out of Seattle headed for Japan and Manchuria. The ship encountered a typhoon near Kobe, Japan, and went to the rescue of another vessel in distress nearby. The *Western Glen* also experienced engine failure at the start of the return voyage, requiring a return to port in Japan. These misfortunes resulted in a late arrival back in the United States, too late for Stratton to enroll at Stanford that year. In search of an alternative, he succeeded in gaining late admission to the University of Washington in Seattle. That year he pursued his primary interests, electricity and mathematics. A classmate persuaded him, however, to apply for transfer to MIT, where he was admitted in 1920. He found his way out to the east coast by plying his favorite trade as a radio operator—this time first grade—aboard the SS *Eastern Pilot* bound for New York City via the Panama Canal, finally arriving in Boston in August 1920, a week before the start of classes.

At MIT (known at that time colloquially as “Boston Tech”) Stratton enrolled in the Electrical Communications: Telegraph, Telephone, and Radio option of the Department of Electrical Engineering, which he later described as “far more interesting than that of ordinary dynamo-electric machinery. Line telegraphy and telephony involve some of the most complex mathematics known.”[1] He was awarded the S.B. degree in June 1923, with a thesis titled “The Absolute

Calibration of Wavemeters." The equipment he developed for this project generated harmonics up to 30 megahertz from a one-kilohertz tuning fork.

During his senior year, Stratton considered continuing his studies in Europe. Professor Arthur Kennelly of the Electrical Engineering Department urged him to enroll at the Université de Nancy, and gave him a reference. He traveled to Paris via Cherbourg (this time as a passenger) with the dual goals of continuing his education and becoming fluent in the French language. During the 1923-1924 academic year, he traveled to Nancy, Grenoble, Toulouse, and Italy, returning to the United States in August 1924. At this time he was not focused solely on science and mathematics. While at Grenoble and Toulouse, he seriously considered a doctoral thesis on the influence of science on literature—a reflection of the influence of his MIT English teacher, "Tubby" Rogers.

From September 1924 through June 1926 Stratton worked as a research assistant in communications at MIT and studied for his master's degree in electrical engineering, graduating with a thesis titled "A High Frequency Bridge." During this period he wrote to his father with remarkable prescience about the trajectory of his career: "I will admit that an ultimate goal which would cause me complete satisfaction would be the administration of such an institution as Tech or the Bureau of Standards at Washington."[2]

Upon completion of his master's degree, Stratton was awarded a traveling fellowship that enabled him to return to Europe, where many universities were seething with excitement over the latest developments in quantum theory and atomic structure. He enrolled for a doctor of science degree in mathematical physics at the *Eidgenössische Technische Hochschule* (ETH) in Zurich, Switzerland, where he studied under Peter Debye and graduated in March 1928 with a thesis titled "Streuungskoeffizient von Wasserstoft nach der

Wellenmechanic" (The Scattering Coefficient of Hydrogen According to Wave Mechanics). He then returned to MIT as an assistant professor in electrical engineering, a modern physicist embedded in an engineering department.

Stratton's desire to see the world continued to grow. During the summers he traveled to Africa, the Yukon, and Ecuador. His interest in other cultures and nations ran deep, a quality very much in line with MIT's increasing international reach and stature.

On June 14, 1935, in Saint Paul's Chapel at Ivy Depot, Virginia, Julius Adams Stratton married Catherine Nelson Coffman. From this fortunate union came three daughters: Catherine, Cary, and Laura. Their mother, known to all as Kay, is active in the MIT community as a member of the Council for the Arts and as the guiding force behind two annual panel discussions: one each fall on a selected critical issue, and one each spring on some aspect of aging gracefully.

THE YOUNG PHYSICIST

Stratton's experiences at the ETH helped shape his professional focus and further stimulated his passion for mathematics and physics. As he captured the shift: "In the years 1923-1924 I was thinking of a doctorate in literature or philosophy. This was to be the subject: The Influence of Science on 19th Century French Literature. I decided to go into pure physics. The years 1925 through 1928 changed my mind."[3] In 1930 his MIT appointment was moved to the Department of Physics.

Karl Taylor Compton, the newly appointed president just arrived from Princeton, was setting out to strengthen the sciences in general at MIT, and especially to give greater emphasis to modern physics. Stratton became an integral part of this transformation. He was promoted to professor in 1941, the same year his book *Electromagnetic Theory* was published. This work, now long out of print, is still widely consulted and referenced more than a half century later. In 2006 the Institute of Electrical and Electronic Engineers selected it for reprinting as part of their series of electrical engineering classics.

Much of Stratton's research in the 1930s was carried out at the Round Hill Experiment Station in South Dartmouth, Massachusetts. Colonel Edward Green owned this estate. He had inherited a large fortune from his mother—Hetty Green, known in her day as the witch of Wall Street—and was insatiably curious about science, particularly radio communication. He invited MIT to use the property for research in meteorology and the propagation of electromagnetic waves. Stratton's work there involved the propagation of very short radio waves and light through rain and fog. He also studied the possibility of using intense electromagnetic radiation to disperse fog, and made measurements of the field of an antenna over the open sea, employing the *Mayflower*, a dirigible loaned to him by the Goodyear Zeppelin Company. He prepared and published, through the National Academy of Sciences, tables of spheroidal functions—solutions of differential equations arising in his study of antennas. Between 1927 and 1942, 11 of his technical papers were published in refereed journals.

THE WAR YEARS

As for many other scientists, the German invasion of Poland in 1939 marked a watershed in Stratton's career. Well before the start of the war, British scientists had employed high-frequency radio waves (ca. 100 megahertz) as an early form of radar by exploiting reflections from aircraft. This system, known as "Chain Home" was very important during the Battle of Britain in the summer of 1940, when it gave the Royal Air Force warning of the approach of the German bombers.

While the scientists realized that higher frequencies would permit much smaller antennas and would yield greater precision in target location, vacuum tube transmitters were unable to generate radiation of sufficient intensity at frequencies in the gigahertz range. But the invention of the microwave cavity magnetron a few months after war broke out made possible the creation of radar systems that would prove remarkably effective as a tool of war. Unsure that they could develop the invention at home under wartime conditions, British scientists in August 1940 sent the Tizard Mission, (more formally "The British Technical and Scientific Mission to the United States") along with the magnetron and its developers, to the United States, where American engineers and scientists were in a position to develop—without hindrance or distraction—militarily useful microwave radar systems.[4]

When the federal government established the Radiation Laboratory at MIT in October 1940, Stratton was one of many who joined in the task of making microwave radar useful to the military on land and sea as well as in the air. He was a natural for this work, given his understanding of electromagnetic radiation and the applications of Maxwell's equations. He was appointed in November 1940 as a volunteer consultant to the Microwave Section of Division D of the National Defense Research Council, and seconded by MIT to the Rad Lab, as it came to be known.

His initial work at the Rad Lab was on the development of loran (long-range navigation), a system that employed synchronized transmission of pulsed signals from a variety of locations.[5] Comparison of signals from two or more transmitters enabled determination of the precise location of the receiving aircraft or ship. Loran foreshadowed the development a half century later of the Global Positioning System

(GPS)—a ubiquitous satellite-based system that employs similar principles. Loran was the first system developed by the Rad Lab to be applied by the military. It was instrumental both in winning the war against German submarines in the Atlantic and in directing Allied aircraft flights sent into Europe on bombing missions.

The lab developed multiple radar systems, some for use on the ground for targeting weapons and for detection of aircraft; some installed in aircraft, both for nighttime combat and for location of enemy submarines and surface ships; and some for use on ships in surveillance and directing the fire of heavy weapons. The lab's influence on the conduct of the war was evident in both the eastern and western theaters.

The rapid pace of development and of improvements to radar equipment at the Rad Lab was not matched, unfortunately, by the American military bureaucracy, which proved so lethargic that the troops usually had "the third best [radar] set." Stratton outlined the problem in a letter to his Rad Lab colleague Edward Bowles:

> Despite sincere good will on the part of individual officers I am nevertheless impelled to the belief that the planning and implementation of a rational program and the procurement of radar equipment is proceeding with intolerable slowness. . . The most glaring defect in the system is the number of hands through which each problem and paper must pass for discussion, revision, and endorsement. . . Unfortunately the time consumed by conference after conference is bought, under the circumstances of war, by soldiers lives.[6]

This problem resisted solution throughout the war years and beyond. Procurement of rapidly evolving technical equipment by the government is an ongoing problem to this day.

In August 1942 Stratton was appointed expert consultant to the secretary of war, Henry G. Stimson, and served in that capacity until December 1945. In this role he made frequent visits to the theaters of war. In October 1942, as a member of a committee investigating communication problems in the North Atlantic, he traveled by air to England with extended stopovers in Presque Isle, Labrador, Greenland, and Iceland. In 1943, soon after the Allied invasion of North Africa, he spent time in Algiers, Tunis, Italy, and London assessing radar utility and communications effectiveness.

Decades later Stratton told me of a trip he had made in the spring of 1944 by British destroyer from Britain to Iceland. It was a dangerous passage because of German submarine activity in the North Atlantic. On board also was the archbishop of Canterbury, headed to greet British troops in Iceland. When the vessel pulled into port, the commander of the British garrison was surprised to see the archbishop because nearly all British soldiers training in Iceland had been quietly returned to Britain to prepare for imminent invasion. The commander, assuming that the cleric would be upset about having made the dangerous trip for no reason, summoned the courage to explain over dinner. "Do not be concerned, son," the Archbishop assured him. "I have come to Iceland often in the spring to fish for salmon and I was not going to miss the opportunity this year."

During the Rad Lab's five years of operation, more than 4,000 people were employed either there or in related efforts, such as the Radar School, that trained soldiers—more than 8,000 in all—to operate and maintain the new equipment. The taxpayer dollars expended through the laboratory approached $100 million, a sum in excess of MIT's total expenditures during the first 75 years of its existence![7]

Robert Buderi wrote, "The Atomic Bomb only ended the war. Radar won it."[8] Stratton, it must be noted, contributed to this outcome. He was awarded a Presidential Medal of Merit in 1946 upon recommendation of the secretary of war.

SENIOR LEADERSHIP

In August 1945 the Office of Scientific Research and Development, the agency that had overseen all laboratories created to aid the war effort, was shut down and the Radiation Laboratory began to wind down its affairs. But there had already been talk about keeping its work alive in one form or another. "As early as 1943 there was speculation about a peacetime sequel to the Rad Lab. There had grown a remarkable spirit of cooperation between the physicists and the electrical engineers."[9] On January 1, 1946, Stratton took over administration of the disappearing Rad Lab's Division of Basic Research, which had been created in August 1945 following the surrender of Japan. On the suggestion of John Slater, head of MIT's physics department, Stratton named it the Research Laboratory of Electronics (RLE).

Research support in the early days of RLE came from the Department of Defense through a multiservices contract administered by the Office of Naval Research, much of it as a block grant of $600,000 per year. RLE was "responsible for extending the useful range of the electromagnetic spectrum . . . to shorter wavelengths, approaching ultimately that of infra-red."[10] Title to the temporary MIT buildings that had housed the Rad Lab and to all its equipment, was transferred to RLE in July 1946. The largest of the temporary buildings became Building 20. Until its demise in 1998 at age 55 it was much cherished research space for some of MIT's most creative and productive minds.

While interdepartmental laboratories are now common in universities, the novel idea, in 1946, of a laboratory with its own director, in which faculty would have dual loyalties both to the lab and to their home department, and in which technical and research staff would be appointed without review by a department, received mixed reviews from the MIT faculty. Further, there was concern about the appropriateness of military support in peacetime, even though all the research to be undertaken was unclassified. Stratton, as founding director, together with his colleagues from the electrical engineering and physics departments who formed the RLE Steering Committee, resolved these and other critical issues during the formative years of the nation's first university-based interdepartmental research laboratory. Its history, now spanning more than six decades of scientific and engineering accomplishments, owes a great deal to his leadership of the laboratory in the beginning.

Soon, however, he entered on another phase of his career. In 1949 James Rhyne Killian Jr. succeeded Karl Taylor Compton as MIT president and appointed Stratton as MIT's first provost. This was the start of a period of extraordinary growth at MIT. Vannevar Bush's landmark 1945 report, *Science, the Endless Frontier*, led to the creation of the National Science Foundation and the National Institutes of Health. Cold-war tensions, much raised in 1957 by the Soviet's launch of *Sputnik*, caused enrollments in engineering and science to soar. The federal government vastly increased financial support for research and for students in science and engineering fields. Charles Stark Draper's Instrumentation Laboratory (originally affiliated with MIT's Aeronautics Department, later to become the independent Draper Laboratory) expanded to add the Apollo mission to its development of inertial navigation systems for the military services. The compound annual growth rate of sponsored research was in double digits until the late 1960s.

Stratton was responsible for overseeing the physical and intellectual growth of MIT in these decades and for the thoughtful development and implementation of necessary structures, policies, and procedures that became the foundation of and model for MIT in the modern age. During his tenure as provost, two new schools were created: the School of Humanities and Social Studies in 1950 (now the School of Humanities, Arts, and Social Sciences) and the School of Industrial Management in 1952 (now the Sloan School of Management).

In 1957 Killian was called to Washington to serve as President Eisenhower's science adviser, and Stratton, who had been appointed chancellor in 1956 (again a new position at MIT), became acting president and an ex officio member of the governing board. In 1958 he was elected the 11th president. His presidency saw much physical expansion at MIT. New buildings for Chemistry, Earth Sciences, Biology, and the Center for Materials Science and Engineering filled former parking lots. McCormick Hall, the first dormitory for undergraduate women, opened in 1965. This was the crucial first step in increasing the number of women at MIT, who now make up 45 percent of the undergraduate student body, a dramatic change from fewer than 3 percent in the postwar period. Stratton was so liked and respected by students that they suggested the new student center, completed in 1966, be named for him.

As founding director of RLE, as provost, and as chancellor and president, Stratton deserves—along with Compton and Killian—a large share of the credit for transforming MIT from the premier school of engineering to a modern research university.

THE NATIONAL ACADEMY OF ENGINEERING

The National Academy of Sciences (NAS) was created in 1863 under a charter signed by President Lincoln. NAS membership was, and continues to be, a widely respected honor, treasured by those who are elected. Although from early on the NAS maintained a section for accomplished engineers, it was small and relatively few engineers were elected to membership. In 1961 the idea of a comparable national academy to recognize outstanding engineers was proposed in an article in the *Journal of Engineering Education*.[11] The national engineering societies associated with the Engineering Joint Council strongly backed the idea. A specific proposal was made to the NAS Council in April of 1963.

The precise way that the engineers' academy would be set up and structured provoked strong feelings and frequently contentious debate. Some wished the new academy to be independent of the NAS; others wanted it as an integral component of the NAS.

The president of the NAS, Frederick Seitz, was deeply skeptical at first about the idea of a sister academy. He voiced his reservations to the NAS Council, referencing a letter written by Thomas K. Sherwood in support of an affiliated academy of engineers.[12] Such an affiliated academy, he argued

> could result in a large and powerful organization competing with the NAS. It will be able to enlist strong support from industry as well as government. It is likely that congressional committees and government agencies will find more reason to ask for advice and help from the NAE [National Academy of Engineering] if and when it becomes respectable than from the scientific community. . . The first major difference of opinion as to who should do what could lead the engineers to terminate the proposed cooperative arrangement and go off entirely on their own.

Stratton, who served then on the NAS Council, chaired a committee that was formed in 1963 to study the matter. He expressed his views on the question of independence versus affiliation in a letter to committee member Augustus B. Kinzel:[13]

> I am prepared to take the engineers at their word and to believe that they would prefer to develop a new academy in affiliation with the National Academy of Sciences but that if this proves unfeasible they will proceed on their own. It seems to me that it would be most unwise and indeed unfortunate

for the National Academy of Sciences to reject the overtures made by the engineers without a sincere try to work something out. Such an unfortunate action on our part could only deepen a feeling of distrust that has lately been developing between scientists and engineers.

In the fall of 1964 Seitz—finally persuaded by arguments on the other side—suggested to the Council that the NAE become a part of the NAS, rather than having the engineers seek a separate charter for themselves. The NAS Council approved the proposal on December 5, 1964. The NAE, consisting then of the 25 founding members (Stratton among them), held its first meeting on December 10. A public announcement appeared the next day.[14]

The wisdom of creating an affiliated academy for the engineering community, and of subsequently engaging it as a partner with the NAS in the management of the National Research Council, has been evident in the four-plus decades since the decision was reached. The two academies, joined more recently by the Institute of Medicine, represent the organization of first response to requests from the federal government for expert analysis of issues in science, technology, and health. Stratton's persuasiveness and clarity of vision were important in shaping the evolution of the enterprise, now commonly referred to simply as "The National Academies."

THE FORD FOUNDATION

Following his retirement as president of MIT in 1966, Stratton was elected chairman of the board of the Ford Foundation, at that time the largest grant-making charitable agency in the nation. He had served as a trustee of the foundation since 1955. At the MIT retirement party given in Stratton's honor, his lifelong friend—physicist William P. Allis—described the transition as "taking off academic robes to put on foundation garments."

During his term as chairman, Stratton changed a number of Ford Foundation policies that related to board size, composition, and function. Some of these changes reflected practices that had concerned him during his years as a trustee. For example, board meetings had been conducted in a manner that left little opportunity or time for discussion. Officers of the foundation had been instructed not to talk with a trustee unless the president of the foundation was present. And he believed that the specific interests of some trustees influenced grants to too great a degree. He described the changes he made in an oral history conducted after his term ended:

> My procedure has been to involve every member [in discussions], to turn to him for what he thinks on each issue.
>
> [We] introduced the counterpart of the collegiate visiting committee. [Such trustee committees had long been in use at MIT.] The purpose was clearly to get the trustees to know the staff members and what was going on. [There was] one for each division and one for the vice-presidents. My impression is that these have taken on in a most extraordinary fashion. And it was the VPs themselves who said "This is great. Let's have meetings. Let's keep this up." This was all part of the strategy to break down the walls that lay between the trustees and the staff. I think it has been a very very useful contribution.[15]

Stratton also introduced a mandatory retirement age and fixed terms for trustees. He worked with the membership committee to appoint trustees with attention to varieties of experience.

When Stratton retired, the board concluded its resolution with the following sentences:

> "He has demonstrated in every word and action the meaning of the standards to which he has held us all: that we are here to serve not our own ends but those for which the Ford Foundation is chartered. He leaves the foundation stronger than he found it, and all who care for its work are deeply in his debt."[16]

During his years as chairman of the Ford Foundation, Stratton also accepted presidential appointment as chairman of the Committee on Marine Science, Engineering, and Resources (COMSER). The committee of 15 announced by President Lyndon B. Johnson on January 9, 1967, commenced work six weeks later. COMSER emerged from a growing sense, both here and abroad, that the world could no longer afford to go without an authoritative assessment of troublesome, potentially disastrous environmental problems. "The need to develop an adequate national ocean program arises from a combination of rapidly converging and interacting forces: world population growth; the need for sources of protein; ocean industries as components of inviting opportunities for economic growth." Under Stratton COMSER was charged with recommending "National Policy to develop, encourage and maintain a coordinated, comprehensive, and long range program in marine science for the benefit of mankind . . . expanding scientific knowledge of the marine environment and of developing an ocean engineering capability to accelerate exploration and development of marine resources."

COMSER's final report, *Our Nation and the Sea, A Plan for National Action,* was presented to a different president following its publication in January 1969.[17] With remarkable clarity and foresight it laid out key problems facing the marine environment.

•The environment [of the sea] is being affected by man himself, in many ways adversely. It is critical to protect man from the vicissitudes of the environment and the environment, in turn, from the works of man.

•The oceans and marine-related activities must be viewed in the context of the total land-sea-air environment. Mankind is fast approaching a stage where the total planetary environment can be influenced, modified and perhaps be controlled by human activities.

•Means for reaching reasonable accommodation of competing national interests must be found to achieve efficient and harmonious development of the sea's resources. The atmosphere, which is so influenced by the oceans, knows no national boundaries; the nations of the world share a common interest in its monitoring and prediction and in its modifications.

One outcome of the COMSER's work was the creation of NOAA, the National Oceanic and Atmospheric Administration. Other recommendations relating to international cooperation and to the conservation of marine resources were strongly opposed by fishing and other commercial marine interests, and did not lead to hoped-for changes in policy.

Stratton's close relationship with MIT continued during his time at the Ford Foundation. He remained a member of the MIT's governing board and served on several committees, including a presidential search committee formed in the fall of 1970.

FINAL CHAPTERS

Stratton returned to MIT full-time in 1971, at the conclusion of his term as Ford Foundation chairman. His affection and concern for the MIT, central as they were to his professional life for more than half a century, were undiminished by his years in New York, and he immersed himself once more in the life of MIT with the same quiet energy and vigor for which he was so well known.

Stratton's lifelong interest in the history and cultures of institutions was reflected in his determination to prepare a comprehensive history of the origins of MIT, and he began this work in earnest when he returned to Cambridge in 1972. His administrative assistant Loretta B. Mannix, who had gone to the Ford Foundation with him, did most of the archival research for this project. Eventually she progressed from editing his work to doing portions of the writing herself, and Stratton made it clear that they were to be listed as co-authors when the book was published. Following Stratton's death, Ms. Mannix carried on with the writing as long as she was able.

When it became clear in late 2002 that help was needed to complete the book, MIT commissioned Philip N. Alexander, a research associate in the MIT Program in Writing, to complete the research, to bring together the separately written chapters, to write the last six chapters, and to make it whole. As the page that often holds a dedication puts it:

A Work
Initiated by Julius A. Stratton
Continued by Loretta H. Mannix
Completed by Philip N. Alexander

The book, titled *Mind and Hand—The Birth of MIT*, was published by MIT Press in 2005. It begins with the European antecedents of technical education in the United States, introduces the founders, describes the origins of MIT, and concludes with descriptions of the first curriculum, the modes of instruction, the faculty, and the first group of students who entered in 1865.

In January 1971 the MIT governing board elected Jerome B. Wiesner as president, and also named the writer of this memoir as deputy to the president, with the title of chancellor. This was only the second use of this title at MIT—Stratton had been the first to hold it more than 15 years earlier.

Our common titular bond led to a friendship that lasted until Stratton's death on June 22, 1994. While I had had two occasions as a very junior faculty member to talk with him in the 1960s, we did not become well acquainted until his return to MIT. Then we regularly sought a quiet place to talk, usually over lunch, about MIT affairs. As a new, somewhat green senior administrator, I benefited beyond measure from both the questions he raised and insights that he imparted during these informal chats.

During the last 20 years of his life, Jay Stratton had the opportunity to observe up close the continuing transition from premier engineering school to world-class research university that he—together with Compton and Killian—had set in motion at MIT 60 years earlier.

His life spanned most of the twentieth century, a period of wars hot and cold, intervals of peace, the Great Depression, scientific discoveries, and technological innovations unimaginable at the end of the prior century. The faculty, staff, and students are only the closest of those who benefit from his work, his character, and his values—demonstrated in a life well spent.

I AM INDEBTED TO two members of the staff of the MIT Archives—Elizabeth Andrews, associate director, and Nora Murphy, research archivist—who provided essential guidance and to Philip Alexander, whose careful reading of an earlier draft of this paper was of great help.

NOTES

1. Stratton's letter to parents, October 14, 1922, MIT Archives Manuscript Collection MC-341, Series I, Box 2.
2. Stratton's letter to father, April 4, 1924, ibid.
3. Ibid.
4. R. Buderi. *The Invention That Changed the World,* pp. 108-109, 265. New York: Touchstone, 1996.
5. Ibid.
6. Stratton's letter to Edward L. Bowles, May 4, 1943, MIT Archives Manuscript Collection, MC-341, Series III, Box 29.

7. 1945-1946 Report of the President, MIT, pp. 8, 10, 16.
8. R. Buderi. *The Invention That Changed the World*, p. 247. New York: Touchstone, 1996.
9. R.L.E.: 1946+20 (An RLE publication, May 1946), p. 1.
10. Ibid, p. 5.
11. Work, Harold K. The question of establishing a national academy of engineering. *Journal of Engineering Education* 51, no.9 (1961): 698-700.
12. Seitz letter to the NAS Council, May 13, 1964, MIT Archives Manuscript Collection MC-341, Series III, Box 29.
13. Stratton's letter to Kinzel, March 26, 1963, MIT Archives Manuscript Collection MC-341, Series III, Box 29.
14. NAS/NAE announcement December 11, 1964, MIT Archives Manuscript Collection MC-341, Series III, Box 29.
15. Stratton Oral History, Ford Foundation, MIT Archives Manuscript Collection MC-341, Series III, Box 12, pp. 8, 99-105.
16. MIT Archives Manuscript Collection MC-341, Series III, Box 13.
17. January 7 White House Announcement, 1969, MIT Archives Manuscript Collection MC-341, Series III, Box 13.

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