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Chapter 2

Goddard and Lindbergh: The Role of Charles A. Lindbergh in the Rocketry Career of Robert H. Goddard*

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Introduction

This year [2002] marks the 75th anniversary of one of the most extraordinary aviation feats in the history of aviation, Charles A. Lindbergh's solo flight across the Atlantic Ocean, 20–21 May 1927. Ironically, this singular event was to indirectly affect the career of a man whose life's work focused on an entirely different aspect of flight—rocketry. This pioneer was Robert H. Goddard, whose name, like Lindbergh's in the history of aeronautics, stands out preeminently in the history of astronautics. This is a fitting, and first time for the Lindbergh–Goddard connection to be examined. This article uses published material and hitherto unpublished documents.

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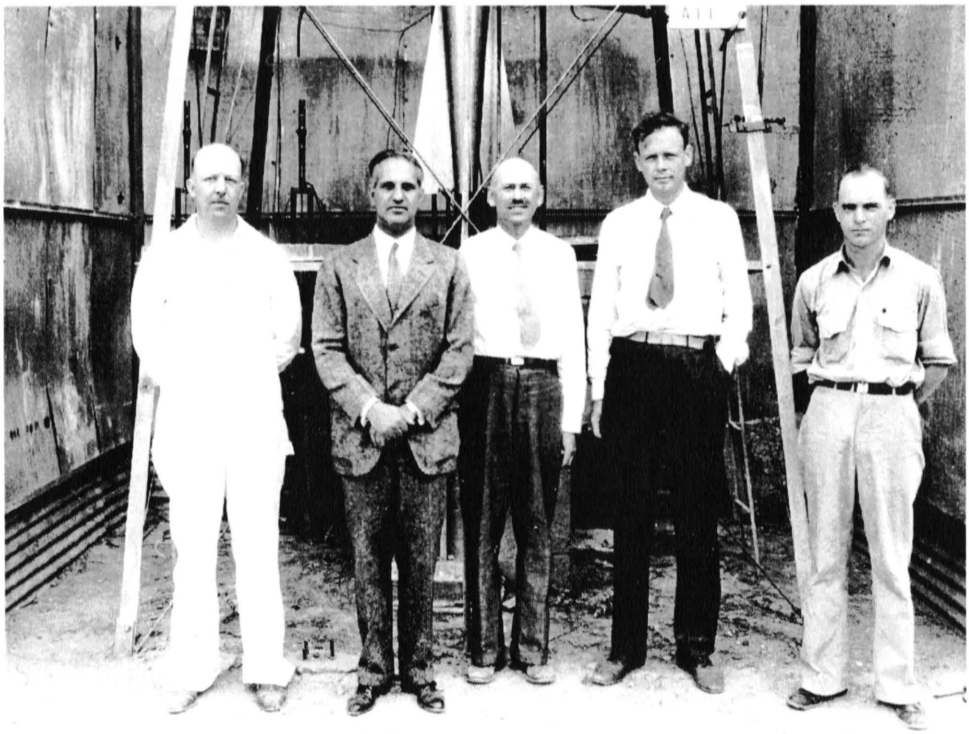

Figure 1: Standing in front of Goddard's rocket launch tower near Roswell, New Mexico, on 23 September 1935, are (left to right): Albert Kisk, Harry F. Guggenheim, Dr. Robert H. Goddard, Col. Charles A. Lindbergh and N. T. Ljungquist. NASA Photo 74-H-1215. Credit: NASA.

Background

As is well documented elsewhere, Robert H. Goddard (1882–1945), born in Worcester, Massachusetts, began his lifelong career in rocketry on 19 October 1899 at age 17. He then experienced a childhood daydream in which he envisioned a trip to Mars after avidly reading two serialized science fiction stories that appeared in the *Boston Post* newspaper. These stories were: "Fighters from Mars, or the War of the Worlds, in and near Boston" and "Edison's Conquest of Mars," by H. G. Wells and Garrett P. Serviss, respectively. By his own account, the stories "gripped" his "imagination tremendously" and from the time of his daydream he made a personal vow to devote his life toward finding a solution to the accomplishment of spaceflight. But he did not think of the rocket just yet. Nor did he have any knowledge of the work of the Russian astronautics pioneer Konstantin E. Tsiolkovsky, who had begun to look at the scientific possibilities

of spaceflight from the 1880s. As far as Goddard knew, he was the only one who seriously attempted to study this subject. From the appearance of the ancient Greek book *Vera Historia* (*True History*), by Lucian of Samosota in 160 BCE, to the classic stories by Jules Verne , and later those of Wells and Serviss, which were also published as novels, the literature of spaceflight was strictly one of fantasy.[1]

It took Goddard many years of theorizing on possible means of achieving spaceflight until he discovered, by February 1909, the reaction propulsion by rocket as a possible solution. Prior to this time, he had considered everything from centrifugal force to magnetic repulsion to guns a là Jules Verne as potential forms of space propulsion, yet his analyses of each method showed fundamental flaws. By contrast, he came to realize that reaction propulsion should theoretically work in the vacuum of space as it does on Earth. The rocket also carries its own oxygen in its oxidizer for combustion. But for centuries, up to his own time, the rocket was a very weak device propelled by gunpowder and had been used for little more than a festive firework or occasional weapon. Goddard also knew from his calculations that liquid oxygen and liquid hydrogen was the best possible propellant combination for lightness and maximum energy output but cryogenic technology was in its embryonic stage. But he could ill afford to financially undertake any experimentation. As early as 9 February of the same year, he made his first effort. Basically, he attempted to "determine the efficiency of a few grams each of two gunpowder rocket mixtures" by placing them in glass tubes with small mouths" then measure the "reactive force" and duration of each. Needless to say, this crude experiment ended in failure. One tube broke and the other was left with a brownish residue, besides filling up his school's physics lab with smoke. It was not until six years later that Goddard again took up experimentation. By that time he had advanced further in his education and was resolved to be more systematic.[2]

In pursuit of his lifelong goal, in 1910 Goddard had obtained a master's degree in physics from the Worcester Polytechnic Institute in his hometown. In 1911 he earned a doctorate from Clark University, also in Worcester. He became an instructor of physics at Clark, and later a professor and head of the Physics Department. In February 1915, Goddard resumed his rocketry experiments and continued them for the next 30 years until his death in 1945. Steadily progressing from gunpowder to more powerful smokeless propellants and using steel rocket cases and nozzles for greater efficiency, he finally switched from solid to liquid fuel systems in January 1920. For expediency's sake, he chose the combination of liquid oxygen and gasoline because of their availability and low cost. As is also well known, on 16 March 1926, Goddard flew the world's first liquid pro-

pellant rocket. However, he was prone to secrecy and rarely revealed his spaceflight goals in public. One reason was his deep-seated Yankee attitude about protecting original inventions or discoveries by patents, and then scrupulously guarding them before the invention was "ready." On a practical level, he felt at the time that it was not appropriate for an academic to espouse the topic of spaceflight. More important, if he were to do so it might spoil his chances of gaining financial support for the work. Goddard thus mainly chose to confine his spaceflight theories to his notebooks and focus on the rocket as an ideal way to explore the upper atmosphere, beyond altitudes reached by ordinary sounding balloons, or 20 mi (32 km). In effect, he advocated the development of the world's first upper-atmospheric, or sounding, rockets.[3]

In need of financial aid to pursue his expensive experiments, he wrote to the Smithsonian Institution on 27 September 1916, which resulted in a grant of $5,000 to conduct his research. This research led to his now famous treatise *A Method of Reaching Extreme Altitudes*, published by the Smithsonian in 1919. The release of *A Method* in January 1920 resulted in unexpected and undesirable results. Apart from details of his work with steel-cased solid propellant (nitroglycerine-nitrocellulose or "double-base") rockets with nozzles, which were vast improvements over centuries-old gunpowder rocket technology, he dared include a theoretical speculation on the possibility of an unmanned, multistage solid fuel to the Moon. Newspapers across the country sensationalized this concept. Overnight, Goddard became known as the "Moon professor," with the bulk of the press accounts of his work greatly distorted. Even volunteers came forward and offered to accompany him to the Moon in his "Moon rocket," or to Mars. The serious-minded Goddard was bewildered and annoyed by this sudden attention. As a result, he became more secretive and wary of the press but persisted with his experiments. On 17 July 1929, he launched his fourth rocket flight. It reached the highest altitude he had obtained thus far—90 ft (27 m)—but its appearance was "bright and noisy" and ended with a terrific thud. The local populace thought an airplane had crashed. Others thought it was a meteor. Ambulances were summoned. Once more, Goddard found himself the center of attention in the press, some of the papers declaring that his "Moon rocket" had exploded.[4]

Lindbergh Enters the Picture

The story spread also to magazine accounts. One was *Popular Science Monthly* for October 1929. "Aims Rocket at Roof of Sky," ran the headline, followed by the subhead, "Goddard Tests New Missile to Explore the Upper Air for Science." After sketching a description of the alleged explosion and Goddard's

work, *Popular Science* magazine explained that "In the course of his experiments, there have been persistent reports that Goddard planned to shoot a rocket to the Moon . . . Professor Goddard never has denied that his invention might prove practicable." Carol Guggenheim, wife of Harry Guggenheim, a close friend of Charles A. Lindbergh, brought the *Popular Science* article to Lindbergh's attention during one of his visits to the Guggenheim home, known as Falaise, on Long Island, New York. This was apparently during one morning in mid-November. The three were relaxing in the spacious living room, Carol seated on a sofa by the fireplace. "Listen to this!" she suddenly announced. Carol then read the article aloud. Lindbergh was fascinated. He too had contemplated the rocket for spaceflight, but mainly its applications to aviation. Lindbergh was totally unaware of Goddard before this time, much less of the 1920 wave of Goddard publicity. During that period, 19-year-old Lindbergh was working on his father's farm at Little Falls, Wisconsin, far removed from metropolitan newspapers reporting on "the Moon Professor."[5]

According to one of Lindbergh's own accounts, his thoughts on rocketry for space travel and aviation alluded to above occurred a year earlier, in 1928 during a survey flight he made between New York and St. Louis. In another version, told to Milton Lomask, this event occurred in 1929. If the flight did occur in the former year, it may have been one of his route survey missions he was making for Transcontinental Air Transport, Inc. He says he was flying a Ryan monoplane, but not the *Spirit of St. Louis* which was by then [by 1928] on exhibit in the Smithsonian Institution. He was referring to the commercial version of the *Spirit of St. Louis*, a Ryan Brougham monoplane fitted with a Wright J-5 Whirlwind 220-hp engine and capable of a cruising speed of 85 mph (136 km/hr). In this version, he wrote that: "At an 85 mile [136 km] air speed, and bucking a fairly strong wind, I had plenty of time to think. I began considering man's accomplishments in travel. The wheel had given him conquest of the land; the hull, the sea; and the wings, the air. Only space was left. Could man ever enter space? If so, obviously we would have to overcome the need for wings and the limitations of propellers. Some form of inertial reaction would be essential for power. I immediately thought of rockets." In the account in Lomask, the description is essentially the same with only the year given differently, as 1929, and without mention of which plane he flew.[6]

"My only contact with rockets," Lindbergh went on, "related to the Fourth-of-July, and shooting rockets into the air when I was a boy. How much fuel could a rocket carry? What range would it achieve? Could rockets be used to increase the speed and altitudes of airplanes? From whom could I obtain answers to such questions? On that flight, I decided to look into the potentialities of rockets, and

that my first approach would be to the Du Pont Company. Since the Du Pont Company manufactured chemicals and explosives, and was among the largest in the world, I felt that its scientists and engineers would be able to supply the basic information I wanted."[7]

In another of his accounts of these events, in his *Autobiography of Values*, Lindbergh remembered some details somewhat differently. He said it was only after "many months" after the survey flight that he thought of approaching Du Pont. Before thinking of them, "wherever opportunity arose, I inquired about rockets, but was unsuccessful. Finally, I decide to ask . . . Du Pont . . . with its century and more of experience in making chemicals and explosives." (Historically, Eleuthère Du Pont de Némours established his explosives manufactory earlier, in 1802, in Wilmington, Delaware.) Lindbergh also decided that a "pragmatic approach" was needed in order to give the Du Pont engineers something specific to go on. His concept was the use of the rocket in aviation emergencies, specifically in the event of engine failure, a rocket activated by the pilot to provide emergency power for a safe landing. Unbeknown to Lindbergh, the concept was not entirely original, but still novel for the time. (In *Autobiography of Values*, Lindbergh said he came up with this idea as a project "that could precede piloted rocket flight . . . I wanted to start those trained and brilliant minds thinking in terms of jet-rocket propulsion.")[8]

A telegram exists, dated 18 October 1929, from Henry B. Du Pont to Lindbergh showing that they were in communication by that late date, so it is possible that Lindbergh really did think of rockets in that year rather than 1928. It is also interesting to note that on 10 September 1929, he did fly nonstop between St. Louis and New York, although that flight departed *from* New York and headed west. On the other hand, the flight was not made with his Ryan Brougham. Thus, there may be additional errors of recollection on Lindbergh's part, and he might have contacted the Du Pont Company not long after his St. Louis–New York flight of 10 September *1929*, not 1928. For now, this aspect of the background of the Lindbergh–Goddard connection must remain a mystery. At any rate, Du Pont told Lindbergh he would "be back in Wilmington early next week and will get in touch with you then." Whether this appointment was kept is not known but a follow-up letter from Du Pont to Lindbergh of 23 October shows Du Pont was still difficult to reach. "As I have been out of town for the past week," he wrote Lindbergh. "I have not been able to get in touch with you sooner in regard to the matter we discussed." Du Pont was able to finally inform Lindbergh that "The Du Pont Company is making a preliminary study of the possibility of using an explosive, as an emergency propellant for airplanes. Our Dr. [Charles M. A.] Stine has assigned a ballistic engineer and a physicist to look into this. Would it be possi-

ble for you to come down here in a few days, in order to confer with Dr. Stine and his assistants?"[9]

Stine asked G. Harvey Cameron of Du Pont's Experimental Station to "look into the possibility of using one or more rockets to help get a three-motored aeroplane [*sic*] safely into the air when one of the engines fails." Cameron made the calculations, but they were based on a rocket driven by gunpowder. Also taken into account were the examples of the daring, if unscientific rocket car and airplane experiments made in Germany by the automobile magnate Fritz von Opel during 1928–1929. (Why Cameron and his colleagues at Du Pont failed to cite Goddard's work is unknown. No doubt it was partly because Goddard's *Method of Reaching Extreme Altitudes,* published in 1919, was long out of print. Another likely reason was that since that period, Goddard had kept his rocketry activities largely hidden from the press, especially his work with liquid propellants.) Cameron concluded that the calculations "seem to indicate that the scheme is sufficiently promising to warrant further investigation" and that such a rocket would weigh 150 lb (67.5 kg).[10]

According to Lindbergh in his *Autobiography of Values,* he was asked to attend a meeting at Du Pont and flew his own plane to Wilmington. (In his letter to Durant he says he was the one who requested the meeting.) This was held on 1 November. About 20 of the company's engineers and other officials were present, including Stine, Cameron, and Alexis Felix Du Pont. Lindbergh does not mention whether Cameron's hopeful letter was discussed. On the contrary, the most outstanding thing he remembered was "a general shaking of heads" by the Du Pont people. "Rockets were too inefficient to be used as power plants for aircraft. The weight of fuel consumed would be immense." In short, the conference produced "completely negative results." Some time after the meeting they sent him a report which stated that "to equal the thrust of a 500 horse power [aircraft] engine for one minute would require about 400 pounds [180 kg] of black powder, [and] that the powder would have to be burned in a firebrick-lined combustion chamber." "It was doubtful," he went on, that their engineers believed, "that even a fire-brick lined chamber could withstand the heat of combustion of 400 pounds [180 kg] of black powder in one minute." "The Du Pont report was so discouraging," he concluded, "that, while I did not abandon all hope, I took on further action in regard to rockets." This was until Carol Guggenheim read aloud the article on Goddard.[11]

The "firebrick" report has not been found. Perhaps the term "firebrick" was only an oral mention that Lindbergh remembered. But the Cameron letter of 29 October cited above, and dated before the meeting, does mention the figure of 400 H.P. for the plane's engine. Curiously, there also exists a follow-up letter by

Stine, dated 6 November, in which there are mentions of a "metallic envelope" as a possible rocket chamber. In addition, Stine quoted from a piece appearing in the *Literary Digest* of 26 October 1929 which clearly mentions the possibilities of liquid propellant rocket fuel. Stine also enclosed a clipping from the *New York Times* of 3 November 1929 and a typed copy of an item in the British magazine *Nature* for 19 October 1929, both of which likewise reported promising new rocket experiments in Germany suggesting they were using liquid fuels. Lindbergh does not mention this letter from Stine in his recollections, and it is difficult to assess what his reaction might have been. Whatever really happened, Lindbergh did not fully find the answers he sought. It may also be possible that Lindbergh never saw this letter.[12]

Lindbergh Meets Goddard

Shortly after learning of Goddard from the *Popular Science* piece, Lindbergh "inquired about Goddard's reputation." He queried C. Fayette Taylor, president of the Massachusetts Institute of Technology (MIT). "On finding that he [Goddard] was indeed not a showman but a respected university physicist," Lindbergh continued, "I telephoned to arrange for a meeting at Worcester, Massachusetts." This call was made on the morning or afternoon of 22 November. Meanwhile, on the same day, at Cambridge, Massachusetts, Taylor, of MIT's Department of Aeronautical Engineering, had already written the following letter to Goddard: "At a meeting the other day of people interested in aviation, Colonel Charles A. Lindbergh expressed an interest in the work on rocket propulsion which you are said to be doing. He asked me if there was a possibility that he could get in touch with you and perhaps arrange for a visit to your laboratory at Worcester and a talk with you." Thus, one way or the other, Lindbergh was determined to meet Goddard. Following the call made from the most famous aviator in the world, Goddard informed his wife, Esther. Her startled reaction was: "Of course, Bob. And I had tea with Marie, the Queen of Rumania."[13]

Lindbergh's visit was made the next day. He drove up in his Franklin automobile from New York, arriving at 4:00. Goddard gave him a tour of his laboratory then went to his home where they sat on the porch and talked. Shortly after, Goddard sent a full report of the events to Charles G. Abbot of the Smithsonian. (The original $5,000 Smithsonian grant, from the Hodgkins Fund, lasted from 1917–1924. After this, he was able to get an additional, although smaller, Smithsonian grant from their Cottrell Fund and covered his work from 1924–1930 so that the Smithsonian was still his main sponsor by this time but the money was soon to run out.) Lindbergh's purpose, Goddard informed Abbot, was

to pursue his idea of applying the rocket to planes as a safety device. When Lindbergh gave him an idea of the power he needed, Goddard responded that this could be easily furnished with either a solid or liquid propellant. It thus appears the articles sent to Lindbergh on 6 November by Charles Stine of Du Pont, suggesting liquid fuels, had not made an impression and Lindbergh was surprised at Goddard's progress along these lines. Again, it may be that Lindbergh never read Stine's letter or that the articles were too vague for him until he was able to witness Goddard's actual progress with liquids.[14]

However, "Possibly what impressed me most," Lindbergh later recounted, "was Goddard's statement that he was using one thirty-second inch duralumin for the walls of his combustion chamber—not firebrick [as allegedly suggested by the Du Pont engineers]. I was also impressed by the fact that he was using liquid fuel, not black powder." According to Goddard's report to Abbot, Lindbergh was now convinced liquids would be superior but recognized their development would take longer and require greater funding. Lindbergh further believed the Du Pont Company might be willing "to contribute very substantial support if the applications to aircraft could be made clear." He would get back to Goddard if a meeting could be set up at Du Pont.[15]

Nothing is said, either in Lindbergh's writings or Goddard's, as to their personal impressions of each other in their first meeting, nor what else they discussed. Certainly for Goddard, Lindbergh's great accomplishments, his personality, and even minutia of his personal life were already highly publicized in the press and newsreels. For Lindbergh, Goddard was more of the mystery man, although it was clear he was a highly respected member of academia. From the available evidence, their meeting was businesslike yet they instantly took to each other and formed both a professional bond and friendship for life. Although Goddard was 20 years Lindbergh's senior, the two had remarkable similarities that we may briefly summarize.

Above all, each of the men were visionaries, driven, yet loners. Both were very reserved by nature and craved solitude. Of the two, Lindbergh, at first reluctantly, was the more willing to become a more public figure for his own cause—the progress of aviation—than was Goddard in his personal quest to advance the progress of astronautics. But both shared an unshakeable personal sense of destiny and even immortality in their roles for their respective causes. Both were lovers of science and mechanics, although later in life Lindbergh became more devoted to ecological and related issues. Both may have realized fairly early that they had much in common in their personal lives. Each was born in or near big eastern cities, Lindbergh in Detroit, Goddard in Worcester, a sizeable town close to Boston, where Goddard spent much of his youth. Yet both loved the stark wil-

derness, Goddard later settling in the New Mexico desert, and Lindbergh in any number of places from the remote Brittany coast to corners of untouched Hawaii and the Philippines. Both, for different reasons, disdained the press, and both were their own, strong-willed men. Each, in a sense, was an only child. Goddard had a younger brother, but the sibling died in infancy; Lindbergh had estranged stepsisters. Curiously, both had a Swedish connection, Lindbergh from his forebears, Goddard from his wife's family. It is not within the scope of this article to delineate further similarities except to add one. Both had a strong sense of patriotism. During wartime, Goddard and Lindbergh served their country. Goddard worked on rocketry for the Navy, Lindbergh on aviation for use by the Army Air Corps.[16]

Characteristically, Goddard did not reveal the ultimate aim of his rocket research to Lindbergh at their initial meeting. Indeed, in Goddard's view it would have been inappropriate. Lindbergh could only say that "Goddard believed . . . rockets had a future." "I did not realize until later," Lindbergh added, "how conservative he was in the estimates he gave me. I asked what altitudes he thought a rocket could achieve. He replied that he thought it would be practical to build a rocket that could carry scientific instruments to an altitude of seventy five miles [120 km], and that such an altitude would permit taking scientific observations not possible with airplanes or balloons. I wanted to sound Goddard out in regard to his ideas of ever getting into space . . . He replied that theoretically it would be possible to build a multistage rocket capable of reaching the Moon . . . But, he added with a smile, it might cost a million dollars." "In 1929," Lindbergh wrote in his *Autobiography*, "a million dollars seemed an astronomical figure, far too much to invest in rocketry."[17]

"I was tremendously impressed with Goddard," Lindbergh remembered, "his accomplishments, his knowledge, and his confidence in the future of rocket flight . . . even though his experiments with rockets were regarded with skepticism and some amusement. I asked him what support he needed to carry on his research . . . He told me he had about reached the end of his funds for research, and about the restrictions that had been placed on his rocket launchings in Massachusetts." (By "restrictions," Goddard meant that after the rocket flight of 17 July, he found it necessary to continue his work in a less populated area.) Goddard replied more directly to Lindbergh's question on the funding. He told the young aviator that "what he really would like would be twenty-five thousand dollars a year for four years. With such an amount, he said, he could set up a laboratory and launching tower somewhere in the west where he wouldn't have to worry about neighbors' complaints and police restrictions. He could then accom-

plish in four years . . . what might otherwise take him a lifetime . . . I decided to try to help Goddard get their financial support."[18]

Still very much lionized by the public, Lindbergh's every move was watched intently by the press. The *Worcester Sunday Telegram* ran a bold banner headline on Lindbergh's first visit but exasperatingly provided no details. "Col. Charles A. Lindbergh," they said, "came to Worcester unheralded and visited for several hours Prof. Robert H. Goddard . . . whose scientific experiments with rockets have caused much discussion throughout the world. The nature of the Colonel's visit could not be learned." Goddard was questioned by the paper, but he was typically evasive. "It was merely a friendly call," he said, and "We did not discuss any scientific subjects." An additional story in the *Telegram* three days later, but datelined from Washington, speculated that Lindbergh's sudden interest in rocketry might have something to do with aviation, but they were not sure how.[19]

Meanwhile, on 26 November, Lindbergh called Goddard again. This time he requested him to meet Henry Du Pont the next morning, in his office at Wilmington. Goddard accordingly visited "another of the Du Ponts [probably Felix], who said that the rocket application to aircraft had been turned over to them." He then met Henry Du Pont and went to his home where Lindbergh was present. The emphasis was now on looking "into the question of rockets using liquid oxygen." The Du Pont assistants bombarded Goddard with numerous questions on the technical aspects of his liquid fuel rocketry and took notes. This brought out Goddard's secretive and suspicious nature, but as later revealed to Lindbergh, he had his own motives. "I realized soon," Goddard reported to Abbot, "that the object of this questioning was not to determine what could be done on airplanes as to find out every last detail of the rocket I have developed during the last nine years." "After I saw this I evaded further questions as to these constructional details as much as possible. Even at that, I said more than I wish I had." "Colonel Lindbergh," Goddard added, "remained, for the most part, silent."[20]

Goddard flew back to New York with Lindbergh, Goddard's first plane ride. They had a long talk in which Goddard divulged the motives for his guardedness toward the Du Ponts. Both men agreed that the Du Pont people "did not have the right attitude toward the work" and appeared more interested in "immediate developments" rather than long term research. Lindbergh himself well understood Goddard's desire for more scientific support of the research and posed his own alternative, the Carnegie Institution, "a well-endowed scientific organization," of which he was a trustee. Afterward, Goddard wrote that "Colonel Lindbergh . . . impressed me very favorably throughout these events, and I believe he is a keen-minded young man." As Lindbergh later remembered the af-

fair, "I thought the Du Pont scientists and engineers would be deeply impressed . . . The Du Pont Company could easily appropriate twenty-five thousand dollars a year for further research in such a fascinating and little known field. But the Goddard–Du Pont meeting was unproductive. Du Pont . . . seemed only moderately interested, and Goddard seemed quite reticent about his ideas and the details of his work." On returning, Goddard himself wrote to Henry Du Pont and thanked him for the loan of his winter flying suit. "It was so cold," he said, "that I do not know what I should have done without it, but as it was it made the trip to New York perfect." "I am sorry," he added, "to have been uncommunicative regarding the work I am carrying on, but I have made it a practice to do this, to protect myself."[21]

Lindbergh was as good as his word and immediately contacted the president of the Carnegie Institution, Dr. John C. Merriam, and told him about Goddard's work. Merriam's reaction was positive. He even suggested to Abbot that $100,000 or more should be made available for the research. On 5 December, Merriam wrote directly to Goddard inviting him to a meeting on the 10th at the Carnegie in Washington to discuss the support. Present were, besides Merriam and Goddard: Lindbergh; Abbot of the Smithsonian; Charles F. Marvin, chief of the U.S. Weather Bureau, who was interested in the rocket for gathering meteorological data; Dr. John A. Fleming of Carnegie's Department of Terrestrial Magnetism; and Drs. Walter S. Adams and Harold D. Babcock of the Mount Wilson Observatory, both of whom were interested in the potentials of the rocket for astronomical or upper atmospheric observations. Merriam opened the conference by relating how Lindbergh had brought the subject to his attention. Lindbergh then described his own interest and how rocketry could benefit both aviation and study of the atmosphere. Next, Goddard gave a historical overview of his progress thus far. He was followed by Abbot who spoke briefly but had to leave for another appointment. The distinguished visitors then stated their own interests in the work. Adams suggested that the rocket could make a spectrogram of the Sun, take air samples at various heights, and investigate cosmic rays. Fleming thought of making investigations of the still unexplored Kennelly–Heaviside layer of the upper atmosphere while Babcock proposed solar corona photos. Merriam concluded that the rocket could "open up a new world" hitherto uninvestigated.[22]

All in all, it was a constructive and highly optimistic meeting with farsighted ideas that contrasted greatly with the nonproductive Du Pont gathering weeks before. Long range budgets were considered. The upshot was an approval of a $5,000 grant from the Carnegie, announced to Goddard on 19 December by Merriam. Goddard was very grateful but inquired "whether this grant is a part of

the larger support which we discussed." Merriam replied that this amount "should be part of the larger sum and is in a sense a beginning." By 1 May 1930, the last $500 installment of the original Smithsonian grant of $5,000 was sent and fully used up by the end of the month. Goddard had wisely decided not to accept the Carnegie money until the last penny of the Smithsonian bequest was spent thus assuring the survival of the research a little longer. But during the same week, Lindbergh telephoned again and enticingly told Goddard he might hear from him shortly "regarding . . . larger support." The next day, 29 May, Lindbergh called once more, this time telling Goddard "about Daniel Guggenheim."[23]

Enter, the Guggenheims

Charles Lindbergh had first briefly met Harry Guggenheim, scion of the multimillionaire Guggenheim family, at Curtiss Field, Long Island, on 20 May 1927, just before takeoff in the *Spirit of St. Louis* for his epoch nonstop flight to Paris. Harry was one of the many prominent well-wishers and himself had trained as a naval aviator during World War I. The Guggenheim family descended from Meyer Guggenheim of Switzerland who immigrated to America at age 19 in 1847. Meyer did exceptionally well as an importer of Swiss embroidery, then invested his money in copper mining in Colorado. By the turn of the century, he and his sons took ownership of the American Smelting and Refining Company. The Guggenheims became enormously wealthy, yet were outstanding philanthropists and patrons of the arts and sciences. One son, Daniel, vastly extended Guggenheim fortunes into Alaskan gold mines, Bolivian tin mines, and nitrate deposits in Chile. In 1926 this son founded the Daniel Guggenheim Foundation for the Promotion of Aeronautics. Soon after Lindbergh's solo flight to Paris, this fund financed the aviator's highly successful U.S. and Latin American goodwill tours for stimulating "popular interest in the use of air transport."[24]

Lindbergh did not think of approaching the Guggenheims earlier in seeking support for Goddard because, in his words, he "did not like to go to my friends for money, and by that time my friendship with the Guggenheim family was quite close . . . My increasing belief in the future of rockets finally overcame my hesitancy to approach Daniel Guggenheim for Goddard backing. First, I asked his son, Harry, who had directed the Daniel Guggenheim Fund for the Promotion of Aeronautics . . . if he thought it would be all right for me to talk to his father about Goddard. Harry replied that of course it would be all right." (Lomask and other sources say that Lindbergh first wrote to Harry, then ambassador to Cuba if it would be alright to ask his father about financial support for Goddard and Harry is said to have "replied promptly, telling him to go ahead." Thus far, this

alleged letter has not been found. Soon after, Lindbergh visited "Mr. Dan," as he was called, at his home at Hempstead House, near Falaise. Years later, Lindbergh remembered the talk with Daniel as given in the letter to Durant: "Then you think that rockets have a future?" asked the elder Guggenheim. "One can't be certain," Lindbergh replied, "but if we advance beyond airplanes and propellers, we'll probably have to turn to rockets." "And this professor, you believe he is a pretty able man?" said Daniel. "I think he knows more about rockets than any other man in the country," responded Lindbergh. "How much money does he need?" Daniel asked. "He would like to have twenty-five thousand dollars a year over a four year period," Lindbergh boldly said. "Do you think it's worth my investing a hundred thousand dollars in this project?" Guggenheim shot back. "Well, it's taking a chance but—yes, I think it's worth it," Lindbergh answered. "All right, I'll give it to him." Lindbergh's version of this same conversation given in his *Autobiography of Values* is almost identical and mainly differs in Guggenheim's added statement at the conclusion that "We'll want an advisory committee. Of course you'll [Lindbergh] be on that." The entire exchange, Lindbergh also said, took less than 10 minutes, but it changed Goddard's entire life.[25]

On 28 May 1930, Lindbergh lunched with Merriam and Colonel Henry Breckinridge, Guggenheim's attorney who had also been President Woodrow Wilson's assistant secretary of war. They spoke at length on the subject of Goddard and no doubt already received word of the elder Guggenheim's wonderful offer. Lindbergh phoned Goddard on 5 June and invited him to come to New York to speak with Breckinridge directly. The following day, Goddard, accompanied by President Wallace W. Atwood, president of Clark University, and his wife, Mary Atwood, drove to New York and saw Breckinridge and Lindbergh in the afternoon. Just a few days later, on 12 June, the word became official. Daniel Guggenheim informed Goddard, through Atwood, that it was his (Guggenheim's) "pleasure in offering twenty-five thousands dollars a year for two years" for Goddard's work on rockets for reaching high altitudes. If "the results warrant further expenditure," he added, "I should be glad to give twenty-five thousand dollars per year for two more years." Thus, for legal reasons, Guggenheim had offered the money to Goddard's employer, Clark University, with the stipulation that the university was to be the administrator and the money "applied to the prosecution of Dr. Goddard's experimentation." On 13 June, Atwood replied to Guggenheim that "The University accepts with gratitude your offer and with your permission will establish on its records the Daniel Guggenheim Fund for Measurement and Investigation of High Altitudes."[26]

The advisory committee for the latter was to consist of: Merriam, Abbot, Adams, Atwood, Breckinridge, Fleming, Lindbergh, Marvin, and Dr. Robert A.

Millikan, director, Physics Laboratories, California Institute of Technology. As early as 23 June, Guggenheim already sent Atwood the first check of $25,000. It is likely that Merriam at Carnegie would have done everything to continue funding Goddard beyond the $5,000 already promised from Carnegie, but the surprising Guggenheim developments rapidly overtook these events and there was no need to pursue the Carnegie path any further. (The Carnegie grant, which was shortly forthcoming, was thus used in 1930 along with the initial Guggenheim grant.)[27]

Now that the money was literally in hand, the next question was: where would Goddard conduct his research? As pointed out by Lomask, contrary to popular belief, after the publicity generated by his 17 July 1929 rocket flight, neither the Massachusetts state or local fire inspector banned him from further tests. Rather, the inspector's investigation found that the "substances used in his experiments are non-explosive in themselves." But as Goddard told Abbot, it would be "necessary to limit the landing of the rocket to the plot of ground on which we have been working." Put another way, he had to undertake the experiments away from a populated area. Goddard thus sought a suitable "location from which trespassers can be barred." He succeeded in finding Camp (later Fort) Devens, a military reservation about 25 mi (40 km) north of Worcester, near Ayer Junction. With Abbot's help, he secured permission to use a portion of the land from the War Department. He resumed his experiments here on 3 December 1929, although there were no flights. This site was not entirely satisfactory for a number of reasons. It was distant from his "laboratory" near Worcester, heavily wooded, and there had been thefts of his equipment. Beyond this, there were noise complaints. But the Guggenheim grant presented the option of choosing the best possible location. His preference had always been out West to a more remote place and where he could enjoy launch weather the year around. Goddard talked over the matter with Lindbergh in New York. At first they thought of the Great Plains region, then dismissed it "owing to winds and dusts." Goddard next spoke with Dr. Charles F. Brooks, professor of meteorology at Clark University, who examined climatic and topographical maps. Brooks came up with Roswell, New Mexico. On 15 July, Goddard and Esther departed by car from Worcester to check it out for themselves, and had already made the U.S. Weather Bureau at Roswell their forwarding address because they intended to explore from there if the place was not suitable. They arrived by the 25th and were much taken with the area and decided to stay. "The country surrounding here," wrote Goddard to George Crompton, a Worcester friend, seems ideal for our work." Hence, through the help of successive Guggenheim grants, Roswell remained Goddard's base of rocket research until 1942. (The launch site itself, with its tower he had brought

from Massachusetts, was on the Corn Ranch in Eden Valley 13 miles, or 21 km away.) There was only one slight break, during 1932–1934, in which the Guggenheim grants temporarily ceased due to the Great Depression. During that interval, Goddard went back to Massachusetts in July 1932 then returned to Roswell in September 1934. (During that period Goddard resumed full-time teaching at Clark University and carried out tests that did not require flights.) At first, the Goddards rented the spacious adobe house on the Mescalero Ranch 3 mi (4.8 km) northeast of Roswell and used an adjacent workshop as his laboratory, then later purchased the house.[28]

The Roswell years of Goddard's rocketry experimentation were his happiest and most fruitful. His accomplishments there have been covered in detail by the lead author and others. From 1926–1929, Goddard made four flights while at Roswell; he conducted 103 static tests and had 31 successful flights out of 48 attempts. His flight vehicles were as large as 22 ft (6.7 m) long and 18 in (46 cm) in diameter. Thrusts ranged from 289 lb (131 kg) to 985 lb (447 kg). With the help of a handful of assistants, Goddard designed and built gas generators, turbine-powered centrifugal rocket pumps, gyro-stabilization systems featuring retractable air vanes, and jet deflector vanes. His rockets reached flight velocities of 500 mph (800 km/hr) and altitudes of more than 8,250 ft (2,515 m).[29]

The Lindbergh Visits to Roswell

Despite the fact that Lindbergh made Roswell possible for Goddard, he paid only three visits but, according to his *Autobiography of Values,* "I was never lucky enough to see a successful rocket ascent. Something always went wrong in spite of detailed preparations." The visits were conducted from 15–16 September 1934; 22–25 September 1935; and 10–11 May 1939. During the first, as Goddard tersely noted in his diary entry for Saturday, 15 September 1934, "Col. and Mrs. Lindbergh called in afternoon. Took them out to the tower, and had supper at the Nickson [Hotel]." The following day, he recorded he "Flew with Col. Lindbergh around the tower, and landed there and looked things over. E. [his wife Esther Goddard] flew with him, also." Elsewhere, in a letter to James C. O'Neil, a reporter for the *Worcester Telegram*, he noted: "The visit of Colonel and Mrs. Lindbergh was quite unexpected. They dropped in for a short time on one of his tours of inspection, and there was not much to show him, as the place had been opened only a few days before." Although nothing had happened, Roswell made much of the visit of the world-famous flyer. The *Roswell Dispatch* ran a banner headline. Several hundred visitors met him at the local airport, then situated right in the city and about a thousand saw them off. Years later, Anne Morrow Lind-

bergh, wrote, "I never saw a launching, but I remember an evening sitting on a screened porch, while my husband and this quite intense professor talked of space exploration."[30]

On the second visit, 22–25 September 1935, made almost exactly a year later, Lindbergh was accompanied by Harry Guggenheim. This time Goddard was anxious to show them a real flight. (Anne was not with them, and Daniel Guggenheim had died in late September 1930. The grants were continued by his widow, Florence.) In preparation for the visit, Goddard had large canvases thrown on equipment on the cacti-desert ground at his launch site, around the base of the tower. "Strangers," reported the *New York Times*, were halted more than 200 yards [180 m] from the 60-foot [18 m] high rocket tower." His guests arrived on Sunday, the 22nd, at 11:00 a.m. (although the *Roswell Daily Record* reported they landed at 12:30), Lindbergh flying a small Lambert monocoupe, probably his D 145 model. Goddard showed them his shop and two 9-in (22.5 cm) diameter flight test rockets, a rocket meant for static tests, his photo lab, and a small centrifugal pump. On the following morning, 23 September, they went out to the tower early, accompanied by Goddard's assistants Albert W. Kisk, his brother-in-law, and Nils T. Ljungquist. By 9:00 a.m. test A11 was attempted. According to Goddard, "On making the test, a flame showing excess gasoline appeared in the concrete gas deflector, occasionally rising up toward the nozzle but not reaching it. This flame lasted during the entire run of 10 to 15 sec." As Lindbergh put it in his *Autobiography of Values,* "For me [and Guggenheim], there was only a puff of smoke and a fire." Goddard's notes explained what went wrong: "Apparently the oxygen gas, which during the filling of the oxygen tank passed down through the chamber, had caused premature burning of the string holding the igniter in the chamber before the run. After ignition, the propelling charge burned entirely outside the rocket." At some point during the morning, a reporter from the *Roswell Daily Record* arrived and was motioned to stop about 100 yd (90 m) from the tower by Goddard himself. Goddard would give no more information than he had already given on Sunday and said that "only routine work was being done" and could not say "when it was anticipated to send up a rocket." The reporter also observed that Lindbergh was walking "near the base of the tower wearing a light suit blue shirt." Neither Lindbergh nor Guggenheim wished to be interviewed.[31]

Undaunted by the lack of a flight, Goddard wanted to try again the next day. But he noted in his diary, "Weather too poor to go out to tower in morning." However, on the following morning, 25 September, he made another try, his men getting up at 4:30 a.m. to prepare everything at the tower. According to his diary, he "Went out to tower with E. [Esther], Col. Lindbergh, and Mr. Guggenheim in

morning." Test A12 was started at 9:00 or 9:30. Things looked promising. "The flame," Goddard later wrote, "was very white from the start and lift was soon indicated. On pressing the key, the rocket was released, but did not rise, and at the same time or soon afterward, the chamber burned through . . . Apparently, the equalizer must have functioned improperly, although it was tested beforehand." A post-mortem examination showed there had been an excess of oxygen, which had made the flame "whiter and noisier than usual," that resulted in chamber burnout. Two hours after the test, Goddard saw Guggenheim and Lindbergh off at the airport. They left at 11:45 under clear skies, reported the *Daily Record,* and on his departure Lindbergh dipped the plane in salute to Goddard and circled the rocket tower twice. When later questioned by the *Roswell Dispatch* reporter, Goddard offered no details, especially as to when he would next make a successful flight. "Statements as to hopes or expectations are 'bad luck,'" he said, "and I'd rather show results afterwards." He could also offer a sports analogy: "Expectations in experimental work are a lot like football. In the final moment before the finish, something can happen that will change the whole expected result." For his part, Guggenheim issued a statement to the *Daily Record* that "in view of the successful results so far achieved in the high-altitude rocket the Daniel and Florence Guggenheim Foundation would continue to finance the work . . . The object of this work is to obtain meteorological, astronomical, magnetic, and other data at altitudes greatly exceeding those . . . reached by balloons."[32]

Undeniably, both failures during Lindbergh and Guggenheim's visit were great disappointments to all, especially since Goddard had achieved 11 flights at Roswell since his arrival in 1930. The last, on 12 July 1935, was especially impressive. The rocket reached some 6,600 ft (1,980 m), and Goddard's gyrostabilization system showed "excellent correction" up to 3,000 ft (900 m). Moreover, both Lindbergh and Harry Guggenheim had been encouraged by Goddard's written progress reports, besides photos and movies he showed them, for example, on his visit to Falaise back on 27 April. On that occasion, Lindbergh asked Goddard when his last paper was published. Goddard responded, "1920." Lindbergh wanted to know when the next paper would appear, to which the professor replied, "when important scientific results or impressive results were obtained, namely a height exceeding the range of sounding balloons [above 20 miles, or 32 km]." This was unsatisfactory to Lindbergh and at his urging and that of Guggenheim, Goddard produced another paper, "Rocket Flight." As cited above, "Rocket Flight" appeared as his second Smithsonian publication in the Smithsonian's *Miscellaneous Collections* for 16 March 1936, but it was thin, did not reveal much, and had nowhere near the impact of his classic *A Method of Reaching Extreme Altitudes* of 16 years earlier.[33]

Both Guggenheim and Lindbergh took the opportunity during this time to strongly suggest to Goddard "to have one of the complete rockets . . . placed in some institution where the disposition can be made a matter of record." Goddard reported this to Abbot and added: "It seems to me particularly fitting that the Smithsonian should eventually have such a rocket on exhibition, because of the help which it gave in the early stages of the work, when assistance was so important and . . . so difficult to obtain." Yet, at the same time, Goddard's reluctance to share or make his results known openly again came to the fore. He told Abbot bluntly, "It is not desirable to have it on exhibition for a time, in order to give me the opportunity of completing the work . . . before details of construction are made public." The rocket, evidently the same one he attempted to fly before Lindbergh and Guggenheim, was donated the following year as the first rocket to enter the collections of what became the National Air and Space Museum. (This rocket was later placed on exhibit at the Museum's Udvar–Hazy Center (near Dulles International Airport) that opened 17 December 2003. This same rocket had been on exhibit for the first time just a few years after Goddard's death. It was in 1947, with the consent of both Harry Guggenheim and Lindbergh, as an advisor to the fund, that the rocket was taken out for a Guggenheim-sponsored exhibit posthumously honoring Goddard. That exhibit first opened at the American Museum of Natural History in New York City on 21 April 1948.) Thus, despite Goddard's technical setbacks and the persistent secretiveness of their patron, there is no question that the Guggenheims and Lindbergh always displayed remarkable patience and faith in Goddard and his rocket. On 27 September 1935, just a couple of days after Guggenheim and Lindbergh had visited, the Goddards were thrilled to hear the "Time Marches On" radio feature over KSL, Salt Lake City. It was a presentation of Goddard and his work that concluded with the quote from Harry Guggenheim: "Acting on the recommendation of Col. Lindbergh, and in view of the success of your work so far, the [Guggenheim] Foundation will continue to support your work indefinitely." Arguably, the press regularly linked Lindbergh as a great supporter of Goddard and his rockets.[34]

Lindbergh's third and final visit to Roswell was made on 10–11 May 1939. This time, there were no rocket tests. Lindbergh was on a mission to survey U.S. air power for the Army. His visit in an Army P-36 Curtiss Hawk was to be just a stopover. According to Lindbergh's *Wartime Journals*, when he got to El Paso a dust storm was reported moving toward Roswell. "I planned on talking to Goddard for half an hour and then taking off for Midland [in Texas] before the storm arrived." Goddard's diary says he arrived at 3:30 p.m. Goddard was on the field "within fifteen minutes," Lindbergh continued, "and it soon became apparent that there were too many things to talk over to cover in half an hour. He asked me to

stay overnight." Then says Goddard in his own diary, they "Talked on the veranda . . . went to shop, and had a walk with him and E.[sther] to the Berrendo River. Had dinner, and talked over foreign letters, plan of work, pump tests, write-up of report books, and showed movies." Wrote Lindbergh in his own journal: "Mrs. Goddard's mother is visiting her—a fine old Scandinavian lady. We all had supper together. After supper Dr. Goddard showed me the latest motion pictures of his work and flights . . . Goddard has done good work and had a very successful year." On the following morning, Goddard took Lindbergh to the airport. The aviator took off at 8:57 a.m. Mountain Standard Time. Again, he treated Goddard to a flying salute as he had on his 1935 visit. As Goddard observed, he headed "to the tower and coming back over the airport, zooming down to about 20 feet [6 m] above the fence and then going upward at about 45 degrees." This turned out to be the last time Goddard and Lindbergh saw each other although they continued to correspond until 1940.[35]

The threat of war was in the air. Lindbergh's recent trips to Nazi Germany, reporting on the strength of the Luftwaffe, and his antiwar speaking activities during this period are well known. Lindbergh told Goddard what he had observed in Germany and added that when he brought up the subject of rockets, the Germans abruptly changed the subject. "Yes," Goddard is alleged by Lindbergh's biographer to have responded, "They [the Germans] must have plans for the rocket. When will our own people listen to reason?" Whether Goddard did really utter this statement is unknown, but he must have been frustrated over his own disappointment back in 1933 in failing to interest the Navy in pursuing rocket work. That date had been his last effort to approach the military. But from 1938, with the strong possibility of hostilities, coupled with Lindbergh's persuasive urgings and Goddard's own strong sense of patriotism, he again seriously looked at military possibilities. In his "Outline of a Ten-year Program on Rocket Development," written on 15 August 1938 (at the suggestion of Lindbergh made on 8 July), Goddard included potential military applications. These were primarily a continuation of his World War I work on solid (smokeless-powder) rockets as weapons that could "supplement . . . present day artillery."[36]

On 17 May 1939, a few days after Lindbergh's last visit, Goddard wrote to him and offered a review of the technical areas they had discussed. "If, as you have reason to believe, such propulsion is being developed for military purposes in Europe, we ought by all means to turn our efforts in this direction in this country, without delay . . . The work here . . . laid good groundwork for numerous applications . . . There appear to be three main lines of rocket development for military use: as a long-range projectile, as a rocket using atmospheric air on planes or gliders, and as a light artillery projectile." Goddard then went on to out-

line his military applications in more detail to Lindbergh. Lindbergh's comments on this summary are not recorded, and he may not have responded. His last correspondence with Goddard was on 19 July 1940 in which he thanked him for his quarterly report to the Guggenheim Foundation and added the following: "As you know, I have always felt that it would be advisable for the Army to cooperate in the development of jet propulsion for military purposes. I hope that the sudden awakening this country is going through in regard to our military backwardness will create a new attitude toward the research you have been carrying out." It turned out the Navy did gain an interest in his rocketry—but in none of the applications he had envisioned. Rather, on 24 December 1941, shortly after the bombing of Pearl Harbor on 7 December, which brought the United States into the war, Goddard signed a contract with the Navy to develop a throttleable or "variable thrust" liquid-fuel Jet-Assisted Take-Off (JATO) rocket. These were to be used for heavily loaded seaplanes, because the Navy contemplated using them to boost heavy bomb loads in the coming Pacific campaign. The idea of Goddard's development of JATOs for the Navy dated back much earlier, perhaps to April or May of 1940. But it so happened that the Navy had opened negotiations some months before Pearl Harbor and the contract was ready for Goddard's signature just shortly after the bombing. After a few months work on the JATOs at Roswell, Goddard finally left there on 4 July 1942 and moved to Annapolis, Maryland, where the tests of the seaplane fitted with the JATO were to take place. It was during the course of this work that Goddard died on 10 August 1945 at age 62 of throat cancer in the Johns Hopkins Hospital in Baltimore.[37]

Conclusion

We can only speculate why Lindbergh lost contact with Goddard after 1940. There may be several reasons. Mainly, it boiled down to his being extremely busy with his own war work, first with the Ford Motor Company in helping them effectively produce war planes. Earlier, he would have liked to have made more visits but was compelled to move to Europe in 1935 to avoid publicity, especially after the 1932 kidnapping and murder of his first child.

For certain, Lindbergh was for a long time a true believer in the promise of rocketry, although he gained another perspective by the end of the war. On 10 June 1945, exactly two months before Goddard died, Lindbergh encountered rockets again when he entered the underground German V-2 rocket factory of Nordhausen, in the Harz Mountains. It had been after the surrender of Hitler's Germany in early May that Lindbergh had been sent to Europe with a U.S. Navy mission to make a survey of Germany's wartime developments in high-speed

aircraft and other armaments. The visit included a gruesome tour of Camp Dora where slave laborers worked and died at the hands of their captors while building the V-2s. There were also V-2s in various stages of assembly. "There," he wrote in his *Autobiography*, "I began to realize the terrible effect that the missiles and explosives of science could have on our civilization. What a contrast it was to the scientific dreams I had listened to at the Goddard home in Worcester sixteen years before. World War II had placed a nightmare of time between me and the hours we spent together while he was carrying on his pioneering work."[38]

Regarding another aspect to the V-2s and Goddard—the key question of whether the Germans had learned from Goddard—Lindbergh came close to saying they did. "How the Nazi rockets reminded me of Professor Goddard's, blown up in size, and how deadly efficient they had grown!" Lindbergh continued. "How had the Germans jumped so quickly far ahead of Goddard's pioneering work? Partly because America [that is, Goddard] built rockets for scientific knowledge, at a tempo set for peace, while Germany developed them for war." Later, he also wrote: "A quarter-century ago Goddard financed by Guggenheim was pioneering the liquid-fuel that was developed for use against us a decade later, by [Wernher von] Braun, financed by Hitler." Lindbergh's biographer went further than his subject and repeated the often used quote alleged to have been made by a German "technical officer" to a U.S. interrogator in May 1945 when asked about the origin of the V-2. "Why don't you ask your own Dr. Goddard," was the supposed reply. On the question of Goddard's patents, von Braun stated it was "only in 1950, or thereabouts, approximately five years after my arrival in the United States that I first had an opportunity to see these patents. There is no question that many of the essential features of the V-2 are covered by Goddard patents, but they were used unknowingly." The notion of a German–Goddard connection is arguably the most persistent myth about Goddard. It is not within the scope of this article to delve into this, and other misconceptions about Goddard, except to say that the V-2 and Goddard's work appears to be a monumental case of parallel development. Goddard's own biographer admitted that: "Like many inventors . . . Goddard was reluctant to accept the possibility that inventions and ideas may proceed independently in many places, a point . . . advanced by the Germans." This, and related historical issues concerning this pioneer, requires further research and is now under study by the co-author of this paper, Frank H. Winter, toward a book on Goddard tentatively titled, *Lone Experimenter—An Assessment of the Accomplishments of Robert H. Goddard*.[39]

In conclusion, there is still much to unravel on Goddard's real impact on mainstream rocketry. We have concentrated on the Goddard–Lindbergh connection, especially of Goddard himself, who is still largely misunderstood despite

reams of words already written of him. Lindbergh's own faith in both the rocket and Goddard are undeniable. His belief could have not been put more poetically when he wrote the following in his *Autobiography of Values:* "When I see a rocket rising from its pad, I think of how the most fantastic dreams come true, of how dreams have formed into matter, and matter into dreams. Then I sense Goddard standing at my side, his human physical substance now ethereal, his dreams substantive. When I watched the fantastic launching of *Apollo 8*, carrying its three astronauts on man's first voyage to the Moon, I thought about how the launching of a dream can be more fantastic still, for the material product of dreams themselves are not. What sunbound astronaut's experience can equal that of Robert Goddard, whose body stayed on Earth while he voyaged through the galaxies?"[40]

To this, may be matched Goddard's own sense of vision. On 20 April 1932, after more than 30 years had passed since he had been inspired as a youngster back in 1899 by the science fiction story *War of the Worlds* by British novelist H. G. Wells, Goddard wrote him an overdue letter of appreciation. He told Wells how the story had made "a deep impression" and led him to take up a search for a way to spaceflight. "The spell did not break," he said, and the research continued to be "the most fascinating problem in existence." "How many more years I shall be able to work on the problem," he continued, "I do not know; I hope, as long as I live. There can be no thought of finishing, for 'aiming at the stars,' both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning."[41]

Reference Notes

[1] Esther C. Goddard and G. Edward Pendray, eds., *The Papers of Robert H. Goddard* (hereafter, *The Papers*) (New York: McGraw-Hill, 1970), Vol. I, pp. 7, 9; Frank. H. Winter, *Rockets into Space* (Washington, DC: Harvard University Press, 1993), pp. 2–9.

[2] Robert H. Goddard, "Green Notebook," unpublished, Vol. IV, pp. 28, 31–32, in Robert H. Goddard Library, Clark University, Worcester, Massachusetts; *The Papers,* Vol. I, 99; Winter, *Rockets*, p. 16. At first, according to his notes of 2 February 1909 (not 31 January 1909 as incorrectly given in *The Papers*), Goddard believed a gunpowder rocket would require far too much mass of propellant to be practical as a propulsion device for space. Thus, on the same date, he thought of an alternate approach of "H & O explosive jets, with compressed gas in small tanks." (Goddard had mentioned the rocket once or twice earlier, but only in passing, and it is from this date that he began seriously considering the rocket as a potential means of space propulsion.) From these crude ideas, Goddard gradually evolved improvements in the rocket, notably the substitution of far more powerful smokeless powder over gunpowder, and the adoption of the de Laval convergent-divergent nozzle. In addition, the use of multiple stages also promised to make the rocket more feasible for space-

flight. During the same period, Goddard developed his theories on liquid propellant rocket propulsion, which he knew would ultimately be far more efficient than the solid propellant rocket. In this case, he would have to create an entirely new technology, which he set out to do in 1921.

The erroneous notion that air was needed for the rocket to *push against* in order for it to move was a prevalent belief for centuries. If this were so, then the rocket would not have been able to work in the *vacuum* of space. It was thus a major breakthrough when Goddard (and independently, Tsiolkovsky and others) recognized that Newton's Third Law of Motion, describing reaction propulsion, *does* work in a vacuum, as it does in air. Despite Goddard's experiment of June–July 1916 proving the rocket works in a vacuum, and the subsequent write-up of his results in his later *Method of Reaching Extreme Altitudes* (1919), the antiquated *air-pushing* belief was still widely held by many and was used by critics of his space travel concepts. For one example of Goddard's responses on this issue, appearing as late as 1932, see *The Papers*, Vol. II, p. 820.

[3] Goddard, "Green Notebook," Vol. IV, pp. 28, 31–32; *The Papers*, Vol. I, 99; Winter, *Rockets*, p. 16; Robert H. Goddard, "Actual Facts about the Rocket to the Moon," *The Sunday World Magazine* (6 October 1929): p. 23. Goddard's principal rationale for avoiding the topic of spaceflight when he first approached the Smithsonian is explicitly spelled out in this article when he wrote: "The matter of interplanetary communication was not stressed," he said, "for the [Smithsonian] Institution would not have supported such an undertaking . . . and moreover . . . the first step was actually to develop and use the high-altitude rocket."

[4] *The Papers,* Vol. I, pp. 170–175; Vol. II, pp., 406–413, 668–674; and Vol. III, p. 1662; "Meteor-Like Rocket Startles Worcester," *New York Times* (18 July 1929): p. 2, col. 4. "To Explore Skies with 'Moon Rocket," *New York Times* (21 July 1929): p. 11, col. 1. Smithsonian Secretary Abbot attempted to correct misinterpretations, if not dampen the publicity, after this event. "No such wild project as going to the Moon is contemplated," he announced to the press. "We [Goddard and the Smithsonian] wish to create a method to gather meteorological and atmospheric data in outer space which man cannot reach by aerial navigation [airplanes], balloons, or kites." but even the *New York Times* could not refrain from including the phrase "Moon Rocket" in its headline.

The lead author, Frederick C. Durant III, presented his first paper on Goddard, as "Robert H. Goddard and the Smithsonian Institution" at the Second History Symposia of the International Academy of Astronautics, New York, 16 October 1968. It is published in Frederick. C. Durant III and George S. James, eds., *First Steps toward Space* (Washington, DC: Smithsonian Institution Press, 1974), pp. 57–69. His second Goddard paper, "Robert H. Goddard: Accomplishments of the Roswell Years (1930–1941), is cited in reference 29 of the present article.

[5] Alden P. Armagnac, "Aims Rocket at Roof of Sky," *Popular Science Monthly*, Vol. 115 (October 1929): p. 24; Charles A. Lindbergh, *Autobiography of Values* (New York: Harcourt Brace Jovanovich, 1977), pp. 337–338; A. Scott Berg, *Lindbergh* (New York: Berkley Books, 1999), pp. 53, 210; *The Papers*, Vol. I, p. viii; Milton Lomask, *Seed Money: The Guggenheim Story* (New York: Farrar, Straus and Co., 1964), p. 142. In several versions of the account of Carol Guggenheim's discovery of the article on Goddard, including the one appearing in the foreword of *The Papers of Robert H. Goddard*, it is supposed to have appeared in a newspaper. In the version in Lomask and in Lindbergh's letter to Durant, it is even mentioned that it was the "back page of the newspaper." (The letter to Durant says it was the *New York Times*.) There is also a bronze plaque in the living room in Falaise, which commemorates this event and also states that the Goddard article was in the *New York Times*, without giving a date. Lindbergh's *Autobiography of Values* is the only source that identifies the article as coming from *Popular Science* and quotes at length from it. The authors of this article have thus located the article and give its title and date here to set the

record straight. It may also be seen that events happened amazingly rapidly in the Lindbergh–Goddard connection. It had only been a matter of weeks or days from the time of Lindbergh's visit to the Du Pont Company to the time Carol Guggenheim brought the Goddard article to the attention of Lindbergh and Harry Guggenheim.

[6] Letter, Charles A. Lindbergh to Frederick C. Durant III, 30 January 1970, copy in possession of the authors; Lomask, *Seed Money,* p. 141; *Jane's All the World's Aircraft, 1928* (London: Sampson Low, Marsden and Co., 1928), p. 246C; R. E. G. Davies, *Charles Lindbergh: An Airman, His Aircraft, and His Great Flights* (McLean, Virginia; Paladwr Press, 1997), p. 43. For another version of Lindbergh's recollections as to his first thoughts on the rocket for space travel, see Lomask, *Seed Money*, p. 141. Again, apart from the uncertain year as to when Lindbergh first thought of rockets for aviation and spaceflight, there remains some confusion as to which aircraft he flew on this occasion. This confusion arises out of the plane he mentioned in his letter to Durant. The Ryan Brougham, patterned after the *Spirit of St. Louis*, was first test-flown by Lindbergh at the Ryan plant at San Diego in early April 1928. See *New York Times* (6 April 1928): p. 2, col. 3. He used this plane for survey flights from April to October 1928. His final flight on the *Spirit* had been made on 30 April. See *New York Times* (1 May 1928): p. 1, col. 6; and Charles Lindbergh, *Spirit of St. Louis* (New York: Scribner's Sons, 1953), p. 513. On 13 May 1928, the *Spirit of St. Louis* was placed on exhibit in the Smithsonian Institution. See *New York Times*, (12 May 1928): p. 2, col. 6; and Dom Pisano and Frank R. van der Linden, *Charles Lindbergh and The Spirit of St. Louis* (New York: Harry N. Abrams, 2002), p. 122. Lindbergh joined the Transcontinental Air Transport, Inc. about ten days later. See *New York Times* (23 May 1928): p. 1, col. 6. His survey flights started by the end of the month. He did extensive flying for them yet the only St. Louis to New York flight he made that received press coverage in the *New York Times* did not occur until much later, on 10 September 1929, although that particular flight was not made with the Brougham but with a plane borrowed from Capt. Frank M. Hawk, apparently a Lockheed Air Express (410-hp Pratt and Whitney Wasp engine). See *New York Times* (11 September 1929): p. 16, col. 3, and (12 September 1929): p. 1, col. 2.

[7] Letter, Lindbergh to Durant.

[8] Lindbergh, *Autobiography*, pp. 336–337. Unbeknown to Lindbergh, H. H. Bales of Ashcroft, British Columbia, Canada, probably took out the first patent on applying the rocket to the airplane, U.S. Patent No. 1,003,411 of 19 September 1911 for a "Pyrotechnical Auxiliary Propelling Mechanism." In 1924 Albert Lepinte of France specifically envisaged extra power from a rocket to retard an aircraft's rapid descent or accelerated the plane in time of danger, in his British Patent No. 229,670 of 19 February 1924. He later took out U.S. Patent No. 1,611,353 of 21 December 1926 for the same concept. Still other examples of early concepts of rockets on airplanes can be found. See, for example, Frederick C. Durant III and George S. James, eds., *First Steps toward Space* (Washington, DC: Smithsonian Institution Press, 1974), pp. 255–256.

[9] Postal Telegraph, Henry B. Du Pont, Charles, West Virginia, 18 October 1929, to Charles A. Lindbergh, Hagley Museum and Library, Wilmington, Delaware; Letter, Henry B. Du Pont to Charles A. Lindbergh, 23 October 1929, Hagley Museum and Library. Chemist Dr. Charles M. A. Stine (1882–1954), who joined Du Pont in 1907, was an innovator of pure research and in 1927 established their "Experimental Station." He finally retired in 1945 as a vice president and was internationally known for immeasurably helping Du Pont become a multifaceted chemical corporation. The C. M. A. Stine Award to leading researchers was named in his honor.

[10] Letter, G. Harvey Cameron to A. Felix Du Pont, 29 October 1929, and forwarded to Charles A. Lindbergh, Hagley Museum and Library.

[11] Lindbergh, *Autobiography*, pp. 336–337; Letter, Lindbergh to Durant. Felix Du Pont was a strong advocate of aviation and had been flying since 1918, before Lindbergh, and continued to fly until age 88 and died in 1996. He wrote to Lindbergh on 4 November 1929, soon after the meeting, but only to suggest the possibility of a new safety device for aviators, but not rocket related.

[12] Letter, Charles M. A. Stine to Charles Lindbergh, 6 November 1929, with *New York Times* clipping, "Finds New Explosive for Rocket Planes," (3 November 1929), and typed copy of article in *Nature* (19 October 1929).

[13] Lindbergh, *Autobiography of Values*, p. 338; *The Papers*, Vol. II, p. 713; Milton Lehman, *This High Man—The Life of Robert H. Goddard* (New York: Farrar, Straus and Company, 1963), pp. 158–159, same pagination in reprint, retitled *Robert H. Goddard—Pioneer of Space Research* (New York: Da Capa Press, Inc., 1988), with introduction by F. C. Durant III, but hereafter cited as Lehman, *High Man;* Richard P. Hallion, *Legacy of Flight—The Guggenheim Contribution to American Aviation* (Seattle: University of Washington Press, 1977), pp. 174–175.

[14] *The Papers,* Vol. II, pp. 713–716, 740; Vol. III, p. 1557; "Lindy Guest of Goddard on Visit Here," *Worcester Sunday Telegram*, Worcester, Massachusetts (24 November 1929); Lomask, *Seed Money*, p. 143.

[15] *The Papers,* Vol. III, p. 714; Letter, Lindbergh to Durant.

[16] Scott Berg, *Lindbergh* (New York: Berkley Books, 1998), pp. 40–44, 50–52, 60, 66, 67–68, 400, 413, 416–417, 440; Lehman, *High Man*, pp. xi, 2–3, 10, 16–17, 19, 32–34, 40, 44, 98–99, 106, 145–146, 356.

[17] Lindbergh, Letter to Durant; Lindbergh, *Autobiography*, p. 381.

[18] Lindbergh, Letter to Durant.

[19] "Lindy Guest," "Capital Speculates on Lindy's Worcester Trip," *Worcester Telegram* (27 November 1929).

[20] *The Papers*, Vol. II, p. 715.

[21] *The Papers,* Vol. II, pp. 715, 717; Lindbergh, Letter to Durant; Lindbergh, *Autobiography*, p. 325. In his letter to Durant, Lindbergh appears to be in error in his recollection that, "I flew Goddard to Wilmington in my plane . . . a Curtiss Falcon. At about this time, I had turned in my Ryan Brougham monoplane for a Curtiss Falcon biplane." Goddard clearly states in his letter to Abbot of 29 November 1929, and as related above, that he went to Wilmington by himself and met Lindbergh there. Goddard adds that he made his first plane ride (with Lindbergh) on the trip back to New York. Therefore, Lindbergh probably meant this trip.

[22] *The Papers,* Vol. II, pp. 719–720, 724.

[23] *The Papers,* Vol. II, pp. 726–728, 740.

[24] Berg, *Lindbergh,* pp. 109, 163–164; Lehman, *High Man*, pp. 172–173.

[25] Lindbergh, Letter to Durant; Lindbergh, *Autobiography*, p. 343; Lomask, *Seed Money*, p. 145.

[26] Berg, *Lindbergh,* p. 164; *The Papers*, Vol. II, pp. 743–745.

[27] *The Papers*, Vol. II, p. 646.

[28] *The Papers*, Vol. II, pp. 682–683, 755–757, 759–760, 890, 892, Vol. III, pp. 1662–1664; Lomask, *Seed Money*, pp. 140–141, 146, 148, 286; Lenox R. Lohr, *A Guide For Future Fairs . . . The Story of a Century of Progress Exposition* (Chicago: The Cuneo Press, Inc., 1952), pp. 173, 233; *Billboard*, Vol. 46 (5 May 1934): p. 44; and (18 August 1934): p. 42. During his stay in the east from 1932–1934, Goddard hardly remained idle and feverishly lobbied the Guggenheims in person for a resumption of their support, plus he went to Washington repeatedly to ask for more from the Smithsonian and took time out to go to the Navy to again sell them on rocket weapons. In 1934 he saw Lindbergh three times: 30 January, 31 January, and 6 July. Finally, on 11 July, Harry Guggenheim bestowed the good news that the Guggenheim Foundation agreed to another grant of $18,000. According to Lomask, at some unknown date Harry Guggenheim allayed Goddard's apprehensions about continuing to receive Guggenheim support and told Clark University that if a grant was not renewed he (Harry) would "personally guarantee the salary of the substitute professor." On 6 or 7 September 1934, Goddard returned to Roswell by way of Chicago where he and Esther stopped to pay a visit to the Century of Progress exposition. Here, he may have seen the "Buck Rogers" attraction or ridden the so-called "rocket cars," a type of monorail. "Buck Rogers" was the well-known U.S. fictional space hero of the comic strips, and later on radio and made into a movie, who also played a great role in generating a great deal of public interest in the possible future of rocketry.

[29] F. C. Durant III, "Robert H. Goddard: Accomplishments of the Roswell Years (1930–1941)," presented at the 7th International History of Astronautics Symposium of the International Academy of Astronautics, Baku, USSR, October 1973, in Kristan R. Lattu, ed., *History of Rocketry and Astronautics*, American Astronautical Society (AAS) History Series, Vol. 8 (Published for AAS by Univelt: San Diego, 1989), pp. 317–341; Lomask, *Seed Money*, p. 146; *The Papers*, Vol. II, pp. 751–1104; Vol. III, 1107–1149; Esther C. Goddard and G. Edward Pendray, eds., *Rocket Development—Liquid-Fuel Rocket Research 1929–1941* (New York: Prentice-Hall, 1960), pp. 15–215; Robert H. Goddard, "Liquid-Propellant Rocket Development," in *Smithsonian Miscellaneous Collections*, Vol. 95, No. 3 (Washington, DC: Smithsonian Institution, 16 March 1916); Robert H. Goddard, "Liquid-Propellant Rocket Development," in Robert H. Goddard, *Rockets—Comprising a Method of Reaching Extreme Altitudes and Liquid-Propellant Rocket Development* (New York: American Rocket Society, 1946); Lehman, *High Man*, pp. 177–339; Winter, *Rockets*, pp. 33–34. The first cited work by Durant contains detailed coverage of the many innovations by Goddard in the design, construction, and tests of his rocket engines from 1930–1941.

[30] Lindbergh, *Autobiography*, p. 344; *The Papers*, Vol. II, pp. 887, 889; "Famous Lindberghs Pay Visit to City," *Roswell Dispatch* (16 September 1934); "Goddards Fly with Lone Eagle and Wife," *Worcester Telegram* (17 September 1934); "Large Crowd Sees Lindbergh Leave," *Roswell Daily Record* (17 September 1934); Anne Morrow Lindbergh, *Earth Shine* (New York: Harcourt, Brace and World, Inc., 1969), p. 6.

[31] *The Papers*, Vol. II, p. 932; Vol. III, pp. 1663–1665; "Notables Visit Very Successful Says Dr. Goddard," *Roswell Dispatch* (25 September 1935); "Col. Lindbergh and Guggenheim Are in Roswell," *Roswell Daily Record* (23 September 1935), pp. 1, 4; "H. F. Guggenheim Says Foundation to Finance Continuation of Work," *Roswell Daily Record* (24 September 1935), pp. 1, 8; "Lindbergh Studying Big Goddard Rocket," *New York Times* (24 September 1935); Goddard and Pendray, *Rocket Development*, pp. 67–68; Lindbergh, *Autobiography*, p. 344. Daniel Guggenheim's obituary may be found in the *New York Times* (29 September 1930): p. 1, col. 4.

[32] *The Papers*, Vol. II, pp. 932, 936; Goddard and Pendray, *Rocket Development*, p. 68; "Notables," "Lindbergh, Guggenheim Left Today," *Roswell Daily Record* (25 September 1935): p. 1.

[33] *The Papers*, Vol. II, pp. 920, 937; Vol. III, 1663–1665.

[34] *The Papers*, Vol. II, pp. 936–937, 1065; National Air and Space Museum, accession record, Goddard 1935 Rocket, NASM 364, Cat. # 1936-0022; Hallion, *Legacy of Flight*, p. 183; Lomask, *Seed Money*, p. 144; Lehman, *High Man*, pp. 214–217, 401; The Daniel and Florence Guggenheim Foundation, *The Future of Rocket Power—Addresses Delivered by Harry Guggenheim and J. H. Doolittle at the Preview Opening of the Robert H. Goddard Exhibit Sponsored by the Daniel and Florence Guggenheim Foundation* (New York: Daniel and Florence Guggenheim Foundation, 1948), Lehman and Lomask, the latter deriving his information from Lindbergh, both go into some detail on Goddard's great initial reluctance to donate a rocket to the Smithsonian but was urged to do so by Lindbergh. Even when Goddard finally consented, the rocket was sent in a sealed box with his instructions that it not be opened without the permission of Lindbergh and Guggenheim.

Typical examples of press coverage of Lindbergh's support of Goddard during this time is the lengthy article "Lindbergh Visions Travel in Rockets," and the editorial "The Colonel on Rockets," in the *New York Times* (6 June 1937 and 10 June 1937), respectively. A long statement by Lindbergh was also presented at the Clark University commencement exercises on 5 June 1937, as read by Wallace Atwood, following which Goddard, who was present, was compelled to rise and take a bow. Among other things, Lindbergh had written in that speech: "The rocket is now in that most interesting period of discovery where the shorelines are unplotted and the future limited only by imagination." The entire letter was published in *U.S Air Services* (July 1937): p. 9; *Astronautics*, (the journal of the American Rocket Society) No. 37 (July 1937): p. 8; excerpted in *The Aero Field* (July 1937): p. 165; and in *The Papers*, Vol. II, p. 1065.

[35] *The Papers*, Vol. III, pp. 1250, 1336–1337; Charles A. Lindbergh, *The Wartime Journals of Charles A. Lindbergh* (New York: Harcourt Brace Jovanovich, Inc., 1970), p, 199; "Lindbergh Arrived Here 3:30 Today," *Roswell Daily Record* (10 May 1939): p. 1; "Lindbergh Took Off at Nine O'clock," *Roswell Daily Record* (11 May 1939): p. 1. Lindbergh probably stayed in the "Lindbergh Room," which had been added to the adobe Mescalero Ranch house after the first visit of Goddard's esteemed guest. See Elvis E. Fleming, "Goddard Builds Special Room for Lindberghs," *Roswell Daily Record* (29 October 1998): p. A12. In contrast to the publicity on Lindbergh's previous visits, the *Daily Record* could only report the bare facts of his arrival and departure times, although both were on page 1.

[36] Berg, *Lindbergh,* p. 388; Lehman, *High Man*, pp. 270–272; *The Papers*, Vol. II, pp. 844–845, 1006, 1028–1029, 1034–1036, 1063, 1186–1193: Vol. III, 1171–1172. To briefly review Goddard's connections with the military during this period, Goddard's last experiments for the services ended in May 1923. He had then turned in his final report to the Navy's Bureau of Ordnance on separate, experimental solid propellant projects of armor-piercing projectile and depth-charge projector, but nothing came of these. At the same time other experimental solid fuel work for the Army's Chemical Warfare Service was also discontinued. Interest on the part of Goddard was again renewed in 1933, during a halt in the Guggenheim grant. On 8 May he wrote to Lindbergh suggesting a radio-controlled, rocket-propelled antiaircraft missile, mainly as a way to keep the rocket work. There seems to be no response from Lindbergh and the two did not meet again until 31 January 1934. During this period, Goddard also visited Navy officials in Washington, but that effort too did not lead anywhere. Then in 1936, Maj. Gen. A. H. Sunderland, chief of the Coast Artillery, opened correspondence with Goddard to explore the use of liquid-fuel rockets as the propelling target or drone planes as targets for antiaircraft guns. At first, Goddard judged the idea "impracticable" and told him that "My work here is limited to the development of a rocket to carry meteorological instruments to great heights." It was only through Sunderland's persistence that Goddard reexamined the case in November. He had now changed his mind and believed it was "practicable in the light of the results I have obtained in New

Mexico." On 24 May 1937, during a trip to Washington, Goddard, along with Abbot, met Sunderland and showed the general some movies of his tests. But once more, nothing came of this though Sunderland was impressed with Goddard's work and did say he would "have to blast the Air Corps out of their position." Then, on 8 July 1938, Lindbergh wrote to Goddard and said, "It seems to me that the first practical use for liquid-propelled rockets may be for military purposes . . . Don't you think it might be advisable to establish closer contact with our Ordnance Department?" Lindbergh's advice on Goddard had effect, as on 26 September 1938 he now recontacted Sunderland, but cautiously, inquiring whether his 1918 smokeless powder rocket work for the War Department, should be continued. Again, nothing came of this proposal either.

[37] *The Papers*, Vol. III, pp. 1251–1252, 1336–1337, 1469; Lomask, *Seed Money*, p. 149.

[38] Lindbergh, *Autobiography*, pp. 144, 344, 349; Berg, *Lindbergh*, pp. 466–470; Lehman, *High Man*, p. 399. During their relationship, Lindbergh and Goddard had eight phone conversations, met ten times, and exchanged 42 letters (16 from Lindbergh to Goddard and 26 from Goddard to Lindbergh).

[39] Lindbergh, *Autobiography*, pp. 349–350; Berg, *Lindbergh*, p. 472; Memo, Bonnie Holms (secretary of Wernher von Braun at Huntsville, Alabama), 2 June 1965, Sherrod Collection, file 13260, von Braun Daily Journal, NASA History Office; Letter, Wernher von Braun to Harold K. Mintz, 23 April 1957, Wernher von Braun Papers, Box 3, file 1957 "H" to "N," Manuscript Div., Library of Congress; Lehman, *High Man*, p. 388.

[40] Lindbergh, *Autobiography*, pp. 400–401. Milton Lehman's own account of the Lindbergh–Goddard connection, an adaptation from his then, forthcoming biography *This High Man*, is found in his article "How Lindbergh Gave a Lift to Rocketry," in *LIFE*, Vol. 55 (4 October 1963): pp. 115–118, 120–122, 124, 127.

[41] *The Papers*, Vol. II, pp. 821–823, 825. Wells' response was very brief: "Thanks for your friendly letter. It's the sort of greeting we appreciate—from people like you."