Chapter I

Origins of Marshall Space Flight Center

On his way to dedication ceremonies for the George C. Marshall Space Flight Center on the morning of 8 September 1960, President Dwight D. Eisenhower paused before a test stand holding an enormous Saturn I booster. He turned to Wernher von Braun, the director of the new Center, and said that he had never seen anything like it. "They come into my office and say it has eight engines. I didn't know if they put one on top of the other or what," he told von Braun.

Wernher von Braun describes the Saturn I to President Eisenhower.

The President was not the only American who was impressed but somewhat mystified by what had been going on in Huntsville, Alabama. Indeed, when Eisenhower addressed the 20,000 people who assembled at the ceremonies later that morning, he acknowledged a decade of achievements in rocketry at the Army's Redstone Arsenal in Huntsville. There the Army had developed the Redstone and Jupiter missiles, and with the assistance of the Jet Propulsion Laboratory (JPL) created America's first Earth satellite, Explorer I.[1] The dedication signified a change of command, as the Development Operations Division of the Army Ballistic Missile Agency (ABMA) transferred from military authority to the civilian direction of the National Aeronautics and Space Administration (NASA).

The dedication of the Marshall Center marked the absorption of a talented group of 100 German rocket experts and 4,570 American engineers and technicians into the ranks of the civilian agency. The Germans had been working together for more than two decades, and their experience and leadership gave the new Center cohesion. They had trained the Americans to continue their legacy in rocketry. In the years that followed, Marshall would be at the heart of the American space program, one of NASA's two largest field Centers, proud of its many achievements in technology and exploration.[2]

Chemical munitions work at Redstone Arsenal during World War II.

The political struggles that culminated in transfer of ABMA's Development Operations Division to NASA left a legacy that affected Marshall's role in the space program. ABMA was at the center of key debates over national space policy in the late 1950s. An Army agency, it forced consideration of Army-Air Force rivalry in military missile development. A military organization, it prompted the Eisenhower administration to seek a balance between civilian and military space programs. A research and development enterprise of such versatility that it was virtually a space program unto itself, it opened debate over whether experimental work on rocketry should be contracted to private business or conducted by government specialists. A leader in propulsion and high technology, it stimulated contention over the division of labor between NASA Centers. None of these questions would have final answers by the time of the establishment of Marshall. They would reverberate through Marshall's early years, and carry implications that would affect the Center for decades.

If Marshall's future would be tied to the fortunes of the American space program, its origins rested on an improbable coalition: a small southern town, an obscure federal agency, expatriate rocket experts, and young American engineers. Tracing those origins leads inevitably to World War II, when the

circumstances developed that would bring the coalition together. Huntsville, Alabama, was an agricultural community in the 1940s, an unlikely site for space research, but the wartime activation of an ordnance plant at the outskirts established the future site of the Army's Redstone Arsenal and the Marshall Center. During the war the National Advisory Committee for Aeronautics (NACA), a small federal agency and the forerunner of NASA, broadened its research base beyond the interest in aerodynamics on which its reputation rested.[3] Another part of the coalition was comprised of German rocket scientists and engineers who, during the war, worked under the direction of von Braun on a remote island in the Baltic Sea developing missiles for Adolph Hitler's army.

Huntsville Before the Space Age

Huntsville, a small town a dozen miles north of the southern-most bend in the Tennessee River, welcomed the arrival of defense plants in 1941 as a solution to economic woes. A compact site of four square miles, Huntsville had seen prosperous days, as blocks of ante-bellum houses east of the Courthouse Square attested. By the late 1920s, Huntsville had become the textile center of Alabama, and Madison County the state's leading cotton producer. But even before the Great Depression its single-crop economy fluctuated with the vagaries of cotton prices. Huntsville's leading citizens yearned for economic growth. Two new twelve-story "skyscrapers" revealed ambitions to be more than a small cotton town. One businessman emblazoned his building with the slogan "Great is the Power of Cash," and the Chamber of Commerce declared Huntsville the "Watercress Capital of the World," the "Biggest Town on Earth for its Size."

To the west and south spread a broad plain of cotton fields dotted with mill villages. Mill wages remained low even when cotton prices rose. Many African Americans left Madison County to seek jobs in northern cities; the black population was lower in 1940 than it had been at the turn of the century, even though the total population increased by fifty percent. The Depression made conditions worse. Mill strikes in 1934 hastened decline, ending Huntsville's domination of the state's textile industry.

The infusion of federal money into the economy during World War II lifted Huntsville out of the Depression, and permanently altered the community. During the Fourth of July weekend in 1941, the Chemical Weapons Service announced plans to establish a chemical weapons plant in Huntsville, and 500 people applied for jobs by the following Monday. The Huntsville Arsenal manufactured

toxic agents and incendiary material, and packed them in shells, grenades, and bombs supplied by the Ordnance Department. Three months later, Redstone Ordnance Plant began operations on adjacent land southwest of the city. Redstone manufactured and assembled ammunition for Ordnance. Construction costs for the two arsenals totaled $81.5 million; peak employment exceeded 11,000 civilians. For the duration of the war, Madison County prospered.

The end of the war brought fears of renewed depression, and within months the Huntsville economy seemed on the verge of collapse. Jobs disappeared, and despite efforts to encourage diversification, another "bust" period in Madison County's cyclical economic fortunes seemed imminent. The Department of the Army declared the 35,000 acres of Huntsville Arsenal surplus property, and offered it for sale.[4]

The war nonetheless proved more than a temporary economic surge for Huntsville. The presence of the federal government in Madison County established a foundation for continued prosperity. North Alabama, beneficiary first of the Tennessee Valley Authority, then of Huntsville's defense plants, would see an increasing infusion of federal funds. The twin arsenals, whose futures were uncertain in 1945, would become the launching pads of future growth when the Army chose the site for its missile development team.

NACA: Forerunner of NASA

The war also influenced NACA, which would become the second component of the Marshall coalition, and enhanced its reputation as a research institution. Founded in 1915, NACA supported the aircraft industry with basic research and investigations suited to specific aeronautical problems. With the coming of war in Europe, NACA expanded to new facilities at Moffett Field in California in 1939 and in Cleveland in 1940.

Wartime demands limited NACA to a support role for military requirements. After the war, NACA shed its conservative image, adding new facilities at Wallops Island, Virginia, and at Edwards Air Force Base in California and branching into new fields of research. Hugh L. Dryden, who became director in 1947, initiated research into rocket propulsion, upper atmosphere exploration, hypersonic flight, and other fields previously ignored by NACA. Still minimally funded, but no longer bound by an emphasis on aeronautics, NACA had

already begun the transition by the late 1940s that would lead to the formation of a national space agency a decade later.[5]

Peenemünde and Marshall's German Roots

The third component of the Marshall coalition was a talented team of German specialists who developed the V–2 rocket used against Britain and Allied positions on the European continent in the last years of the war. During World War II, German rocketry advanced beyond that of any other nation. The story of the American acquisition of German rocket expertise, intertwined in the origins of the Cold War, has been controversial ever since.[6]

German rocketry originated with the pioneering efforts of the Rumanian Hermann Oberth and the experimentation of amateur rocket societies in the 1920s and 1930s. Among the members of one such society in Berlin in 1929 was von Braun, a recent high school graduate from the town of Wirsitz in Posen, territory along the Oder River that became part of Poland after World War II.[7]

Rocketry changed from a hobby to a profession in the late 1920s when the German army became interested in using it as a means to take advantage of a loophole in the Versailles Treaty. The treaty forbade Germany to build long-range guns, but included no prohibition against rocketry.[8] The Army wanted to develop a liquid-fueled rocket that could be produced inexpensively and surpass existing guns in range.

Von Braun became a civilian army employee in 1932. Beginning with only one mechanic to assist him, von Braun began to build a team of researchers, drawing from amateur rocket societies, universities, and industry. They began work at Kummersdorf near Berlin and by 1936 began moving to Peenemünde. The army provided von Braun with whatever equipment he needed. The Center concentrated all phases of research and development at one location, a concept that von Braun's military supervisor Captain Walter Dornberger described as "everything under one roof." Von Braun first resisted the notion, arguing that he had no experience in production, but later embraced it.[9] Researchers were available if problems arose during production. Test launch sites were only two miles from manufacturing facilities. Dornberger compared the organization at Peenemünde to "a large private research institute combined with a production plant."[10]

The need for secrecy limited cooperation with industry. Rocket technology was too arcane in the early years for industry to desire participation, and conventional arms contracts offered more money. Ernst Stuhlinger recalled that the arsenal concept took hold in Peenemünde simply because "nobody could build rockets at that time in Germany. Nobody knew how to build rocket motors. We had to develop it, and von Braun had gotten the team together. We did it in our Peenemünde laboratories and became the experts before anybody else was an expert."[11]

Formal cooperation with industry and academia increased as the Peenemünde operation matured, but by then the in-house approach was established. Von Braun sought cooperation with universities, especially for research and recruitment. "The main professors, the lead investigators, became our laboratory directors," Georg von Tiesenhausen recounted. Von Braun preferred direct private contacts to the more rigid structures of the German bureaucracy. "We worked closely with universities all over the country. We gave them the list of problems and they had to solve them," von Tiesenhausen explained.[12]

Von Braun established a flexible management system that could respond to external constraints. He envisioned major projects on a vertical axis, technical support laboratories superimposed on a horizontal axis. Every project manager had direct access to all laboratory facilities. Technical departments were not dependent on the fortunes of any given project, yet had the flexibility to adapt to changing demands.[13]

The research team assembled at Peenemünde included men of exceptional talent. Many of them had advanced degrees and practical experience in industry before joining von Braun. Few had worked in rocketry, but expertise in fields like physics, chemistry, mechanical engineering, and electrical engineering suited them to work on various aspects of rocket development.

Not that everything went smoothly at Peenemünde. Early rocketry was an inexact science, with progress registered through trial and error. Von Braun recalled that "Our main objective for a long time was to make it more dangerous to be in the target area than to be with the launch crew."[14] Hundreds of test firings from 1938 to 1942 brought improvements in stability, propulsion, gas stream rudders used for steering, the wireless guidance communication system, and instruments to plot flight paths.[15]

British intelligence discerned that rocket research was underway at Peenemünde as early as May 1943. On the night of 17 August, British bombers staged a large raid that killed 815 people, destroyed test stands, and disrupted transportation. The raid did little to disrupt V–2 production plans, but nonetheless precipitated changes in plans—most significantly the decision that no production would take place at Peenemünde.[16]

Labor for V–2 production became a pressing problem in 1943. In April Arthur Rudolph, chief engineer of the Peenemünde factory, learned of the availability of concentration camp prisoners, enthusiastically endorsed their use, and helped win approval for their transfer. The first prisoners began working in June. Hitler's concern for V–2 development after July 1943 peaked the interest of Heinrich Himmler, the commander of the SS, who conspired to take control of the rocket program and research activities at Peenemünde as a means to expand his power base. When Dornberger and von Braun resisted his advances, the SS arrested von Braun, charging that he had tried to sabotage the V–2 program. Himmler cited as evidence remarks that von Braun had made at a party suggesting developing the V–2 for space travel after the war. Dornberger's intercession won von Braun's release, but Himmler had made his point. Von Braun's defenders cite his arrest as proof of his differences with the Nazi Party and his distance from the use of slave labor. Von Braun's relationship to the Nazi Party is complex; although he was not an ardent Nazi, he did hold rank as an SS officer. His relationship to slave labor is likewise complicated, for his distance from direct responsibility for the use of slave labor must be balanced by the fact that he was aware of its use and the conditions under which prisoners labored.[17]

Atrocities perpetrated at V–2 production facilities at Nordhausen and the nearby concentration camp at Dora—where some 20,000 died as a result of execution, starvation, and disease—stimulated controversy that plagued the rocket pioneers who left Germany after the war. The most important V–2 production sites were the central plants, called Mittelwerk, in the southern Harz Mountains near Nordhausen, where an abandoned gypsum mine provided an underground cavern large enough to house extensive facilities in secrecy. Slave labor from Dora carved out an underground factory in the abandoned mine, which extended a mile into the hillside. Foreign workers under the supervision of skilled German technicians assumed an increasing burden; at Mittelwerk, ninety percent of the 10,000 laborers were non-Germans.[18]

The oft-delayed V–2 production program staggered into low gear in the fall of 1943. Production built steadily through the early months of 1944, peaking in late 1944 and early 1945 at rates of between 650 and 850 V–2s per month.[19] But the V–2 was a military disappointment. As many as two-thirds of the rockets exploded in mid-air before reaching targets. The campaign against England perhaps did more to rally the British people than to inflict damage. So disappointing was the campaign that Nazi officials regretted the decision to concentrate on the V–2 at the expense of the anti-aircraft rockets.[20]

Project Paperclip: American Acquisition of German Rocket Experts

By the beginning of 1945, the advance of the Russian army into Pomerania threatened Peenemünde, and an Allied victory appeared inevitable. With an Allied victory imminent, von Braun and his associates agreed that their future would be brightest with the Americans, who had suffered the least from the war and might be able to afford to support rocket research. Evacuation of Peenemünde began late in January. Workers destroyed records that could not be evacuated and detonated remaining facilities to keep them out of Russian hands. Von Braun moved his organization to the Harz Mountains near Mittelwerk, where he worked on improving V–2 accuracy and eliminating mid-air explosions.[21]

Work ceased only when the advance of Allied troops forced another move. By early April, 400 key members of the von Braun group scattered in villages near Oberammergau. Anticipating the advance of Allied troops, von Braun directed his men to hide research documents from Peenemünde. They hid 14 tons of numbered crates in an abandoned mine, then sealed the opening to the mine with a dynamite explosion.[22]

Research at a standstill, the Germans waited for the arrival of the Allies. On 2 May, two days after Hitler's suicide in his Berlin bunker, American forces moved into the vicinity of Oberammergau. Von Braun and his group surrendered to the Americans.[23]

The destiny of von Braun's rocket experts, now severed from the fate of Hitler's Reich, passed into the crosscurrents of a new international struggle between the United States and the Soviet Union. The meeting of President Franklin D. Roosevelt, British Prime Minister Winston Churchill, and Soviet leader Joseph Stalin at Yalta in February exposed tension between the wartime Allies.

Consideration of what to do with captured scientists and engineers succumbed to emerging Cold War attitudes, as Washington measured hostility toward an old adversary against fear of a new one.

Colonel Gervais William Trichel, the chief of the Rocket Branch of U.S. Army Ordnance, was one of the few Americans who had pondered the disposition of German rocket experts prior to their surrender. He sent Major Robert Staver to London to work with British intelligence developing a list of German rocket technicians, ranking them in order of significance. Wernher von Braun's name headed the list. Trichel negotiated a contract with General Electric late in 1944 for Project Hermes, an agreement for the development of long-range guided missiles. He anticipated using V–2 rockets in his research, and in March 1945 he directed Colonel Holger Toftoy, chief of Ordnance Technical Intelligence, to locate 100 operational V–2s and ship them to an Army range in White Sands, New Mexico.[24]

As soon as Toftoy learned about the Allied discovery of the V–2 plant at Mittelwerk, he sent Staver to Nordhausen to investigate. After verifying the astounding discovery of rows of partially assembled V–2s in the underground facilities, Staver met with members of von Braun's staff and learned of the hidden cache of Peenemünde documents. The peace agreement stipulated that the Soviet Union would occupy Nordhausen, and Britain would control Dornten before the end of May, so Toftoy and Staver had to improvise quickly. Toftoy sent Major James P. Hamill to Nordhausen, where in nine days he supervised shipment of 341 rail cars containing 100 V–2s to Antwerp in preparation for shipment to the United States. Staver convinced the Germans to help him find the hidden documents. He shipped 14 tons of the Peenemünde cache out of Dornten even as the British were erecting roadblocks prior to assuming control.[25]

The question of what to do with German technicians in American custody was laden with political, military, and moral overtones. Some feared that allowing them to continue their research might allow for a rebirth of German militarism. Secretary of the Treasury Henry Morgenthau sought a punitive policy toward Germany, with no room for coddling weapons developers.[26] The most compelling moral argument hinged on the involvement of the Germans with either the Nazi Party or slave labor at Mittelwerk.

Many German academics, scientists, and technicians had been members of the Nazi Party, often because party membership brought benefits such as research grants and promotions. The Party often bestowed honorary rank as a reward. Heinrich Himmler personally awarded an honorary SS rank to von Braun in May 1940, which von Braun accepted only after he and his colleagues agreed that to turn it down might risk Himmler's wrath. Party membership alone seemed an inadequate criteria, and advocates of using German scientists suggested distinguishing "ardent" Nazis from those who joined the Party out of expediency.[27]

Similar ambiguities clouded the issue of responsibility for the slave labor at Nordhausen. Manufacture facilities were far from Peenemünde, under the supervision of Himmler's SS. Himmler and SS-General Kammler dictated production schedules and allocated V–2s for deployment and for testing. Neither Dornberger nor von Braun had direct authority over Mittelwerk, but both men visited the plant several times and observed conditions. Dornberger—and von Braun—could influence V–2 production only indirectly, by lobbying for greater resources.[28]

In the years after the war, when von Braun and other Peenemünde veterans had risen to responsible positions in the American space program, accusations regarding their role in the Mittelwerk slave labor production rose occasionally. Responding to charges leveled by former inmates of the Dora-Ellrich concentration camps in the mid-1960s, von Braun gave his most detailed response. He admitted that he had indeed visited Mittelwerk on several occasions, summoned there in response to attempts by Mittelwerk management to hasten the V–2 into production. He insisted that his visits lasted only hours, or at most one or two days, and that he never saw a prisoner beaten, hanged, or otherwise killed. He conceded that in 1944 he learned that many prisoners had been killed, and that others had died from mistreatment, malnutrition, and other causes, that the environment at the production facility was "repulsive."[29]

In later years some members of the von Braun group countered criticism by explaining that the Germans at Peenemünde were more interested in the scientific potential of rocketry than weapons, and that they often spent evenings discussing space travel. Some stories, repeated many times, became part of the legend of the von Braun group after its successful work on the Saturn rocket. Several stories revolved around the first successful V–2 test of 3 October 1942, when Dornberger proclaimed the birth of the space age.[30] Von Braun's

discussion of the potential of the V–2 as a step toward space travel had given Himmler the pretense for his arrest in 1944. Eberhard Rees, von Braun's closest lieutenant, put the issue in perspective years later, saying, "Let us be very honest. In Peenemünde we did not work in the field of space flight whatsoever. We worked directly on rockets and guided missiles, and only privately we talked in the evening about space flight. . . . A lot of people have talked about how strongly we worked in space flight and that just simply is not so."[31]

After V-E Day, concern with the background of the Germans gave way to the Cold War preoccupation with the Soviet Union. American strategists argued that the Germans might help bring the war in the Pacific to an end, and pressured the Truman administration to support a program of exploitation of German scientific expertise. Russian and British interest in German scientists raised concern that the United States might miss a historic opportunity. Truman had no reservations about using German expertise as long as the program could be kept secret. On 6 July, the Joint Chiefs of Staff responded by initiating Project Overcast—later renamed Project Paperclip—a top secret program authorizing recruitment of up to 350 experts in specialties of interest to American military.[32]

Interrogation of von Braun's inner circle, now ensconced in Witzenhausen in the American zone, gave way to negotiations over terms for consultation services. Colonel Toftoy requested authority to bring 300 rocket experts to the United States, and received permission to transfer 100. Von Braun had insisted that the smallest group that could be transferred was 520, but he helped pare the list to 127, ensuring that they represented a cross-section of his organization.

Negotiations did not always proceed smoothly. Questions rose over whether transfers would be permanent, if they could be renewed, whether wives could accompany their husbands, what salary they would be paid—none of which had clear-cut answers, given the ad hoc nature of the program. Persistent French, British, and Russian interest in exploitation gave the Germans some leverage. In the end, the von Braun group remained together and stayed with the Americans as the least undesirable alternative. "We despised the French, we were mortally afraid of the Soviets, we did not believe the British could afford us, so that left the Americans," one member of the group explained.[33]

Time in the Desert

In September 1945, seven Germans including von Braun traveled to the United States.[34] All except von Braun went to Aberdeen Proving Ground in Maryland, where they helped organize and translate the cache of Peenemünde documents. Von Braun traveled cross-country by train with Major Hamill to Fort Bliss in El Paso, Texas, where Colonel Toftoy planned to reassemble "the world's only experienced supersonic ballistic missile team."[35] Nearby White Sands Proving Ground, 25 miles north of Las Cruces, New Mexico, offered a vast desert expanse for testing.

By the spring of 1946, most of the Germans selected by Toftoy had arrived at Fort Bliss. The Germans knew little of the desert terrain of the American southwest other than what they had read in the westerns of Karl May, a popular German novelist who set some of his stories in El Paso. An isolated enclave at Fort Bliss, the Germans were never more than a marginal part of the El Paso community. They were still wards of the Army in 1946, subject to many restrictions, living behind a fence in converted barracks, required to have an American escort if they left the base. Those involved in testing at White Sands had fewer restrictions because of its remote location, but their isolation was greater. At first, none of the Germans had much contact with Americans other than those they met in their official duties.[36]

General Toftoy's principal purpose in bringing the Germans to Fort Bliss was Project Hermes, the test firing of the Mittelwerk V–2s, a project intended to give Americans experience in rocket research, testing, and development. The V–2 parts were in disarray, having been packed by soldiers, shipped to New Orleans, reloaded on freight cars, repacked once again on trucks, and finally left in the open on the desert at White Sands. Working with General Electric as the prime contractor, the Germans reassembled rockets, tested engines, and fired the first American V–2 on 16 April 1946.[37]

For the remainder of the decade, the Germans served as consultants to the Army, Navy, and private contractors. Forty-five of the sixty-eight V–2s fired performed successfully, yielding aerodynamic data, information on the composition of the upper atmosphere, and launching American rocketry research. Major achievements included launching a V–2 from the deck of the USS Midway, and firing a Bumper-Wac (a modified V–2 first stage with a Wac Corporal second stage)

The original Peenemünde team shortly after their arrival at Fort Bliss.

from the White Sands Proving Grounds to a record altitude of 250 miles, the first object to be sent outside the Earth's atmosphere.[38]

The years at Fort Bliss were a literal time in the desert for von Braun's rocket experts. Unlike the Peenemünde years before or the Saturn years later, no clear goal unified them. They were consultants to American military and industrial researchers, advisers to the dreams of other men. But the period was crucial, for at Fort Bliss the members of the von Braun group began to view themselves as members of a team. Dornberger and von Braun had fostered cooperative enterprise, of course; but no corresponding sense of collective identity emerged from the military-industrial-university complex supporting Peenemünde.[39]

The peculiar circumstances of life at Fort Bliss reinforced the sense of a team. New to a foreign country in which many had at best a cursory understanding of the language, separated from their families, sharing professional interests, viewed with suspicion by the people of El Paso, the Germans drew together. They hiked in the nearby Organ Mountains, played chess and read, and played ball games on a makeshift field between the barracks.[40] Pranks reflected a boarding-school atmosphere, as when Major Hamill reprimanded von Braun: "The wall of Mr. Weisemann's [sic] room has been broken through. This matter was not reported to this office. The pieces of the wall have evidently been distributed to various occupants of Barracks Number 1."[41] The elite nature of the group that led to charges of arrogance created another common front; one American described them as "a president and 124 vice presidents."[42]

The president, of course, was von Braun. Not only did the other Germans accept him unequivocally as their leader, but von Braun insisted on his prerogatives. Relations with Hamill were often prickly. Von Braun resented it when

Hamill questioned his subordinates, issued orders, or transferred personnel without working through him, and threatened to resign several times. Hamill ignored the threats, but acceded to von Braun's control of the team.[43]

Relations between von Braun and Colonel Toftoy remained on a higher plane. Toftoy exerted a calming influence on the group, and worked to meet their needs. Within a year, he had won the right for the Germans to begin bringing their families. In the spring of 1948, Toftoy and Hamill devised a scheme to overcome a legal technicality that troubled the group. Since they had entered the United States without passports or visas, their immigration status was in doubt. They crossed into Mexican territory and returned the same day with papers listing Ciudad Juarez as their port of debarkation, El Paso their port of arrival.[44]

The Transfer to Huntsville

In 1949, General Toftoy began to search for a new location at which to conduct Army rocket research, thus initiating the chain of events that would lead to the establishment of the Marshall Center. The commander of Fort Bliss rejected Toftoy's plans for expansion, and insufficient funds forced cancellation of research projects.[45] Toftoy believed rocket research had become too decentralized. In August, he visited Redstone Arsenal and neighboring Huntsville Arsenal, then listed for sale by the Army Chemical Corps. Toftoy liked the site. Senator John Sparkman, a Huntsville resident and chair of the city's Industrial Expansion Committee, lent support after the city lost a bid for an Air Force aeronautical research laboratory to Tullahoma, Tennessee. After a personal appeal to General Matthew B. Ridgway, Toftoy won approval in October 1949 to incorporate Huntsville Arsenal into Redstone Arsenal and transfer the von Braun group to Alabama.[46]

Toftoy's shift to Redstone Arsenal began the economic, cultural, and political transformation of Madison County, Alabama. The first small contingent of Germans arrived in March 1950, and others soon followed. The move to Huntsville involved not only the German rocket experts, but 800 others, including General Electric and Civil Service employees, and 500 military personnel. By June 1951, more than 5,000 people worked at the Arsenal.[47] Huntsville's population would triple by the end of the decade, and much of the growth was due to the infusion of federal money for the Arsenal.

When the Germans began the move to Huntsville in April 1950, they did so with some trepidation. Unlike the isolation at Fort Bliss, they would live in the community, and some worried that resentment from the war, which had risen occasionally in Texas, might be a problem. "We had fears," Hertha Heller remembered, recalling especially warnings that Alabama ranked near the bottom in state expenditures for education.[48]

The contrast to the restrictions and bleak terrain of Fort Bliss, however, left the Germans enthusiastic about their new home. "Our freedom began for us," Stuhlinger recalled. "We could live where we wanted to, we could buy or rent houses, buy property. We could send the children to any school we wanted to. We could go to church." Hertha Heller recalled that "we liked Huntsville because it was green and reminded us of Germany."[49]

Huntsville, although a small cotton town, was better prepared to accept its highly educated new residents than might have been expected. "Huntsville was not just a 'hick' town," recalled Ruth von Saurma, who arrived with her husband shortly after the Fort Bliss contingent. "As you can see from the Twickenham District and the ante-bellum homes, there were a good number of educated and prominent families who lived in Huntsville." At first a natural reticence characterized relations between the Germans and native Huntsvillians, and each side perceived clannishness on the part of the other. The Germans lived in clusters, some on Monte Sano, others in downtown Huntsville. Some Huntsvillians were not sure they wanted the Army back, and were not sure what to make of the Germans. But as von Saurma remembered, "Most of the people in Huntsville knew that this was not a group that had just come from nowhere, but that the majority of them were people with a very good professional background." Over time, individuals established friendships, and interaction brought the groups closer. After the Heller's house burned, people contributed clothing, furniture, and money to help the family recover. "The generosity was unbelievable," Heller recalled. "Americans are extremely generous and start immediately. They are 'action-pushed' in America. 'Let's do something!'"[50]

The Germans participated in Huntsville's civic life; one observer claimed "they plunged into community affairs with a proprietary interest."[51] When they arrived, the single bookstore in Huntsville only sold textbooks for public schools; soon a new bookstore opened in response to the new demand. The Germans supported a campaign to build a new public library. They helped found a

symphony orchestra, and several performed with the group. Von Braun and a few others helped form a local astronomical society. Walt Wiesman, the only non-technical person in the group, became president of the Junior Chamber of Commerce in his second year in Huntsville. On 15 April 1955, von Braun and 40 members of his team and their families assembled in Huntsville High School to take the oath as American citizens.[52]

The American Engineers

The Germans provided leadership for an Army rocket development team that included military, civil service, and contractor personnel. Many of those who came to work for the Ordnance Guided Missile Center and its successor organizations at Redstone Arsenal later became second-generation leaders at Marshall. The Army drafted people with professional experience during the Korean War, and they provided a rich pool of talent for Redstone Arsenal.

Charles Lundquist, an assistant professor of engineering research at Penn State University, recalled being drafted into a basic training unit that included lawyers, CPAs, and other professors before he received his orders to Huntsville. "There were lots of people brought in to augment the von Braun team by that process," he explained. They were "sort of a second echelon under the German folks." Robert Lindstrom, who managed Marshall's Space Shuttle Projects Office in the 1970s, came to Redstone via the draft.[53] So did James Kingsbury, who stayed for 36 years and eventually headed the Science and Engineering Directorate. A college graduate with an electrical engineering degree, Kingsbury remembered being pulled out of the ranks and sent to Huntsville in 1951 when his unit shipped out to Korea. "My first job was to take a warehouse that stored chemical weapons during World War II and convert it into a laboratory," he recalled.[54] Henry Pohl, who spent most of his career at Houston, came first to Huntsville as a draftee with a new engineering degree. His first job was at the test layout, where a supervisor told him he would have to watch a Redstone missile launch. "This huge massive building that we were in—you could feel a quiver from the power of that thing," he recalled. "I was hooked. I would have given my $75 a month to work there!"[55]

Not all who came to Redstone with the Army were draftees. Joe Lombardo, a graduate of MIT, enlisted in order to complete his military obligation, and later asked for a transfer to Redstone Arsenal after "reading an article about this

team of German scientists that was working on rockets in a place called Huntsville, Alabama."[56] Stan Reinartz, called to active duty after participating in ROTC at the University of Cincinnati, received orders to Redstone Arsenal and soon found himself working in the Project Control Office.[57] Lee James, a West Point graduate and a World War II veteran who later served as a program manager on Saturn stages, had a unique perspective. "Guided missiles were something I had been introduced to," James recalled. "I had occasion to be in London when the V–2s were landing." When he was in Germany, "the V–1s would go over so low you could read the chalk marking written on them by the soldiers."[58]

Other young engineers came to work at the Arsenal as employees of contractors. Richard A. Marmann, who later managed payload development for Spacelab, first worked for Chrysler Corporation doing weight engineering on many of the early missiles before moving over to work for the government.[59] Jack Waite worked for a contractor as a research design engineer at Redstone Arsenal after graduating from the University of Alabama with a degree in mechanical engineering.[60] John Robertson came to Redstone Arsenal after being laid off from his work on bomber contracts for the Air Force.[61] A few people transferred to Redstone Arsenal from other government agencies. Leland Belew began working with the Tennessee Valley Authority in 1951, but found that the work was not challenging. "Most of the work there was replication of work that had already been done," he explained. He soon took a job with the von Braun group, and later helped manage work on Saturn and *Skylab*.[62]

Some new employees came to Huntsville directly from college or graduate school. William R. Lucas, who would have the longest tenure of any Center director in Marshall's first three decades, was a graduate student at Vanderbilt University when he learned about the missile work at Redstone Arsenal from a professor who was working as a consultant in Huntsville.[63] William Snoddy, who came to Huntsville in 1958 with a degree in physics from the University of Alabama, was another of the dozens of graduates from southern universities who took jobs in Huntsville.[64]

Graduates of southern universities predominated among new employees in Huntsville, but people came from around the nation. Art Sanderson, who made recruiting trips as part of his responsibilities in the personnel office, recalled that "They wanted top-notch engineers and we had a charter to go all over this country to get them."[65] Snoddy, a die-hard Crimson Tide fan, said that the

diverse origins of his fellow workers became most noticeable during football season. "It was really strange to be in Alabama and yet work around people that didn't care," he laughed. "They had these weird teams they were cheering for. Some of them were even Yankee teams [from] places I'd never heard of like North Dakota."

Redstone Test Stand—the "poor man's test stand."

The young American engineers were a brash, irreverent, talented group, who after serving in apprenticeship to the Germans during the 1960s, would emerge as Marshall's leaders in the Center's second and third decades. Snoddy remembered that in his first summer, he, Robert Naumann, and three others rented a lodge on the back side of Monte Sano. "We'd sit out on the back, Bob and myself and others, and drink beer and throw the cans off the back of the mountain," Snoddy recalled. Von Braun had organized a brainstorming group called the Redstone Technical Society. "We formed a counterpart we called the Rednose Technical Society," Snoddy remembered. "We had some really senior level folks that came, [including] the manager of Thiokol in Huntsville at the time, and the head of Research. We'd get quite a group up there, and we had some darned good discussions. One night in the heat of the discussion, there was this tremendous display of the Northern Lights. It was really wondrous; there's never been any thing like it in this part of the country in recent times. . . . So that was a great summer—and the ranger found the beer cans and made us go pick them all up."[66]

Army Missile Development in Huntsville

The German-American team set to work developing missiles for the Army. Within months after arrival in Huntsville, General Toftoy's Ordnance Guided Missile Center won approval to develop the Redstone, a new surface-to-surface missile intended to augment the Army's Corporal and Hermes. Army requirements to use existing components where possible led some of the Germans to consider the Redstone simply another redesign of the V–2. But the development plan contained considerable flexibility. Not only did the Redstone become a reliable vehicle, but its development provided answers to pressing problems in rocketry and served as a foundation for the Jupiter.[67]

The Redstone gave the Germans a project of their own, and Toftoy's confidence in von Braun gave the group latitude they had not known at Fort Bliss. In 1952, the Army established the Ordnance Missile Laboratories at Redstone Arsenal, with von Braun as chief of its Guided Missile Development Division. He began to employ the principles that would be the hallmark of rocket development in Huntsville for the next two decades. "When the Redstone came upon us, we were prepared," Stuhlinger remembered. "We could go right to work."[68]

The "arsenal system" was the heart of von Braun's approach. The system was not uniquely German. It was well understood in the United States, employed first at the arsenal and armory at Harper's Ferry, West Virginia, in the 19th century, and endorsed by the Army ever since. The circumstances under which the von Braun team had matured intensified its commitment to the system, however, and by the time an interservice debate developed in the 1950s over the relative merits of in-house versus contractor development, the group had come to epitomize the arsenal approach. Its principles had been applied at Peenemünde. American engineers concentrated on design and contracted others to execute; German training emphasized hands-on experience, enabling the German engineers to execute a project from design and development to construction. Karl Heimburg, director of von Braun's test laboratory, noted that in Germany "you are not admitted to any technical college or university if you do not have some practical time."[69] Thus training reinforced the German commitment to in-house work, and von Braun's approach meshed well with the Army's own reliance on the arsenal system. Ultimately, the arsenal system would be caught in the whipsaw of a debate over military procurement, with the Air Force and aerospace industrial firms pushing to increase reliance on contractors.

The Army's continued reliance on the arsenal system in its Huntsville rocket program was also a response to budgetary constraints imposed by the beginning of the Korean War. The Army terminated its Hermes program and reduced funding to Redstone. Work could often be accomplished internally at a much lower cost than could be done by a contractor. After he received a bid of $75 thousand to build a static test stand to test rocket motors, Heimburg had his own people build a "poor man's" test stand for only $1 thousand in materials.[70]

Reliability testing became an adjunct to the arsenal system, a response both to conservative engineering practices among the German group and the Army's insistence on better than 90 percent reliability on Redstone. Dr. Kurt Debus proposed a system for monitoring reliability in February 1952. Soon adopted in all laboratories, it became the basis for later management systems. "The proposal derived from analyzing guided missile systems and concluded that any part could be classified as 'parallel' or 'series' in operation," Debus explained. "Failure of a 'parallel' part would probably not result in failure of the system since its function could be taken over by another part. Failure of a 'series' item, on the other hand, would ultimately result in total failure."[71]

In addition to work on hardware, top officials in the missile team also advanced a vision of future space exploration. In a series of articles in Collier's magazine in 1952, von Braun propounded his ideas about prospects for space travel, suggesting that a Moon landing could take place within the next quarter century.[72] The articles established him as one of the foremost American spokesmen on space. His ability to communicate complex ideas in simple terms and his appeal as a speaker made him an attractive public figure.

Von Braun formulated proposals for the initial steps that might make his speculations a reality. In 1953 he proposed using existing hardware to orbit an Earth satellite.[73] The next year the Army suggested an interservice satellite project, which became the basis for a joint Army-Navy proposal known as Project Orbiter. The Air Force and Naval Research Laboratories also proposed independent satellite programs. The Defense Department formed a panel to evaluate these proposals, and in August 1955 ruled in favor of the Naval Research Laboratory's Project Vanguard, apparently ending Redstone Arsenal's space aspirations.[74] Some suspected that sentiment in the Defense Department that the first American satellite should not be launched by a German team influenced the decision.[75]

The Army Ballistic Missile Agency

Organizational changes and new assignments nonetheless demonstrated that Huntsville would remain at the center of military rocketry. The Army reorganized its missile development program, establishing the ABMA at Redstone Arsenal. The new organization incorporated the Guided Missile Center and the Redstone missile project. Redstone's Ordnance Missile Laboratory also received authorization to begin development of an Intermediate Range Ballistic Missile (IRBM), a single-stage liquid-fuel vehicle expected to have a range of 1,500 miles. Designated the Jupiter, the new missile was to exploit Redstone technology.

General John B. Medaris, who assumed command of ABMA in February 1956, was a no-nonsense commander. "He had an iron fist," Helmut Hoelzer recalled, but he was "an excellent, outstanding man." Medaris's direct, demanding approach suited the high expectations the Army had for ABMA. Medaris was "very blunt" according to Erich Neubert, but "it was a time to be blunt." Using the high priority granted him by the Army, Medaris expanded operations. He brought in top military and civilian personnel, tripling the number of employees to 5,000.[76]

The optimistic, "can-do" mood that visitors noticed at ABMA in 1956 was tempered by restrictions preventing Jupiter from competing with Project Vanguard as the American satellite program. Medaris submitted proposals to the Defense Department requesting authority to develop Jupiter as an alternate means of launching a satellite, only to be rebuffed. "We at Huntsville knew that our rocket technology was fully capable of satellite application and could quickly be implemented," von Braun later reflected. When ABMA launched its first Jupiter–C on 20 September 1956, the Defense Department sent observers to ensure that the Army did not activate a dummy fourth stage and orbit a booster before Vanguard.[77]

Jupiter research proceeded in competition not with Vanguard, but with the Air Force's Thor. The greater altitude to be achieved by the new generation of missiles nonetheless allowed ABMA to study problems related to space flight. One of the most puzzling questions was how to deal with the heat generated by re-entry of missiles into the Earth's atmosphere. The Air Force favored a heat-sink concept in which nosecone materials would absorb heat; ABMA preferred ablation, in which materials shielding the nosecone would melt and peel away,

carrying off excessive heat. Ablation had the advantage of dissipating more heat and allowing more accuracy, and came to be the preferred technique. Jupiter–C launches in 1956 and 1957 tested the feasibility of ablation, and allowed ABMA to demonstrate the capabilities of the new vehicle by exceeding an altitude of 600 miles.[78] Reentry studies also gave ABMA a means to skirt Defense Department range restrictions. William R. Lucas remembered that in spite of these restrictions, "we went ahead and developed a launch vehicle anyway and justified it on the basis of testing nose cones."[79]

Explorer Project Leaders: Dr. Rees, Major General Medaris, Dr. von Braun, Dr. Stuhlinger, and (in back) Mr. Mrazek, and Dr. Haeussermann.

From Sputnik I to Explorer I

Until the autumn of 1957, the United States had no coherent space program except as an adjunct to military missile research. The launch of Sputnik I by the Russians on 4 October prompted a reevaluation of the national role in space research. Neil McElroy, the incoming secretary of defense, was visiting Redstone Arsenal when he received news of Sputnik. At dinner that evening von Braun and Medaris sat on either side of McElroy; von Braun insisted that ABMA

could launch a satellite into orbit within 60 days, Medaris cautioned that 90 might be more realistic. Three days later, Secretary of the Army Wilbur M. Brucker urged the secretary of defense to allow ABMA to use a Jupiter–C to launch a satellite, promising a launch within four months of approval. Only after the Soviet Union launched a 1,120 pound Sputnik II with the dog Laika aboard on 3 November did the Department of Defense agree. At the request of the Army, Defense set a launch date of 29 January. After Vanguard exploded on its launch pad on 6 December, ABMA became the focus of American hopes to recoup some of the prestige lost to the Soviet Union.[80]

Frantic activity at Huntsville and the Atlantic Missile Range at Cape Canaveral, Florida, characterized the 84 days between authorization and launch of ABMA's satellite. President Eisenhower, trying to avoid being pushed into a race with the Russians, refused to approve a mission without a scientific satellite that could contribute to the International Geophysical Year (IGY).[81] Dr. William H. Pickering of the JPL at the California Institute of Technology developed Explorer I, a 34-inch-long satellite, 6 inches in diameter, weighing just over 18 pounds. Dr. James A. Van Allen of the University of Iowa contributed instruments to measure cosmic radiation. ABMA fashioned a launch vehicle, designated Juno 1, by attaching a cluster of solid propellant rockets atop a Jupiter–C. Explorer I was ready for launch on schedule, but weather forced postponement for two days. On 31 January 1958, Explorer I lifted into an orbit with an apogee of 1,594 miles.[82]

The Establishment of NASA and the Fate of ABMA

In the harried atmosphere of panic following Sputnik, the Defense Department, Congress, and the Eisenhower administration all generated proposals from which a national space policy would emerge. In the balance were crucial decisions: Would the space program be civilian or military? How would the military services divide responsibility for missile development? Should space research be dominated by manned programs or unmanned satellites?

Since the American space program before Sputnik had been exclusively military, the Defense Department became the principal target of post-Sputnik criticism. Some was facile, such as the allegation that the Russians had gotten the better Germans after the war. More substantive critiques charged duplication in the Army's Jupiter and the Air Force's Thor, bureaucratic delays, and interservice

rivalry. Even before Sputnik, Defense apportioned the military program by limiting the Army to land-based IRBMs with ranges up to 200 miles (the range of Redstone), and giving the Air Force longer range Intercontinental Ballistic Missiles (ICBMs). A week after the launch of Explorer I, Secretary of Defense McElroy sought greater coordination of military space programs by establishing an Advanced Research Project Agency (ARPA), and appointing General Electric vice president Roy W. Johnson as its director. The Agency had authority to initiate space projects approved by the President for one year, and Johnson soon received proposals to put a man in space from ABMA (Project Adam) and the Air Force (Man-in-Space-Soonest).[83]

Congress, awakened to public pressure, entered the debate. Senator Lyndon B. Johnson chaired hearings that treated Sputnik as "a technological Pearl Harbor," and Congressmen began filing proposals for a national space policy.[84]

The Eisenhower administration refused to be stampeded into a space race. Eisenhower transferred the Office of Defense Mobilization Science Advisory Committee to the White House staff, and named James R. Killian, Jr. as its chairman and as special assistant to the President for Science and Technology. Killian agreed with the President that space research should not be approached as a measure of national prestige, but rather as one of many avenues for scientific inquiry, each of which should be evaluated solely on the basis of its potential contribution to scientific progress. Eisenhower directed them to prepare two reports, a policy statement on space research and a recommendation for national space policy. Late in February, the Presidential Science Advisory Committee (PSAC) submitted a proposal to use the NACA as a foundation for a new agency to direct national research on astronautics. In a message to Congress on 2 April, Eisenhower proposed establishment of a National Aeronautics and Space Agency that would absorb the NACA. American space exploration, the President insisted, should be conducted "under the direction of a civilian agency except for those projects primarily associated with military requirements."[85]

While Congress debated the President's proposal, von Braun kept alive ABMA hopes for a role in space by supporting projects managed by ARPA. Another Jupiter–C (Juno 1) failed to put Explorer II in orbit when the fourth stage failed to ignite on 5 March, but the same configuration succeeded in orbiting Explorer III later that month. By the end of the Juno 1 series in October, ABMA had launched three satellites and failed in three other attempts.[86]

In August, ARPA approved an ABMA proposal to develop a multi-stage rocket with a clustered-engine first stage. Although originally called Juno 5, the new project envisioned a rocket much larger than those used in the Juno/Explorer program, powerful enough to generate 1.5 million pounds thrust—enough to lift payloads weighing tons into orbit. Later called the Saturn I, it soon became ABMA's most important project.[87]

ABMA also proposed using a Redstone as a booster for a manned suborbital flight. Project Adam advocated sealing a man in a cylindrical capsule for a flight of 150 miles in altitude and 150 miles range. Ridiculed as the equivalent of firing a person from a circus cannon, the proposal died aborning, the victim of Air Force opposition and uncertainty over plans for a civilian space agency. Despite such criticism, the early suborbital Mercury flights were much like Project Adam.[88]

The civilian space agency became a reality when President Eisenhower signed the National Aeronautics and Space Act on 29 July 1958. Dr. T. Keith Glennan became the first Administrator of NASA. NASA went into operation on 1 October, absorbing NACA's 8,000 personnel and five laboratories.[89] The Space Act also assigned the Navy's Vanguard project and several Air Force projects to NASA, as well as three of ABMA's satellite projects and two of its lunar probes.[90]

Although the Space Act gave some ABMA projects to NASA, it did not specify whether the von Braun team should remain with the Army or transfer to NASA. By the middle of October, Glennan requested transfer of more that half of the Ordnance Missile Command (von Braun's group) to NASA. Medaris was enraged at the prospect of losing the heart of ABMA and by the lack of support from Assistant Secretary of Defense Donald A. Quarles, who seemed to accept the prospect of transfer with undue equanimity. Von Braun opposed transfer, fearing that it might lead to dispersal of his team. He owed Medaris loyalty and feared that NASA might not be as supportive of in-house development.[91] He and some of his lieutenants told of lucrative offers from private industry and threatened to resign from government service if the team was divided.[92]

Eisenhower held a meeting of the National Aeronautics and Space Council on 29 October, and made it clear that he expected NASA and the Department of Defense to resolve the dispute. Five weeks later, Defense and NASA announced an agreement that transferred JPL to NASA. Von Braun's team would remain

intact under Army control, but would be "continually responsive to NASA requirements." Neither side was satisfied. NASA considered the compromise a victory for the Army, since von Braun's Ordnance Missile Command was the more important facility. The Army resented loss of JPL. Although NASA Director Glennan insisted "this agreement is a final agreement," some in the Army suspected that NASA considered the arrangement only a deferred decision, not a resolution.[93]

NASA was disappointed with the failure to acquire the von Braun team, but its appraisal of ABMA was ambivalent. NASA administrators respected the achievements of the Germans at Redstone Arsenal, but harbored misgivings about their way of doing business. Glennan's staff warned him that the Aircraft Industries Association considered the arsenal system to be "hopelessly outmoded," and suggested that if NASA were to absorb ABMA, "it should be made plain beyond any possibility of mistake that what is being taken over are the ABMA personnel and facilities, not the ABMA way of doing business."[94] After reading an article by Walter Dornberger on the lessons of Peenemünde, Deputy Administrator Hugh L. Dryden concluded "I have been generally familiar with the V–2 operation, and I have talked with many of the scientists and engineers involved. The general principles of the required management are well known; it seems difficult to get them adopted in a democracy."[95]

But ABMA was too important to ignore. NASA had to depend on the Army for boosters, and Saturn was a key to civilian space exploration. Glennan respected his agreement not to try to absorb ABMA, but his subordinates had other ideas. "We should move in on ABMA in the strongest possible way," his assistant Wesley L. Hjornevik argued, urging Glennan to seek "a beachhead on the big cluster." Hjornevik, however, worried that ABMA might not "play ball right down the line," and suggested "making clear to ABMA that we don't propose to delegate control or responsibility."[96]

The Army and NASA nonetheless began to work under their ambiguous relationship. Medaris and Glennan maintained proper but cool relations. Glennan rejected Medaris's suggestion to add ABMA representatives to NASA research advisory committees, and dispatched a NASA representative to Huntsville.[97] NASA contracted with ABMA to provide eight Redstones for early Project Mercury suborbital flights; reconfigured Mercury-Redstones would be the workhorses of the early manned space program. ABMA continued work on the clustered Saturn booster, which figured prominently in NASA's long-range plans.

Development of the first stage H–1 engine, which would be clustered to power the first stage, proceeded as ABMA considered proposed configurations for other stages.[98]

Project Saturn elicited controversy from the start, and was the catalyst that led to the transfer of ABMA to NASA. ABMA's position became increasingly untenable, its mission at odds with its capabilities. Project Saturn's large boosters offered power far beyond anything needed by the Army under Department of Defense directives for military missile programs. So while the Air Force and NASA needed large boosters, their capabilities in this field were less than those of the Army, which was forbidden to use them. The Air Force used this logic in proposing the transfer of the von Braun team to its cognizance.[99]

Herbert F. York, the Defense Department's director of Research and Engineering, posed a more serious challenge. York believed that big boosters should be developed under NASA, and that Saturn was becoming both a distraction and a financial drain on DOD's resources. "Von Braun, Medaris, and ABMA were and had been seriously interfering with the ability of the Army to accomplish its primary mission," York recalled. "Whenever the Army was given another dollar, Secretary Brucker put it into space rather than into supporting the Army's capability for ground warfare."[100] In April, York issued an order to cancel Saturn, arguing that there was "no military justification" for the large booster.[101]

York's decision cast doubts on the future not only of Saturn, but of ABMA itself. In bitter memoirs, Medaris described what he considered a well-orchestrated plan by "project snatchers" to sever von Braun's group from the Army. He described the dilemma: "By this time it was crystal clear to both von Braun and myself that we were faced with a Solomon's choice—either we could hold firm in an attempt to keep the von Braun group in the Army, being sure that in doing so we were guaranteeing that their space capabilities would die on the vine, or we could support the effort to take the von Braun organization out of the Army and hope that a fond and wealthy foster parent could be found."[102]

The only potential foster parents were the Air Force and NASA. The Air Force, which would have fallen under York's strictures in any case, was an anathema to Medaris and von Braun. Von Braun feared that Air Force reliance on contractors, and aircraft industry hostility to major in-house activities operated by the government, would have led to decay of his team under the Air Force. NASA had drawbacks, too. Eisenhower and his science advisors favored a civilian

space program, but one in which space would have to compete with other scientific research programs for federal dollars, so funding could be limited.[103] In contrast, pressures of the Cold War, which by now included allegations of a missile gap between the United States and the Soviet Union, seemed to promise a continued military program. Nonetheless, to Medaris and von Braun, NASA seemed the lesser evil.

Discussions between Defense and NASA continued through the summer and into the autumn of 1959. York, who later claimed that he was "largely responsible" for the transfer of the von Braun group, approached Glennan and proposed another attempt. Glennan agreed, although York admitted "there was more push on my part than there was pull on his part." York conferred with McElroy and the President, and won their concurrence.[104] By 6 October, negotiators hammered out an agreement to transfer von Braun's Development Operations Division of ABMA to NASA, and to assign NASA "responsibility for the development of space booster vehicle systems of any generations beyond those based upon IRBM and ICBM missiles as first stages."[105]

Medaris and von Braun attacked the agreement. Medaris announced that he would retire, and von Braun threatened to do the same.[106] Brucker privately assured von Braun that his team could stay together and continue to work on Saturn under NASA, and later claimed that von Braun "expressed to me at the time not only a willingness, but finally a desire" for the transfer.[107]

From ABMA to the George C. Marshall Space Flight Center

President Eisenhower met with Glennan, McElroy, Dryden, York, and his top science advisers on 21 October and approved the transfer.[108] Glennan suggested that the new NASA facility be named for General George C. Marshall because of his "image of a military man greatly dedicated to the cause of peace." Marshall's Nobel Peace Prize, initiation of the Marshall Plan, and service as secretary of state obviated concerns about the propriety of naming a civilian space center after a military man. Eisenhower agreed, saying "I can think of no one whom I would more wish to honor."[109]

The President forwarded a formal transfer plan to Congress on 14 January 1960. Under the terms of the 1958 Space Act, the transfer would become effective in 60 days unless Congress adopted a resolution opposing it. Joint Army-NASA

support made opposition unlikely, but rumors persisted that von Braun had been "clubbed" or "blackmailed," that communications between Defense and NASA had broken down. The Senate Committee on Aeronautical and Space Sciences held hearings in February to determine if there were difficulties that might impede transfer. General Medaris, by then retired, offered the most volatile testimony, explaining that "With the army's total inability to secure from the Department of Defense sufficient money or responsibility to do the space job properly, we found ourselves in the position of either agreeing with the transfer of the team or watching it be destroyed by starvation and frustration." But even Medaris conceded that "this transfer is the least bad solution that can be found, and I therefore support it."[110]

Nothing rose in hearings in either the House or Senate that threatened to derail the plan. The House even passed a resolution urging immediate implementation. The Senate failed to follow suit, however, and the plan became effective on 14 March after the expiration of the 60-day statutory waiting period. President Eisenhower issued an executive order on 15 March making the action official.

President Eisenhower and Mrs. George C. Marshall unveiling the bust of General Marshall at MSFC dedication.

The transfer would be effective on 1 July to coincide with the start of a new fiscal year, allowing time to work out final details of the arrangement. NASA received all unobligated Saturn funds immediately, although it did not assume full responsibility for Saturn until July.[111]

Von Braun remained at the head of his organization and became the director of the George C. Marshall Space Flight Center. The transfer shifted 4,670 people to NASA. NASA took control of 1,200 acres at Redstone Arsenal under a 99-year, non-revocable, renewable use permit, and received facilities of the Development Operations Division of ABMA valued at $100 million, of which $14 million was at Cape Canaveral. ABMA's Missile Firing Laboratory at the Cape became the Launch Operations Directorate under NASA, with Debus of the von Braun team retained as its director. The operational laboratories under ABMA's Development Operations Division became the new divisions of the new space center.[112]

George C. Marshall Space Flight Center became a reality in a quiet ceremony on 1 July. Major General August Schomburg, commander of the Army Ordnance Missile Command, said he felt like the father of the bride, commenting that the Army had provided a sizable dowry. "And I don't mean to imply that this is a shotgun wedding," he joked.[113] On 8 September, President Eisenhower dedicated the Center in a ceremony attended by Marshall's widow, and highlighted by the unveiling of a granite bust of the general which now stands in the lobby of the Marshall Center headquarters.

Marshall was now a full-fledged unit of NASA. For most employees, the change made little difference. Kingsbury remembered that on 1 July, "about 4,000 of us were told, 'You now work for somebody else. Your check will have a green stripe down the middle.' That was the only difference."[114]

But the year of controversy preceding transfer of the Development Operations Division had ramifications. Von Braun's decision to stay with the Army kept his team together, but also kept it out of NASA during the Agency's formative first year, limiting its role in the early development of the American civilian space program. During that year a small group of engineers from Langley, designated the Space Task Group (STG), assumed a role at the center of NASA planning for manned space flight. Comprised of only 35 members at NASA's founding, STG's numbers swelled to 350 by July 1959.[115] Suspicion of ABMA's approach—arsenal system, reliability testing, engineering conservatism—took hold among NASA administrators. One account of the Apollo program claimed that von Braun's people "had missed their chance to run the whole mission when they had stayed with the Army for the first year after NASA was founded."[116]

Other uncertainties clouded Marshall's future. The new Center had responsibility for "research and development of large launch vehicle systems" under NASA; Saturn would remain its major project. But would NASA allow Marshall to broaden its mission beyond propulsion? NASA recognized its new acquisition as "a team of outstanding experts who are capable not only of 'in-house' research and development of large launch vehicles, but also of providing, as needed, the responsible technical monitoring and direction of the various industrial contractors who assist in the engineering and production of such launch vehicles."[117] Would Marshall maintain this in-house capability under NASA? In 1960, even the extent of the national commitment to space was not clear, nor had the military relinquished interest in space. Eisenhower's visit to Huntsville to dedicate Marshall took place just two months before the 1960 presidential election. The questions surrounding the new Center's future would be decided under a new administration.

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1 *Huntsville Times*, 8 September 1960.

2 The Manned Spacecraft Center in Houston (later renamed the Johnson Space Center) was approximately the same size as Marshall in terms of personnel in the 1960s and 1970s.

3 James R. Hansen, *Engineer in Charge: A History of the Langley Aeronautical Laboratory*, 1917–1958 (Washington: NASA SP–4305), pp. 187–88; Alex Roland, "Model Research: The National Advisory Committee for Aeronautics, 1915–1958" (Washington: NASA SP–4103, 1985); Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander, *This New Ocean: A History of Project Mercury* (Washington: NASA SP–4201, 1966), pp. 6, 8.

4 Helen Brents Joiner, "The Redstone Arsenal Complex in the Pre-Missile Era: A History of Huntsville Arsenal, Gulf Chemical Warfare Depot, and Redstone Arsenal, 1941–1949" (Redstone Arsenal, Alabama: Historical Division, Army Missile Command, 22 June 1966), passim.; Elise Hopkins Stephens, *Historic Huntsville: A City of New Beginnings* (Woodland Hills, California: Windsor Publications, 1984), pp. 82–113.

5 Hansen, pp. 187–217; Arnold S. Levine, *Managing NASA in the Apollo Era* (NASA SP–4102, 1982), pp. 9–11; Swenson, Grimwood and Alexander, pp. 9–10.

6 The two most recent comprehensive treatments of the German roots of the group of rocket experts that accompanied Wernher von Braun to Huntsville in the 1950s, and especially of their experiences at Peenemünde, are Michael J. Neufeld, *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era* (New York: The Free Press, 1995); and Ernst Stuhlinger and Frederick I. Ordway III, *Wernher von Braun, Crusader for Space: A Biographical Memoir* (Malabar, Florida: Krieger Publishing Company, 1994).

7 Ernst Stuhlinger and Frederick I. Ordway III, *Wernher von Braun, Crusader for Space: A Biographical Memoir* (Malabar, Florida: Krieger Publishing Company, 1994), p. 15; Walter A. McDougall, *... the Heavens and the Earth: A Political History of the Space Age*

(New York: Basic Books, Inc., 1985), pp. 20–40. Stuhlinger and Ordway's book is the most comprehensive biography of von Braun.

8 Historian Michael J. Neufeld has argued, however, that the lack of a clause forbidding rocketry in the Versailles Treaty has been overrated as factor in the army's interest in rockets since the Army pursued development of other prohibited weapons, such as poison gas. Neufeld, "The Guided Missile and the Third Reich: Peenemünde and the Forging of a Technological Revolution," in Monika Remmeberg and Mark Walker, eds., Science, *Technology and National Socialism* (Cambridge: Cambridge University Press, 1994), p. 56.

9 Cited in Michael J. Neufeld, "Peenemünde-Ost: The State, the Military, and Technological Change in the Third Reich," paper presented at the International Congress of the History of Science, Hamburg, West Germany, 2 August 1989, p. 3. Neufeld cites von Braun team member Gerhard Reisig in attributing the phrase to Dornberger.

10 Walter R. Dornberger, "The Lessons of Peenemünde," *Astronautics* (March 1958), p. 18.

11 Neufeld, "Peenemünde-Ost: The State, the Military, and Technological Change in the Third Reich," pp. 4–6, 10–11; Ernst Stuhlinger, Oral History Interview by Stephen P. Waring and Andrew J. Dunar (hereafter OHI by SPW and AJD), 24 April 1989, Huntsville, Alabama.

12 Georg von Tiesenhausen, OHI by AJD and SPW, 29 November 1988, Huntsville, Alabama; Neufeld, pp. 10–11.

13 Stuhlinger, OHI, 24 April 1989.

14 Major General John B. Medaris with Arthur Gordon, *Countdown for Decision* (New York: G. P. Putnam's Sons, 1960), pp. 37–38.

15 General Walter Dornberger, "Rockets," interview by F. Zwicky, 1 October 1945, Von Braun Interrogations in Germany folder, NASA History Division Documents Collection; Von Braun, "An Historical Essay."

16 Dieter K. Huzel, *Peenemünde to Canaveral* (Englewood Cliffs, New Jersey: Prentice-Hall, 1962; reprinted by Greenwood Press, 1981), pp. 57–63; Michael J. Neufeld, *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era*, (New York: The Free Press, 1995), pp. 198–200; Ordway and Sharpe, pp. 111–23.

17 James McGovern, *Crossbow and Overcast* (New York: William Morrow & Co., 1964), pp. 46–54; Albert Speer, *Inside the Third Reich* (New York: The Macmillan Company, 1970), pp. 371–72.

18 "History of German Guided Missiles;" Christopher Simpson, *Blowback: America's Recruitment of Nazis and Its Effects on the Cold War* (New York: Weidenfeld & Nicolson, 1988), pp. 28–31.

19 Ordway and Sharpe, pp. 405–408. Appendix A in this volume discusses sources for estimates of V–2 production.

20 "History of German Guided Missiles;" Speer, pp. 365–66.

21 "History of German Guided Missiles."

22 McGovern, pp. 110–17; Dieter K. Huzel, *Peenemünde to Canaveral* (Westport, Connecticut: Greenwood Press, 1962), pp. 151–65; Ordway and Sharpe, pp. 261–67.

23 McGovern, pp. 141–45.

24 McGovern, pp. 96, 100–03; Ordway and Sharpe, pp. 277–78. Toftoy's position was chief of Ordnance Technical Intelligence in Europe; Staver was assigned to the Ordnance Technical Division in London. Trichel would soon retire, but his contribution to Army

rocketry and to the assembly of the von Braun team was crucial. Staver and Toftoy (and Toftoy subordinate James Hamill) played key roles in Project Paperclip and in the transfer of V–2s to the United States, and Robert Porter of Project Hermes was one of the first Americans to interrogate the Germans. Toftoy credited Trichel with "planning and working out the original Army missile program," and for doing the ground work from which the program developed. Cited in Shirley Thomas, *Men of Space*, Vol. 3 (Philadelphia: Chilton Company, 1961), p. 220.

25 McGovern, pp. 154–75. The Army shipped the V–2 parts, which filled the hulls of sixteen Liberty ships, to the newly commissioned White Sands Proving Ground in New Mexico, storing them on the open desert. Major General H.N. Toftoy and Colonel J.P. Hamill, "Historical Summary on the Von Braun Missile Team," 29 September 1959, p. 2, University of Alabama in Huntsville (UAH) Saturn Collection.

26 Clarence A. Lasby, *Project Paperclip: German Scientists and the Cold War* (New York: Atheneum, 1971), pp. 51–61.

27 Christopher Simpson, *Blowback: America's Recruitment of Nazis and Its Effects on the Cold War* (New York: Weidenfeld & Nicolson, 1988), pp. 32–36. Regarding von Braun's SS award, Ernst Stuhlinger explained that Himmler tried to lure von Braun from the army to the SS, presenting the honorary rank in 1940 and a promotion in 1943. Von Braun's refusal contributed to Himmler's decision to imprison him in a Gestapo prison in 1944. Stuhlinger, undated comments to authors on chapter draft; Stuhlinger and Ordway, pp. 32–33.

28 Simpson, pp. 28–30. The case of Arthur Rudolph was another matter, for Rudolph served as production manager at Mittelwerk. Rudolph, who earned honors as the chief of the Saturn booster program in the 1960s, became the center of controversy in the 1980s when a Justice Department investigation reopened his case. First investigated in 1947, Rudolph was at that time cleared for entry into the United States. For information on Dornberger's and von Braun's influence on production schedules, see Stuhlinger to Michael Wright, comments on draft chapter, 1990, MSFC history office.

29 Stuhlinger and Ordway, pp. 46–53.

30 David Irving, *The Mare's Nest* (Boston: Little, Brown and Company, 1964, 1965), p. 21; McGovern, pp. 19–20; Ordway and Sharpe, pp. 41–42.

31 Eberhard Rees, OHI by Donald Tarter and Konrad Dannenberg, Huntsville, Alabama, 1985.

32 Simpson, pp. 32–34; McGovern, p. 78.

33 Lasby, pp. 88–92, 102, 114–16, 124–25; McGovern, pp. 73–74.

34 The six to accompany von Braun were Wilhelm Jungert, Erich Neubert, Theodore Poppel, Eberhard Rees, Wilhelm Schulze, and Walter Schwidetzki. William Joseph Stubno, Jr., "The Impact of the Von Braun Board of Directors on the American Space Program," (MA thesis, University of Alabama in Huntsville, 1980), p. 23.

35 Ordway and Sharpe, pp. 310–14; quotation is from Toftoy and Hamill, "Historical Summary on the Von Braun Missile Team."

36 Ordway and Sharpe, pp. 346–49; Stuhlinger, OHI, 24 April 1989; Erich Neubert, OHI by AJD, 27 July 1989, Huntsville, Alabama.

37 Colonel Holger N. Toftoy, press release, 10 May 1946, Press Release by Col. Toftoy file, Dr Wernher von Braun, White Sands/Fort Bliss 1945 (Sept.)—1950 (April) Drawer, Von

Braun Collection, ASRC; Stuhlinger, OHI, 24 April 1989; E. H. Krause, "General Introduction" to "Upper Atmosphere Research Report No. I," Naval Research Laboratory, (1 October 1946), pp. 1–2.

38 "What We Have Learned from V–2 Firings," *Aviation Week* (26 November 1951), 23 ff; David S. Akens, "Historical Origins of the George C. Marshall Space Flight Center," MSFC Historical Monograph No. 1 (Huntsville: MSFC, 1960), pp. 30–35. The launching that won the most publicity was an errant V–2 that strayed over the Mexican border toward Ciudad Juarez. A tragedy was averted when the rocket landed harmlessly on a hillside, and the Germans could later joke that they had launched the first American missile against a foreign nation.

39 Michael J. Neufeld, who is conducting a study of Peenemünde, has found no term corresponding to "team" in the Peenemünde period, and suggests that the closest equivalent might be the term "Arbeitsgemeinschaft Vorhaben Peenemünde" (roughly translated as Peenemünde Project Working Group or Working Community), a label used to signify some of the university-technical links that relied on personal ties as well. Neufeld to SPW, 29 August 1989.

40 Stuhlinger and Ordway, pp. 74–75.

41 Hamill to von Braun, memorandum, 7 February 1946, Personnel: Regulations, Restrictions, 1946 Fort Bliss File, Dr. Wernher von Braun White Sands-Fort Bliss, 1945 (Sept.)-1950 (April) Drawer, Von Braun Papers, U.S. Space and Rocket Center, Huntsville, Alabama.

42 Ordway and Sharpe, p. 351.

43 Von Braun to Hamill, 12 January 1948, Correspondence—Special Letters File, White Sands-Fort Bliss, 1945 (Sept.)-1950 (April) Drawer, Von Braun Papers, U.S. Space and Rocket Center; Ordway and Sharpe, p. 351.

44 Thomas, p. 223; Ordway and Sharpe, pp. 358–59.

45 Among the canceled projects was a 1947 proposal developed by von Braun, Hamill, and Eberhard Rees to develop a 200-ton thrust rocket motor. Major General H.N. Toftoy and Colonel J.P. Hamill, "Historical Summary on the Von Braun Missile Team," p. 10, UAH Saturn Collection.

46 Erik Bergaust, *Wernher von Braun* (Washington, D.C.: National Space Institute, 1975), pp. 151–53; Peter Cobun, "Toftoy's Foresight Led to Huntsville's Rebirth," *Huntsville Times*, 4 June 1989; Toftoy and Hamill, p. 10; Stuhlinger and Ordway, p. 97.

47 Helen Brents Joiner and Elizabeth C. Jolliff, "The Redstone Arsenal Complex in its Second Decade, 1950–1960" (Army Missile Command, Redstone Arsenal, 28 May 1969), p. 29.

48 Hertha Heller, OHI by AJD, 16 February 1989, Huntsville, Alabama; Stuhlinger, OHI, 24 April 1989; Ordway and Sharpe, pp. 357–59.

49 Stuhlinger, OHI, 24 April 1989; Heller, OHI.

50 Ruth von Saurma, OHI by AJD, 21 July 1989, Huntsville, Alabama; Hertha Heller, OHI; "From Cotton to Space," *Huntsville Times*, 8 October 1989.

51 Paul O'Neill, "The Splendid Anachronism of Huntsville," *Fortune* 65 (June 1962), p. 155.

52 Ordway and Sharpe, pp. 367–69, 376–77; Walter Wiesman, OHI by AJD and SPW, 13 April 1989, Huntsville, Alabama; Hertha Heller, OHI. The first members of the von Braun group to become citizens took their oath in Birmingham in November 1954. Weisman, undated note to authors on chapter draft.

53 Charles R. Lundquist, OHI by SPW, 21 August 1990, Huntsville, Alabama, p. 1.
54 James Kingsbury, OHI by SPW, 22 August 1990, Huntsville, Alabama, pp. 1–2.
55 Henry Pohl, OHI by AJD and SPW, 13 July 1990, Houston, Texas, pp. 1–2.
56 Joe Lombardo, OHI by Jessie Whalen, 12 May 1989, Huntsville, Alabama, p. 4.
57 Stan Reinartz, OHI by SPW, 10 January 1991, Huntsville, Alabama, p. 1.
58 Lee B. James, OHI by SPW, 1 December 1989, Huntsville, Alabama, p. 1.
59 Richard A. Marmann, OHI by AJD, 19 July 1994, Huntsville, Alabama.
60 Jack Waite, OHI by Sarah A. Kidd, 5 August 1992, Huntsville, Alabama, p. 1.
61 Sylvia Doughty Fries, *NASA Engineers and the Age of Apollo* (Washington, D.C.: NASA SP–4104), pp. 102–03.
62 Leland Belew, OHI by SPW, 1 September 1990, Huntsville, Alabama, pp. 1–2.
63 William R. Lucas, OHI by AJD and SPW, 19 June 1989, Huntsville, Alabama, pp. 1–2.
64 William C. Snoddy, OHI by AJD and SPW, 22 July 1992, p. 1.
65 Arthur E. Sanderson, OHI by AJD, 20 April 1990, Huntsville, Alabama, pp. 1–2.
66 Snoddy, OHI, pp. 3–5.
67 Toftoy and Hamill, pp. 10–13; Akens, pp. 36–38; Ordway and Sharpe, pp. 370–74.
68 Stuhlinger, OHI, 24 April 1989.
69 Karl Heimburg, OHI by AJD and SPW, 2 April 1989, Huntsville, Alabama.
70 Akens, p. 37; Heimburg, OHI; Ordway and Sharpe, pp. 372. James Kingsbury, former director of science and engineering at MSFC, note that the $75,000 figure is not truly a fair basis for comparison, since it included salaries while the $1,000 figure did not. Kingsbury, undated note to authors on chapter draft.
71 Kurt H. Debus, "From A4 to Explorer I," paper presented at 24th International Astronautical Congress, Baku, USSR, 8 October 1973, Debus/1973/Redstone/Pershing/Jupiter folder, NASA History Division Documents Collection, Washington, D.C.
72 Wernher von Braun, "Man on the Moon: The Journey," *Collier's* (18 October 1952), pp. 52–59. The *Collier's* series continued with occasional articles by von Braun and other authorities on space travel in 1953 and 1954. Another von Braun article (27 June 1953) advocated the establishment of a Space Station.
73 Von Braun's proposal, titled "A Minimum Satellite Vehicle Based Upon Components Available From Missile Development of the Army Ordnance Corps," advocated using the Redstone for a launch vehicle.
74 Akens, pp. 38–39.
75 Ordway and Sharpe, p. 376.
76 Helmut Hoelzer, OHI by AJD, 25 July 1989, Huntsville, Alabama; Neubert, OHI; Debus, p.33; Medaris, p. 72.
77 Patricia Yingling White, "The United States Enters Space, 1945–1958: A Study of National Priorities and the Decision-Making Process in the Artificial Satellite Program," (MA Thesis, Ohio State University, 1969), pp. 90–93; Akens, pp. 42–43.
78 Debus, p. 36; Medaris, pp. 142–44; William Lucas, OHI by AJD and SPW, 19 June 1989, Huntsville, Alabama. H. Julian (Harvey) Allen of Ames Research Center, who developed the blunt-body theory used for Project Mercury capsule re-entry, also conducted pioneering experiments on ablation in the 1950s independent of the work at ABMA. Muenger, Elizabeth, *Searching the Horizon: A History of Ames Research Center*, 1940–1976 (Washington: NASA SP–4304, 1985), pp. 66–67, 131–32.

79 William Lucas, OHI by SPW, 4 April 1994, Huntsville, Alabama, p. 7.

80 White, p. 95; Medaris, pp. 151–90; Ordway and Sharpe, pp. 382–83; Akens, pp. 44–47.

81 Robert A. Divine's *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993) is a comprehensive examination of Eisenhower's attempts to respond calmly in the midst of national panic after the launch of Sputnik. The IGY was a 1957 program of international cooperation in Earth science research.

82 Ordway and Sharpe, pp. 382–86; Debus, pp. 42–54; Medaris, pp. 207–26; Stuhlinger and Ordway, pp. 134–40.

83 Swenson, Grimwood, and Alexander, pp. 25–28; White, pp. 11–112; John M. Logsdon, *The Decision to Go to the Moon: Project Apollo and the National Interest* (Cambridge, Mass.: MIT Press, 1970), pp. 28–29; Alison Griffith, *The National Aeronautics and Space Act: A Study of the Development of Public Policy* (Washington, DC: Public Affairs Press, 1962), pp. 10–11.

84 White, pp. 114–20; McDougall, pp. 151–52.

85 White, pp. 110–11; Swenson, Grimwood, and Alexander, pp. 82–83; Griffith, p. 14; Akens, p. 67.

86 J. Boehm, H. J. Fichtner, and Otto A. Hoberg, "Explorer Satellites Launched by Juno 1 and Juno 2 Vehicles," in *Peenemünde to Outer Space*, edited by Ernst Stuhlinger, et. al. (Huntsville: Marshall Space Flight Center, 1962), pp. 163–65.

87 ABMA initially proposed Saturn in December 1957 in a report titled "Proposal for a National Integrated Missile and Space Vehicle Development Program." Akens, pp. 58–60; Wernher von Braun, "The Redstone, Jupiter, and Juno," *Technology and Culture*, IV(Fall 1963).

88 ABMA, "Development Proposal for Project Adam," (17 April 1958), pp. 1–3; Norman L. Baker, "Air Force Won't Support Project Adam," *Missiles and Rockets* (June 1958), pp. 20–21; Swenson, Grimwood, and Alexander, pp. 99–101, 177.

89 NASA assumed control of the following NACA facilities: Wallops Island Station and Langley Research Center in Virginia; Lewis Research Center in Cleveland; Ames Research Center at Moffett Field and the Flight Research Center at Edwards Air Force Base in California.

90 Richard L. Smoke, "Civil-Military Relations in the American Space Program, 1957–60" (BA Honors Thesis, Harvard University, 1965), pp. 70–71.

91 Smoke, pp. 73–75; Medaris, pp. 242–45; Hoelzer, OHI.

92 *Washington Post*, 16 October 1958; Jim G. Lucas, "Army Expects to Lose Von Braun," *New York World-Telegram & Sun*, 31 October 1958; "The Periscope," *Newsweek*, 10 November 1958.

93 Smoke, pp. 75–76; Medaris, pp. 244–47, 264; T. Keith Glennan and Donald A. Quarles, Press Conference, 3 December 1958, Folder 4.8.2, NASA History Division Documents Collection, Washington, D.C.

94 Memorandum, Walter T. Bonney to Glennan, 30 September 1958, NASA-Army (ABMA) folder, NASA History Division Documents Collection, Washington, D.C.

95 Dryden to Lieutenant General Arthur G. Trudeau, 25 February 1959, Krafft Ehricke—The Peenemünde Rocket Center folder, Vertical file, JSC History Office. Dornberger had

come to the United States as part of Project Paperclip, but not with the von Braun group. He worked for Bell Aircraft Corporation in Buffalo, New York. The article to which Dryden responded was "The Lessons of Peenemünde" *Astronautics* (March 1958), pp. 18–20, 58–60.

96 Memorandum, Wesley L. Hjornevik to Glennan, 20 January 1959, Folder 4.8.2 ABMA, NASA History Division Documents Collection, Washington, D.C.

97 Medaris to Glennan, 18 March 1959, and Glennan to Medaris, 26 March 1959, Folder 4.8.2 ABMA; Memorandum, Glennan, 29 April 1959, NASA History Division Documents Collection, Washington, D.C.

98 Von Braun, "The Redstone, Jupiter and Juno;" Roger E. Bilstein, *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles* (Washington: NASA SP–4206, 1980), pp. 35–37. ABMA also continued to work on ARPA projects, including several satellite missions and deep space probes launched by the Juno 2 series of rockets. Successful missions in this series in 1959 included the launch of Pioneer 4, a deep space probe which went into orbit around the Sun on 3 March; and the launch of Explorer VII, which contained x-ray and cosmic ray experiments on 13 October. The most acclaimed mission of the year was the launch (using a Jupiter booster) and recovery of two monkeys, Able and Baker, on 28 May 1959. Finally, ABMA supervised development of the Pershing, a solid fuel missile, by the Martin Company of Orlando, Florida. Akens, pp. 52–58; U.S. Army Ordnance Missile Command press release, 26 October 1959.

99 Smoke, pp. 78–79.

100 York to Eugene Emme, 10 June 1974, UAH Saturn Collection.

101 Eugene M. Emme, "Historical Perspectives on Apollo," *Journal of Spacecraft and Rockets* 5(April 1968), p. 372. York later acknowledged legitimate Defense interest in Saturn, but not until after approval of the ABMA transfer. At a press conference on 23 October 1959, he granted that "people in Defense regard it as probable that a need will develop, may develop over the next few years. So we do have a positive interest in Saturn because we feel that despite the fact we have no clear-cut need this is a rapidly changing world, space is a new environment, and under no conditions could we foreclose on the possibility that we would need one." Herbert F. York, NASA press conference, 23 October 1959, Washington, D.C., Folder 4.8.2 ABMA, NASA History Division Documents Collection, Washington, D.C.

102 Medaris, p. 266.

103 John M. Logsdon, *Decision to Go to the Moon: Apollo and the National Interest*, (Cambridge, Mass.: MIT Press, 1970), pp. 17–18, 33.

104 York to Eugene Emme, 2 May 1973, UAH Saturn Collection.

105 Draft Memorandum, NASA Administrator and Secretary of Defense to the President, 6 October 1959, NASA-Army (ABMA) folder, NASA History Division Documents Collection, Washington, D.C.

106 *Washington Post*, 21 October 1959.

107 U.S., Congress, House, Committee on Science and Astronautics, hearing, "Transfer of the Development Operations Division of the Army Ballistic Missile Agency to the National Aeronautics and Space Administration: Hearings pursuant to H. J. Res. 567," 86th Cong., 2d sess., 3 February 1960, p. 12.

108 Eisenhower statement, 21 October 1959, ABMA-Transfer to NASA folder, NASA History Division Documents Collection, Washington, D.C.

109 Glennan to Major General Wilton B. Persons, 17 December 1959, Transfer from ABMA file, UAH Saturn Collection.

110 "Transfer Plan Making Certain Transfers from the Department of Defense to the National Aeronautics and Space Administration," 14 January 1959, NASA-Army (ABMA) folder, NASA History Division Documents Collection, Washington, D.C.; Smoke, pp. 88–89; U.S., Congress, Senate, NASA Authorization Subcommittee of the Committee on Aeronautical and Space Sciences, "Transfer of Von Braun Team to NASA: Hearings pursuant to H. J. Res. 567," 86th Cong., 2d sess., 18 February 1960, pp. 2–3, 8–9, 39.

111 Akens, pp. 76–77.

112 ABMA facilities transferred to NASA included: Computation Laboratory (58,465 square feet); Aeroballistics Laboratory (38,860 square feet), including two wind tunnels; Fabrication and Assembly Engineering Laboratory (348,411 square feet), including two missile assembly shops and the Structural Fabrication Building; Guidance and Control Laboratory (306,475 square feet); Test Laboratory (186,614 square feet), including the blockhouse and Static Test Tower; Research Projects Laboratory (7,000 square feet); Missile Firing Laboratory (135,000 square feet), of which the major facilities were located at Cape Canaveral, Florida, and which became the Launch Operations Directorate on 14 June. "Army-NASA Transfer Plan," 11 December 1959, Appendix C in Akens; Akens, pp. 77–80; "Facilities Given NASA Worth $100,000,000," *Redstone Rocket* (6 July 1960), pp. 9–10. Akens details the Army-NASA agreements reached during the negotiations between 14 March and 1 July.

113 *Huntsville Times*, 1 July 1960.

114 James Kingsbury, OHI by SPW, 22 August 1990, p. 2.

115 Swenson, Grimwood, and Alexander, p. 149.

116 The account continued, "They could have come in, after NASA's civilian supremacy was conceded, if they had been willing to desert the Army unceremoniously, but von Braun had not been willing to do that and he had reconciled himself to the consequences." Charles Murray and Catherine Bly Cox, *Apollo: The Race to the Moon* (New York: Simon and Schuster, (1989), p. 136.

117 Albert F. Siepert, "Relating to the Transfer of the ABMA Development Operations Division to NASA," 3 February 1960, NASA Release No. 60–121.