International Academy of Astronautics

35th History of Astronautics Symposium

IAA-01-IAA-2.1.08

Dr. Kurt H. Debus: Launching a Vision

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52nd International Astronautical Congress
1-5 Oct 2001/Toulouse, France

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FOR THE

52nd International Astronautical Congress

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ABSTRACT

The life and career of Dr. Kurt H. Debus, the rocket pioneer from Peenemunde, Germany, who led the creation of what is known today as the Cape Canaveral Spaceport, is a story yet to be reported from start to finish. Yet, this story begs to be told in an age when there is renewed interest in creating a vision of space travel that includes advanced "spaceports." Dr. Debus was a key leader in the German "rocket team" of Wernher von Braun. This paper covers Dr. Debus' life and the extraordinary contributions that he made to the astronautical profession. The paper also describes the important systems engineering role that Dr. Debus and Wernher von Braun encouraged, built, and passed on to succeeding generations. Finally, the paper reflects on the legacy of Dr. Debus and the challenges that remain in developing advanced spaceport architectures and in travel to and from space for anyone, anytime, anywhere.

INTRODUCTION

Space travel, a dream before the twentieth century, has become a series of achievements within living memory. Departures and arrivals to and from space today, while still infrequent, are quite often taken for granted. What common ideas and experiences enabled the pioneering space achievements in the twentieth century? To explore the often-overlooked life and career of Dr. Kurt H. Debus (Figure 1) is to discover the human as well as the scientific nature of how space travel came about.

The technical aspects of Dr. Debus' career cover the operations and support needed to successfully achieve human space flight. However, in tracing the life of Dr. Debus, we also encounter the human qualities of courage, intellect, integrity, vision, and wisdom.

The span of Dr. Debus' astronautical activities is indeed impressive. When researchers were peering into wind tunnels and inventing means for measuring and observing fundamental high-speed aerodynamic phenomena, Dr. Debus was there—in Europe, at Darmstadt Technical University. When Professor Wernher von Braun and Dr. Ernst Steinhoff were exploring on-board measurement techniques for the V-2 rocket and thus creating the newly emerging astronautical discipline of guidance and control, Dr. Debus was there—first in academia, then at the Peenemunde Research Station on Germany's Baltic Coast.

In the late 1940s and early 1950s, Dr. Debus found himself in the sandy desert of New Mexico, putting up tents and removing rattlesnakes during the Cold War's ballistic missile race. He was at Cape Canaveral, standing ready to

FIGURE 1—*Dr. Wernher von Braun and Dr. Kurt H. Debus, a partnership that left us a giant legacy on which to build.*

"call the shot" that would launch the first U.S. satellite into orbit in 1957 for the International Geophysical Year. It was a call that Dr. Debus waited patiently for, and when it finally came in January of 1958, Explorer I was boosted into orbit. He was there to help a nation gain confidence in launching its first citizen into space (Alan Shepard) on the suborbital Mercury-Redstone.

His duty still not completed, Dr. Debus helped the United States meet an ambitious and awe-inspiring goal—to create a "Moonport" to repeatedly land men on the Moon and return them safely to the Earth.

Dr. Debus drew continually from his experience, his insight, and those of other trusted colleagues. His leadership, though, was particularly marked by his ability to convey, both effectively and authoritatively, the vision of space travel that his close colleague, Dr. Wernher von Braun, promoted. In addition to creating the impressive structures and equipment needed to achieve the vision and by applying his team-building knowledge and skills to build real, down-to-Earth capabilities, he established a launch site organization that could help the distant design teams create operationally effective launch vehicles and spacecraft. Further, by drawing from early rocket test stand experiences and familiarity with ballistic missile flight-test operations, his team also created an infrastructure and a knowledge base still intact today. There can be no doubt that many of the fundamentals of large-scale "spaceport technology" emerged from the team he established through his leadership.

Some insight into the von Braun–Debus success story is provided in NASA's history of the Kennedy Space Center ("Moonport, A History of Apollo Launch Facilities and Operations," NASA SP-4204, 1978):

> *The von Braun team preached and practiced that rocket and launch pad must be mated on the drawing board, if they were to be compatible at the launching. The new rocket went hand in hand with its launching facility.*[1]

Their shared successes and failures taught them that the entire architecture (flight and ground systems) had to be thought completely through before commitment. This seamless engineering, the inherent understanding amongst flight system designers, ground systems designers, and operations engineers, is even more relevant today. It is certainly worth exploring in an age when public space travel and tourism (presumably occurring from advanced spaceports) appear to be a part of our future.

FORMATIVE YEARS

Kurt Heinrich Debus was born on November 29, 1908, in Frankfurt-am-Main, Germany, to Heinrich P. J. Debus and Melly F. Graulich (Figures 2 & 3).[2,3] His was an upper middle-class upbringing by his German parents. His youth spanned the pre– and post–World War I period, being reared by his father, who was a bookkeeper and accountant, and his seamstress mother. He experienced the post-war economic depression in Germany and recalled to his children that he would run for a mile just to get bread from a nearby grandmother. During that time after World War I, or the Great War, the emerging field of aeronautics fascinated young Kurt, as the new airplanes of the twentieth century soared nearby his family's home.[4]

FIGURE 2—*Heinrich Debus, father of Kurt Debus*

FIGURE 3—*Young Kurt with his mother, Melly*

Education and Training Around Easter of 1915, the 6-year-old Kurt began school at Klinger-Oberrealschule. He received his formal training at Liebig-Oberrealschule and finished secondary school in 1928. After considering a career in medicine, the young man entered Darmstadt Technical University to pursue electrical engineering.[5]

His practical training was from Easter of 1928 until the fall of 1928. In between various semesters at school, he also trained and worked at Halderwerken A. G. in Frankfurt. He performed various machine shop functions such as machine fitting, tool making, and working with lathes and milling machines. He was then employed for a time with Voight & Haeffner, A. G., also in Frankfurt, engaged in pattern making, foundry operations, creating fixtures, and conducting field tests.[6]

This alternation between semesters of work and study bear a resemblance to the summer student and cooperative (co-op) training programs in place at many colleges and universities today. It is interesting to note that NASA and its Kennedy Space Center have a long and successful tradition with its Co-op Training Program. Dr. Debus initiated this program at Cape Canaveral's Missile Firing Lab in 1958.

Debus initiated more formal studies during the winter of 1929 at the Technical University in nearby Darmstadt, Germany. His course work was in "electro-technique." He joined a fraternity while there and pursued sports, music, and photography. At Darmstadt, he enjoyed a fraternity lifestyle that allowed him to exercise his skills in cooperation and leadership (Figure 4). It also allowed him to take up the highly honored and traditional sport of fencing. This pursuit led to a set of lifelong (and prestigious for those times) scars on his chin and left cheek. At least one event he participated in was photographed

FIGURE 4—*Kurt Debus in fraternity uniform*

FIGURE 5—*Irmgard Helene Brueckmann*

before, during, and after wounds he received from his opponent.[7]

By 1934, he passed examinations for a diploma in "high-tension" techniques. The main subjects during this period were theoretical electro-techniques, measuring techniques, high-tension techniques, and construction of electromechanical machines, networks, installation techniques, and technical theory of heat.[8]

ROCKETRY AND DARMSTADT

Beginning in 1935, Kurt Debus assisted Prof. Dr.–Ing. (Engineering) Ernst Hueter at the Technical University in Darmstadt in "theoretic electro-technique and high tension techniques." Debus continued in this role through the early 1940s as he became associated with the rocket and missile research at Peenemunde, Germany.[9]

Making Ends Meet in the 1930s During the Christmas season of 1932, the young student had met 17-year-old Irmgard 'Gay' Brueckmann (Figure 5). Debus was 24 at the time. Over the next few years, he taught Gay to dance and made numerous trips back and forth to Frankfurt while courting the young, blonde dental assistant. They were married on June 30, 1937. Kurt and Gay Debus would have two daughters in Germany—Ute and Sigried ('Sigi').

During the late 1930s, Darmstadt, including Debus, was given tasks by the German Army (for example, to pursue various scientific investigations into pressure measurement techniques). In later years, Dr. Debus indicated that he knew nothing of the true purpose of these tasks, which was to develop a long-range guided missile.[10]

As Gay later recalled, he would listen to Nazi-banned British radio broadcasts, convinced by what he was hearing and experiencing that the Nazi oppression would bring Germany to "certain destruction."[11] The fencing scars across the face of the good Dr. Debus could not compare with the scars that were about to appear across Europe and the rest of the world during that dark and ominous period of history.

<u>Contracts With von Braun and Peenemunde</u> It was during this period, around 1939, that Debus won his engineering doctorate with a thesis on surge voltages. He continued to serve as an assistant professor under Professor Hueter. Shortly after Hitler initiated hostilities in Europe in 1939, Dr. Debus met Professor Wernher von Braun, Technical Director at the Peenemunde Research Station, Germany's rocket research and development facility. The Peenemunde organization, Debus finally learned, had contracted with Darmstadt to explore various measurement challenges associated with wind tunnels, test stands, and the V-2 missile itself. (The V-2 was known to the team at Peenemunde as the A-4. The Nazi propagandist, Dr. Joseph Goebbels, had redesignated the A-4 rocket as one of Hitler's vengeance, or V–weapons.) For example, Darmstadt conducted research into sensors for measuring oxygen pressures in the A-4 rocket and for devices that would better measure the conditions for shutdown of the missile's propulsion system (or the *Brennshluss* conditions, as it was known to the German scientists).[12] Dr. von Braun had attempted to recruit Dr. Debus into his group, but Debus repeatedly refused.[13]

As World War II progressed, it became difficult to stay neutral from the increasing military activities dominating German life. With growing emphasis by the Reich on rocket research, he was finally given the choice in 1943 of serving at Peenemunde as a civilian or elsewhere as a soldier.[14]

"<u>PRUF STANDS" AND PEENEMUNDE</u>

Dr. Debus appears to have actually joined the research team at Peenemunde in August of 1943.[15,16] Dr. Hans Gruene, a close associate of Dr. Debus through their mutual astronautical careers, recalled being "drafted as a civilian" by the German Army in the summer of 1943. He believed he started at Peenemunde about the same time as Dr. Debus.[17] Dr. Debus and Dr. Gruene soon went to work under Dr. Ernst A. Steinhoff. Specifically, Debus and Gruene worked on the electrical and the guidance and control systems.

Dr. Debus was at first assigned as an "experimental engineer" working on the A-4 missile test stands, or *pruf stands*. The operations team working the actual test launches of the A-4 at Pruf Stand VII was organized into two groups. One group was responsible for the mechanical, fluid, and propulsion systems, while the other belonged to Dr. Steinhoff's mysterious Department of Electrical, Guidance & Control, and Instrumentation.[18,19] It was in this second group that Dr. Debus and his deputy, Dr. Gruene, went to work establishing mobile deployment and firing procedures as well as testing the production units at Peenemunde. Karl Sendler, another lifelong professional associate, was in Dr. Steinhoff's group working in Dr. Gerhard Reisig's measurement section.[20] It was at the test stands training the troops, that Albert Zeiler, later a key associate of Dr. Debus, first met Dr. Debus and Dr.Gruene.

<u>Turning the Prototype Rocket Into an Operations Success</u> By the time Debus and Gruene were officially employed under Steinhoff in the summer of 1943, the Peenemunde team had already achieved the initial design and development of the A-4 and conducted the first successful launch. What remained was the hard, tedious, and somewhat frustrating work of turning prototype system hardware into a dependable, production quality, field-deployable weapon system.

In order to meet the challenge of making the Rocket Team's prototype research an operational reality, the team had to figure out how to improve on the prototype to achieve the highest degree of reliability and operability that could be built into the flight and ground systems. It also meant thousands of component and system test runs, along with hundreds of static test firings and qualification launches. Nobody had ever done this with the types of systems, components, and commodities they were now working with. Both designers and their newly acquired operators (like Dr. Debus and Dr. Gruene) were all now learning together.

Peenemunde's German Army commander, General Walter Dornberger, struggling to bring the A-4 from prototype to production, believed that to overcome excessive pad stay times required a shift in the design team's thinking:

> *The whole design has apparently been done as if hundreds of people had the time to spend weeks going over the rocket on the test stand, installing valves, doing assembly work, moving cables, and generally fumbling around. Cooperation between the Test Group and [the design department] is lacking…*[21]

Dornberger believed that the time had come for a shift in design focus to meet the demands of simplicity and ease of access that would be essential for production and field use. Instead, he found the missile was a "flying laboratory" to make relatively minor, but expensive and time-consuming, performance improvements.

THE "LOST CONVOY"

The situation for the German Army operation at Peenemunde grew desperate in the early months of 1945. Years later, Dr. Debus recalled the basic situation confronting the Peenemunde rocket team in early 1945:

> *The Russians were advancing on one front and the Allies along another. Hitler was still saying we'd win the war—but we knew this was foolishness. It was simply a matter of choosing whether to live under Communist rule or in a free society. We chose the latter because many of us knew first hand what it was like to live in Russia.*[22]

By early 1945, circumstances left Peenemunde's Technical Director, Dr. von Braun, in charge of the rocket development infrastructure and the all-important design drawings, test data, and procedures. It also left him with some urgent and important decisions to make.

With apparently unanimous agreement from his trusted staff members, Dr. von Braun initiated a monumental exodus that transferred the "top secret" missile development infrastructure and its talent to points west, and then eventually to southern Germany in the Bavarian Alps.[23, 24] In February 1945, von Braun announced, *"Launching from Peenemunde will definitely halt. Dr. Debus, your mobile launching convoy will be formed and dispatched to the general area of Cuxhaven* [along the coast of the North Sea west of Hamburg, near Bremerhaven]."[25]

This was going to be a challenging human effort, but one for which Debus' character had been prepared. He would have to bluff or otherwise finesse his way through difficult Nazi SS overlords while violating a "scorched Earth" order issued by Hitler on March 19 to destroy all German research facilities and important documentation.[26] Debus' deputy, Hans Gruene, recalled in later years that all operations came to an end at Peenemunde and Dr. Debus put him in charge of transferring the whole test stand, which at that time had become motorized. Debus and Gruene headed their group directly west through the Mecklenberg region but quickly found that the British would overtake Cuxhaven before the convoy could arrive and establish a test range to continue developmental work. The question of whether to go ahead and surrender to the British or divert south and deal with the American and French forces must have become a point of discussion, now that they were committed. Debus and Gruene's convoy headed to a point directly south of Cuxhaven, near the headquarters of General Dornberger's relocated "Working Staff" at Bad Sachsa on the southern slopes of the Harz Mountains.[27,28]

According to Gruene, it was along the way to Bad Sachsa that they lost the convoy! Gruene and Debus left the trucks and the convoy at the town of Bad Harzburg while they went to get authorization papers for the convoy drivers. These papers were needed to successfully traverse the German checkpoints along the way to their destination. In the meantime, Bad Harzburg was suddenly declared a Red Cross town. This meant that all Army trucks had to be evacuated and sent elsewhere. When Debus and Gruene returned, the convoy was nowhere to be found!

With Debus in a car and Gruene on a motorcycle, they sped off searching all the roads through the Harz Mountains to find the strange-looking vehicles that carried their lost and "top secret" equipment—but nobody had seen them. They looked everywhere and could not find them.

By this time, however, the military situation was deteriorating even further for the German Army. Most of the people from Peenemunde went south with Debus. Gruene stayed in the area in the hopes that they would hear something about the convoy. Sure enough, 3 days later a man showed up on a motorcycle with the "lost" convoy following behind. Gruene gave the drivers the needed clearance papers and Dr. Gruene stayed in the nearby mountains. After a few weeks, according to Debus, most of the convoy eventually arrived at Garmisch-Partenkirken, Germany. Some of the people were convinced that the war was lost and any further launches were absurd so they put the trucks in gear and shoved them into the lakes.

Finally, in April of 1945, Debus and the rest of the team holed up in various villages and towns near Oberramergau and at the Haus Ingeburg Inn near Oberjoch.[29] On May 2, 1945, a small party of the Germans led by Magnus von Braun, Dr. Wernher von Braun's brother, sought out the advancing American 44th Infantry Division near Schattwald. Very quickly Dr. Debus was detained by the Americans with the rest of the Peenemunde scientists (hundreds in number) at Garmisch–Partenkirchen. By the time Al Zeiler was brought there, Dr. Debus had already arrived. Dr. Gruene, still up north in the Harz, would be captured and detained at Witzenhausen. There at Garmisch–Partenkirchen, Debus was interrogated on May 16.[30]

OPERATION BACKFIRE

With the end of the War came a new beginning—and special attention to the German rocket team and Dr. Debus. While concern over the safety and whereabouts of his family filled his thoughts, special attention by the Allies was being focused on locating and protecting the Peenemunde scientists and engineers, like Dr. Debus.

The Allies Learn To Launch an Aero–Ballistic Guided Missile During the spring of 1945, a British project officially designated as "Operation Backfire" was initiated to provide the knowledge and skills needed to operate this emerging technology of guided ballistic missiles.[31] Operation Backfire resulted in one of the most comprehensive evaluations and documentation of the total V-2 weapons architecture—by the Allies or the Germans.[32] To the great surprise of the British, the task would prove to be far more difficult than first thought. Dieter Huzel, a close aid to von Braun and a witness to the Backfire project, wrote in 1962:

> *The full meaning and understanding of the fact that in addition to the missile itself, at least as much equipment is also needed to prepare it for flight was formulated here, probably for the first time.*[33]

Reconstructing Necessary Launch Infrastructure There were many things that needed to come together and be totally reestablished: 1) a safe and capable launch site, 2) facilities, 3) ground support equipment, 4) flight hardware, and 5) a knowledgeable and skilled work team. The location the British selected was an abandoned German naval gun range near Cuxhaven, Germany, on the coast of the North Sea. Since it was outfitted with radar sites, it was well suited for testing this new technology. The Cuxhaven site already had rail sidings and also had some of the infrastructure for the anticipated operations.

The support tasks of Operation Backfire were enormous yet carried out with relative expediency. For example, it took 3 weeks for 2,000 Canadian engineers to construct the V-2 assembly facilities and the test and checkout hangars, including a 300-foot-long facility completely outfitted with a 10-ton overhead crane. Four V-2 vehicles could be worked on at the same time in the facility. The Canadians had succeeded in constructing a vertical checkout stand for the launch system made from sections of a military Bailey bridge in 2 weeks.

FIGURE 6—*Photo from Operation Backfire showing some of the equipment required to operate the V-2.*

Reestablishing a Launch Team and Safe Operations By June 1945, General Eisenhower issued the instructions to guide the upcoming operation: *"The primary object of this operation is to ascertain the German technique of launching long-range rockets and to prove it by actual launch."* In doing so, the Allies hoped to learn the secrets of the *"preparation of the rocket, the ancillary equipment, and the handling of fuel."*[34]

On June 29, 1945, American and British intelligence officers sought to obtain information from General Dornberger at Garmisch–Partenkirchen in support of Operation Backfire. In particular, they were assessing the risks to life and property involved with the proposed firings.[35] Dornberger went into some detail on the subject with regard to: 1) propellant storage, transport, loading, and operational safety precautions; and 2) firing considerations, including choice of firing site, mounting of the firing platform, post–launch conditions at the firing site, and categorizing accident and failure experiences. Dornberger also provided a list of 30 people, held at Garmisch–Partenkirchen, who would be qualified to take part in the various stages of firing procedures.[36]

Dr. Debus was no doubt high on Dornberger's list, since he would have been intimately familiar with the hazards and precautions identified by General Dornberger. Debus told his interrogators at Garmisch–Partenkirchen that starting in March of 1944, he was section leader and supervising experimental engineer for control and electrical functions at the test stands. Debus indicated in a 1972 interview that their main contribution was training German Army and SS units on Pruf Stand VII. These troops then marched off from Peenemunde and performed their mission.[37] Zeiler helped field test the procedures developed at Peenemunde in Poland.[38] Debus was in the Netherlands on the evening of January 1, 1945, to witness the procedures during troubleshooting in the field and check it out. By diving into a foxhole, Dr. Debus narrowly escaped a V-2 flying directly overhead. The errant missile landed not very far downrange. By the time of the evacuation from Peenemunde, Dr. Debus had become the superintendent of the test stands and the firing stands of the V-2.[39]

From Garmisch–Partenkirchen Debus, Zeiler, and Hans Fichtner were transferred to a British Interrogation Camp at Schloss Krauntzburg in Taunus, Germany, just outside Debus' hometown of Frankfurt. The place was known as Camp Dustbin. General Dornberger arrived later and asked Zeiler what he was doing there. Zeiler informed Dornberger that he had been told that he was going to the U.S., *"but I guess they forgot us!"* Dornberger then told the skeptical Zeiler that he would get him out. Two weeks later Zeiler was in Cuxhaven with the others, including Dr. Debus, who was leader of one of two camps of Germans. Debus led the "Interrogation Camp," Camp C, at

Altenwalde. Separate from Camp C, the British also established a Working Camp that was ordered to assemble eight missiles and fire five of them.[40] It was into this camp that Zeiler would go. Dr. Debus became both a technical and diplomatic liaison between the two camps and between the detained Germans and the victorious Allies.[41] Debus recalled a spat over a lost logbook, for instance, that apparently was smoothed over.[42]

<u>We Need More Equipment</u> While the logistics of acquiring the needed flight hardware was not necessarily straightforward, the acquisition of usable ground support equipment was downright troublesome (Figure 6). After running into a few dead ends, at one point they turned to interrogating their German POWs. No doubt, the "Lost Convoy" episode was revealed, and search teams were sent out to locate the items. The recovery of one critical piece of equipment that went into a river required a dredging operation.[43]

The original crew of 30 Germans had now grown to 137 officers and enlisted personnel to form the core launch team by July. A total of some 1,000 German nationals and 2,500 British military and civilian personnel were involved from May through October 1945. By October of 1945, the British were launching V-2s from Cuxhaven. The first attempt came on October 1, 1945, but an igniter failed. Then, on October 3, a successful firing occurred. The last launch, known as Operation Clitterhouse, took place on October 15 with British, American, and Russian officials present.

With the operations concluded, Dr. Debus was now headed for American custody again, where contracts with the U.S. Army had been in preparation at Witzenhausen, Germany, with Dr. von Braun. The families were somehow notified, and Gay Debus and their two young daughters hitchhiked and biked their way to Cuxhaven. At the camp gate, Kurt heard a familiar bird-like whistle from his fraternity days through the fences. He suspected correctly that it was his wife, and the Debus family was back together after nearly 8 months with no communication. They all headed south to the American collection point for the German rocket team and their families. The housing at "Camp Overcast" in Landshut, Germany, just east of Munich, would become the homes for the families of von Braun's group and the launch pad for a new beginning in the United States.

<u>WHITE SANDS AND FORT BLISS</u>

Debus was now under contract as a "special employee" of the U.S. Department of the Army, as were the other German rocket specialists. It was initially a short 1-year contract. However, the interest to continue the development of this exciting new field of astronautics, both for Debus and for the Army, only intensified during the late 1940s and throughout the 1950s, resulting in a long-term commitment.

From January 1946 through December 1948, Dr. Debus was deputy to Dr. Steinhoff's Guidance and Control Branch.[44] Reflecting on the unique circumstances of his change in venue, Dr. Debus noted:

> *…it was one of the few occasions in history when one of the victors in a long, bitterly fought and costly war welcomed a small group of professionals from the enemy nation and gave them opportunity to conduct research and development and to share in the fruits of their work as citizens of a democracy.*[45]

<u>Once Again Reestablishing Infrastructure</u> The most urgent need the Germans had upon arriving at the Fort Bliss–White Sands area was facilities, which they had to build themselves (Figure 7). Debus, along with other top-flight engineers and scientists, trained and skilled as they were in sophisticated instrumentation and test equipment design, all went to work with hammers and saw to establish their new home, one that only marginally kept out the fine sand and rattlesnakes. They also went to work on the test stands by cutting and welding the steel and mixing and pouring the concrete. When the bulk supplies arrived, they took their shirts off to unload and did the cataloging and storing

<u>FIGURE 7</u>—*Dr. Debus and Dr. von Braun enjoy the water together while "prisoners of peace" at Fort Bliss, Texas (Dr. Debus is to the right of two men in white hats; Dr. von Braun is to the right of him).*

themselves. Debus recalled that one requisition was for shovels—1,002 were shipped by the Army.

While there were problems, of course, associated with the circumstances of the immigration, there were also problems with the novelty of their astronautical professions. For instance, Dr. Debus noted that Hans Hueter, the Launch & Handling chief, was officially identified in his civil service classifications as "gun turret designer," although he had nothing to do with guns or turrets.[46]

Of the 130 or so scientists, technicians, engineers, and administrators, about 35 of them went to the test sites at White Sands, while the others remained in the shops and laboratories at Fort Bliss. Dr. Debus resided at Fort Bliss but went frequently to the White Sands site for testing and launch operations.

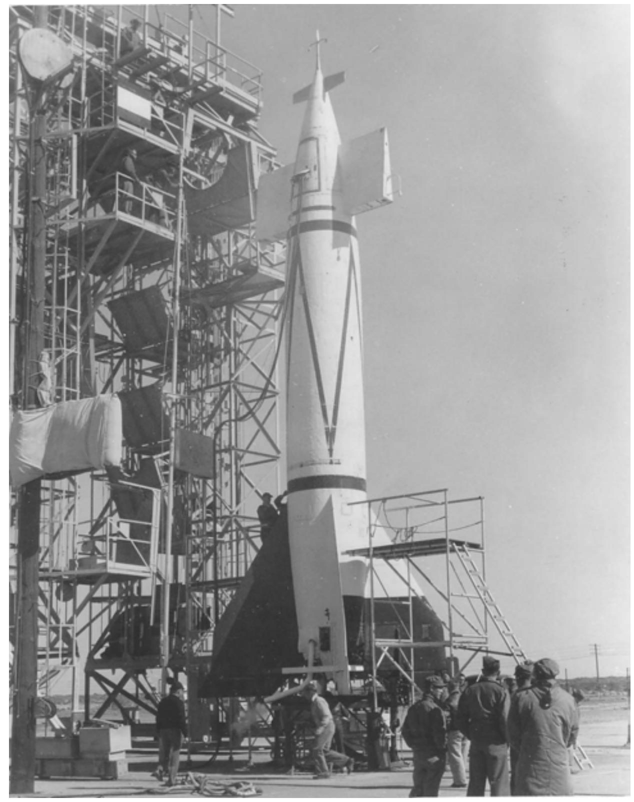
<u>A Renewed Purpose for Launching</u> A V-2 Upper Atmospheric Research Panel was formed in early 1947 and coordinated the experiments conducted during scores of flights that were executed from March 1946 through June 1951—with varying degrees of success, as Dr. Debus readily admitted. Most of these flights were accomplished by vehicles made up of the V-2 parts from the 300 freight cars of hardware captured in Europe and transferred to the U.S. Army. Collaborating with the Army on the panel were experimenters from: the Naval Research Laboratory, the Jet Propulsion Laboratory, Massachusetts Institute of Technology, Princeton University, General Electric Company, and the Ballistic Research Laboratories.

The assignment from the Army included the assembly, checkout, and launch of V-2s in support of the upper atmospheric research program and development work on ramjet vehicles capable of extending the range of various military applications (Figure 8).[47] The Germans organized themselves into five groups: project and design, guidance and control, chemistry and thermodynamics, test, and production.

<u>Advancements in Guidance and Control and Telemetry</u> The Guidance and Control Branch at Fort Bliss where Debus served as deputy to Dr. Steinhoff was responsible for: automated control devices, simulators, telemetry, guide beams, timing devices, gyros, stabilizers, and testing.

In a move to make the most of what had been done at Peenemunde, a rocket motion simulator was brought over from Germany. Once in the U.S., they built a larger and more flexible capability for future guidance and control studies.

Another immediate advancement that the team desired, now that the pressure of war was off them and they were back in a true research and development mode, was expanding the quantity of measurements detailing the health of the systems and components during flight. *"The absence of empirical data greatly complicated the task until refinements and innovations in data acquisition systems enabled designers to define the parameters, understand the conditions, and devise mechanisms to overcome them."*[48] At Peenemunde, the state of the art in 1939 was the ability to record 9 parameters for the 77-second flight of the A-5 prototype missiles, a test bed for the A-4. By the time the war ended, the capacity was 12 channels of information. From 1947 through 1950, the Naval Research Lab, working with the Steinhoff–Debus group, took on the task of expanding flight telemetry to 18 channels for the Hermes II project at White Sands.



<u>FIGURE 8</u>—*V-2 topped by ramjet awaits launch at White Sands Missile Range, New Mexico, in 1947.*

<u>Fixed Versus Mobile Ground Support</u> Another important change from the mobile V-2 in Germany to the research-oriented operations at White Sands was the contrast in support needs. Dr. Debus plainly observed, *"The end purpose for which a rocket system is developed exerts profound influence upon launch concepts."*[49] Outlining many of the support needs for flight research, Debus indicated:

> *In the research environment, such as Peenemunde, or White Sands, the planner may design and build ground support facilities, site launch pads, locate propellant and oxidizer pressure vessels, propellant transmission lines, and other required installations to best advantage considering terrain,*

and range safety to protect personnel and other installations, and take such other steps as desirable to obtain maximum return with highest assurance of success.[50]

Alternatively, Dr. Debus noted that launch would take on quite different characteristics if the requirements demand a mobile capability for launching by field troops rather than by experienced engineers and technicians. This architectural design transformation occurred, for example, when the A-4 prototype became the V-2 weapon. The system was deployed, according to Debus, with a train of 30 vehicles or a combination of rail cars, trucks, and prime movers. A special *Meillerwagen*[51] was developed, which was a custom transporter–mobile launcher with an erector beam that served as access means and connecting carrier. It also carried the launch table.

Expanding Roles and Responsibilities The von Braun–Debus relationship grew a bit deeper during this period. Dr. Debus told the story that Professor von Braun, Karl Heimburg, and Walther Riedel and he pooled their meager earnings (much of which went to their families back at Landshut) to purchase a prewar car and visit California. At the time, they were not allowed to drive and an Army sergeant was assigned as escort. Dr. von Braun, no doubt, shared his ideas about achieving space travel to the Moon and Mars. He was at that time beginning to freely and openly document these concepts—something he was not allowed to do under the oppression of the Nazi regime.

In January of 1949, Dr. Debus was promoted and assigned Assistant Technical Director to Wernher von Braun. The Army assigned Dr. von Braun as chairman of a Development Board, and Debus acted as secretary to the board. Here, he supervised proceedings of the entire development program of the Guided Missile Branch and kept von Braun informed about delays and scheduling difficulties. One special assignment noted in Dr. Debus' civil service application in 1954 was *"devising reliability policies and programs for guided missiles and destruct systems for special warhead missiles."* He held this position until November of 1951.[52]

A Brighter Future in Huntsville The Army, having now recognized at the highest levels the potential of guided ballistic missile technology, began a search for a more permanent home for the growing community of engineers and contractor personnel. With the supply of V-2 components nearing depletion, the Army offered yet another new beginning for the German newcomers. As Debus recalled, it was an opportunity that "brightened the future" for the isolated team. *"We would move the technology forward in new surroundings and we would make a contribution to the defense of our new country."*[53]

The search concluded, and Huntsville, Alabama, was to become Dr. Debus' new home for his family. It would not be too long, however, before a place called Cape Canaveral, down in the hot, mosquito–plagued marshes of Florida's east coast, would exert its pull on Dr. Debus' destiny and on the history of astronautics.

A LABORATORY FOR ACCESSING SPACE

In 1947, a modified V-2 went the wrong way and impacted in a cemetery south of Juarez, Mexico, one of the factors that influenced the Joint Chiefs to move rocket experiments to the East Coast of Florida. Dr. Debus' boss, Dr. Steinhoff described the event:

The control system failed after 15 or 20 seconds. It was already supersonic. By the time the American officials arrived at the cemetery, all the Mexicans were collecting and gathering up pieces of the skin. They had several hamburger stands there. They sold 10 to 15 tons of relics even though the entire missile was only 4 tons![54]

The event, however, pointed to the need for finding a suitable area for U.S. development of long-range ballistic missiles, which was now becoming of interest to both the Pentagon and its industrial contractors.

A New Missile Project—The *Redstone* In 1949, the extended 5-year contracts that the Germans had signed with the U.S. Army Ordnance Department expired. Several choices were given, but Dr. Debus took the most popular one, which was to go with von Braun to the Redstone Arsenal in Huntsville, Alabama. The Army Ordnance Department reorganized the team and called it the

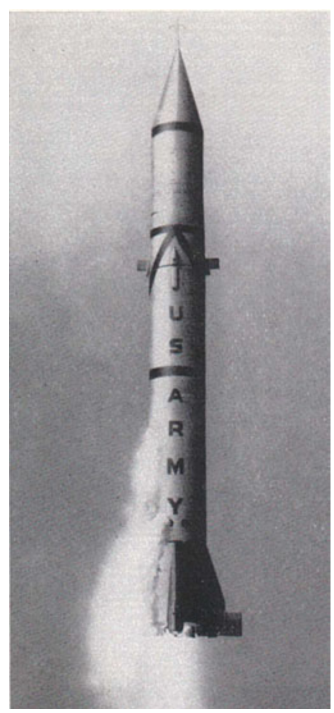


FIGURE 9—*The Redstone would provide a platform to relate the dependability of launch operations to design philosophy.*

Ordnance Guided Missile Center. Its military director was Major James Hamill, and Dr. von Braun was its technical director. At Huntsville Dr. Debus took up residence with his family on Mount Sano on Panorama Drive.[55]

Development of a tactical weapon system was the first objective of the new Missile Center in Huntsville. The weapon (initially designated "Major") was to have a 500-mile range and a 3,000-pound payload. However, when the Korean War broke out on June 25, 1950, an on-going Huntsville propulsion study was lent more urgency and attention.

In February 1951, the Army increased the payload requirement to 6,900 pounds to accommodate the most efficient nuclear warhead. A single stage missile design had been chosen and the Army reduced the range to 50 to 200 miles to achieve a reliable, mobile system for field deployment. A 20-month development period leading to first development flight commenced.[56] Most importantly, however, it was estimated that 170 people were needed to meet the proposed launch rate of 15 missiles per month.[57]

Experimental Missiles Firing Branch By November 1951, the pace had picked up and a new program, the Redstone, was taking shape (Figure 9). Von Braun would now approve a completely new organization with Debus to lead a new Experimental Missiles Firing Branch (Figure 10).

The need to establish smooth-running operations separate from the research and development, laboratory environment led to the creation of the new branch. According to Debus:

> *The conventional way of doing business was for the development agency to be the launch agency as well. The developer took his gadgets and gauges to the pad and worked with them, if work is the right word, and there built a laboratory...months were consumed in preparing the rocket in a laboratory environment. Then it flew when it flew. Schedule was something which you recorded after and not before the launch. Planning was something conducted on a day-to-day basis in terms of what we were going to do in the next hour.*[58]

Where To Launch the Redstone A Joint Chiefs Committee had chosen Cape Canaveral, Florida, as the approved range for U.S. rocket development, in part, to overcome the problems that arose from the errant V-2 intrusion into Mexico. Debus told his confidant, Dr. Hans Gruene, *"If Redstone Arsenal is going to build rockets and we have to use the [Joint Long Range] Proving Ground at Cape Canaveral, we ought to visit the place. We ought to think out what we could do down there. It's not useful for the development group to be traveling there continuously."* Gruene agreed, and Debus took it up with von Braun. *"Why don't you go ahead?"* responded von Braun. Debus then informed Gruene *"You helped get me into this, would you join us?"*[59]

Therefore, in mid-January 1952, Debus and his first employee, Dr. Gruene, drove down from Huntsville for the first time.[60,61] The immediate objective was to look over the site for the first Redstone missile flight for establishment of needed facilities. After driving east from Cocoa to the beach over a *"dreadful"* wooden bridge, they came out over the causeway to nothing. There were no

FIGURE 10—*The lab directors of the Rocket Team in the U.S. Army's Guided Missile Development Division at Redstone Arsenal in Huntsville. All were highly experienced astronautical pioneers from Peenemunde and White Sands. Dr. von Braun is at center (seventh from the left) and Dr. Kurt H. Debus, chief of the Missile Firing Lab, is second from the right.*

houses. Cocoa Beach consisted principally of a traffic light. Patrick Air Force Base to the south had only a few temporary buildings. Heading north they found a *"rickety fishing pier, and a launch pad under construction."*[62] Over the ensuing years, Dr. Debus and his associates would frequently travel between the organizational headquarters in Huntsville and the operations occurring in Cape Canaveral.

<u>Creating Dependable Missiles</u> While the Redstone program was still in its formulation and early design stages in Huntsville, Dr. Debus and the folks in Huntsville began to be concerned about the Army requirement for 90 percent system reliability and the increasing design complexity. In February 1952, Dr. Debus presented to the Center management at Huntsville *"a proposal to elevate reliability functions to top level and install the program in every organizational element concerned with the Redstone development."*[63]

The proposal was to analyze each component and sub-component for its failure cause and effect. Dr. Debus knew that operating overly complex systems could easily become his operational nightmare if not brought to the von Braun team's attention very early in the development.

Later, the launch record of the Redstone would lead to the choice of it as the "old reliable" needed to launch the first Americans into space.[64] While Debus' concept was not so new to many Peenemunde veterans, much of the rest of the workforce in Huntsville had to be won over to this idea of building relatively reliable vehicles by design.[65]

<u>Missile Firing Laboratory</u> Effective January 1953, von Braun's organization was elevated to division status within the Army's Ordnance Research Labs. Dr. Debus' branch was redesignated the Missile Firing Lab (MFL). His work in that role was to *"plan, direct, co-ordinate, and control activities, personnel and facilities"* of a new Missile Firing Lab.*"*[66]

The first launch at Cape Canaveral of the experimental Redstone missile occurred on August 20, 1953. Before the close of the Redstone development program, the von Braun-Debus team had created the infrastructure to launch 36 more Army Redstones by 1958.[67] The initial Redstone launch team, according to Debus, consisted of 30 people. Debus' Missile Firing Lab now had three sections: a Mechanical Section headed by Zeiler; Guidance, Control & Networks Section headed by Gruene; and a Radio Frequency (RF) & Measurements Section headed by Karl Sendler, a talented Austrian and veteran of Peenemunde (Figure 11). Debus recalled: *"Our launch team came in like a circus troupe. We shipped the missile to Melbourne by railroad… Instrumentation was housed in trailers."* For a service structure *"we bought an old oil derrick and converted it, and this was being put up at the same time we were readying the Redstone."*[68]

<u>FIGURE 11</u>—*Missile Firing Laboratory leaders: Dr. Debus, Dr. Hans Gruene, Mr. Albert Zeiler, and Mr. Karl Sendler.*

As the talent grew at Cape Canaveral in the early 1950s, Dr. Debus' superior administrative abilities also began to emerge. Dr. Ernst Stuhlinger, one of von Braun's laboratory directors for space science, recalled a staff meeting in the 1950s in which von Braun singled out Dr. Debus' technique of using weekly notes to stimulate communication and obtain an efficient overview of systems engineering activities and issues.[69] Weekly reports were submitted to von Braun at Peenemunde in the 1940s, as recalled by Mr. Konrad Dannenberg.[70] It may have been that Dr. Debus, drawing on what worked at Peenemunde, revived the practice that had been forgotten at White Sands.

<u>Creating Operationally Efficient Designs</u> The operations feedback to the design agency in Huntsville was very important in the Redstone Program, from its beginning on May 1, 1951, and continuing through the last development launch on November 5, 1958. Redstone test operations produced many hardware changes as lessons were learned from the Cape. A specific responsibility for Debus' Missile Firing Lab was to review firing results and observe operating patterns with a special regard for accuracy and reliability of the system. They were to *"recommend modifications of components or systems, and changes, additions, or deletions of the program."* For example, *"the engine contractor,"* Debus recalled, *"supplied seven different versions of the power plant and introduced [many] improvements…we insisted upon quality and reliability standards that were unprecedented, and specified tolerances and precision that seemed almost impossible."*[71]

Debus liked to reflect on the success of the Redstone program. The two-stage Pershing surpassed it as a tactical missile. However, the Redstone was the basis for the system that launched America's first satellite into space, and the Mercury–Redstone, of course, carried America's first two "astronauts" into space.

THE VISION UNFOLDS

Wernher's Vision of Space Travel—It is worthwhile at this point to discuss the more peaceful aspirations of the von Braun-Debus team. It is easy in tracing the military achievements of the V-2, Redstone, and Jupiter era, to forget that a vision of space travel was being pursued (Figure 12).

From childhood, von Braun was absolutely fascinated and absorbed by astronomy. Throughout his life, his fascination and his incremental achievements in astronautics were highly contagious. Jose Gonzales, a launch veteran from the White Sands era, recalled that von Braun would hold special meetings after working hours at White Sands in the late 1940s and talk about trips to the Moon.[72]

Dr. Debus, no doubt attending some of these sessions, began contemplating what it would take to make these concepts a reality.

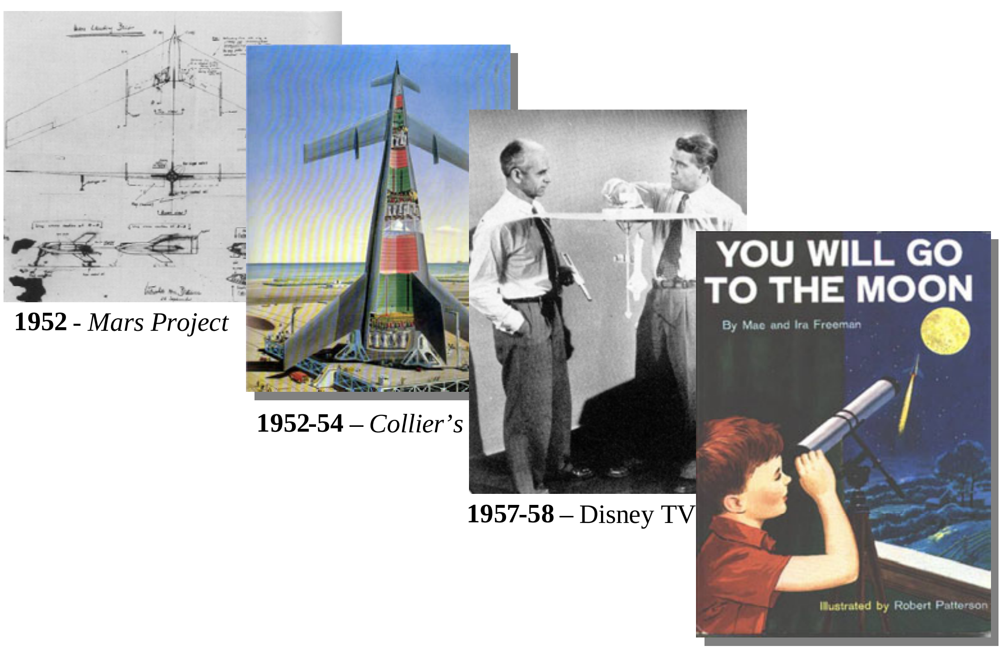
With 25 years of astronautical progress and a fresh political environment, von Braun, Debus, and their colleagues more openly explored and shared their vision of space travel. Debus would say of the subsequent journeys to the Moon:

> *…it was playfully discussed as early as 1950. At that time we were taking the first technical steps, mostly by our earliest computers, that led us to believe travel to the Moon and back was not necessarily a topic simply for science fiction.*[73,74]

As early as 1945, von Braun was telling his interrogator in Germany, Professor Fritz Zwicky of California Institute of Technology, that there were many *"future uses of rockets and that it will be possible to travel to other planets, first of all to the Moon."*[75] Dr. von Braun got his first chance to speak about adventurous space flight to the American public in a presentation to the Rotary Club in El Paso, Texas, in 1947.[76] Inspired by the public reception, Dr. von Braun would publish a very well thought out and highly detailed treatise on a *Mars Project*—a work that even today provides inspiration to generations well removed from his achievements.

In the meantime, a fellow German rocket enthusiast who had fled to America in the 1930s, Willy Ley, was working with Chesley Bonestell, a space artist. An important opportunity arose in 1951 when Ley began to organize a Space Travel Symposium to be held at the Hayden Planetarium. This initial meeting of astronautics experts, physicists, astronomers, and science reporters from around the nation led to a national–level public relations activity. The immediate result was a series of eight feature articles published over a 2-year period in one of America's popular periodicals, *Collier's* magazine. Following that success, a series of television productions were made with Walt Disney's imaginative crew. Ultimately, the1950s would experience a science fiction craze in Hollywood.

By 1959 and continuing for many years into the1960s, America's young children would even learn to read with *You Will Go to the Moon,*[77] by Mae and Ira Freeman. The book made a lasting impression on children and was included in the educational landmark series of "I Can Read It All By Myself" books. The book was distributed by Random House with the now famous Dr. Seuss *Cat in the Hat* book series. The imaginative illustrations were supplied by Robert Patterson and were obviously inspired by the *Collier* & Disney TV series. The von Braun vision would not only inspire the imagination, it would inspire the politicians.



1952 - *Mars Project*

1952-54 – *Collier's*

1957-58 – Disney TV

1959 – Influence on Young Readers

FIGURE 12—*Von Braun's vision of space travel in the 1950s inspires a new generation.*

EXPLORER I

Peaceful space travel and exploration were encouraged through the establishment in the early 1950s of the International Geophysical Year (IGY), set for 1957. The IGY was created for the nations of the world to cooperatively explore, gather, and disseminate scientific data collected about the Earth, its atmosphere, and its nearby environment. In the meantime, ballistic missile development continued to escalate as the Cold War progressed. These two pathways to space, one peaceful and civilian in its purpose and the other driven by the military objectives of the Cold War, would both lead to Dr. Debus' front door at Cape Canaveral.

Missile 29—A Jupiter-C Waits in Storage The Huntsville team had submitted a proposal, along with the Naval Research Lab and the Jet Propulsion Lab, called Project Orbiter to support the IGY. The proposal called for the use of a modified Redstone booster with a clustered set of solid-fuel rockets for upper stages to put up a 20-pound artificial satellite.[78] However, President Eisenhower announced in 1955 that the United States contribution to the IGY would be to launch a satellite into orbit by non-military means, and the Redstone was a military ballistic missile under development. The Navy's three-stage Vanguard was instead approved in 1955 and proceeded as an unclassified project.

General John B. Medaris was assigned February 1, 1956, to head up a new Army Ballistic Missile Agency (ABMA) to turn the experimental Redstone rocket into an operational weapon and to develop a new Jupiter Intermediate Range Ballistic Missile (IRBM). The Agency created the Jupiter-C (composite reentry test vehicle) using the Redstone rocket as the booster and added upper stages to gain the velocity needed on reentry tests for the IRBM capability (Figure 13). The Redstone booster tanks were also elongated. By doing so, it also inherently possessed the capability of inserting a small payload into Earth orbit.

Missile 27, the first Jupiter-C, was launched on September 20, 1956. Missile 29 was built and designated as its backup. It was not needed, however, following Missile 27's success and was put in storage by the ABMA with the hope that its capability of fulfilling the objectives of Project Orbiter would someday be authorized.

The ABMA team was frustrated in possessing the capability to initiate travel into space by the free world but not authorized to launch its first orbiting object. Inspectors were actually sent to the Cape to make sure the upper stages, which could carry a Jupiter-C payload into orbit, were not live in favor of allowing the Vanguard project the first shot. Debus jokingly recalled in 1983 that he discussed several times with Air Force Missile Test Center Commander, Major General D. Yates, the prospects of surreptitiously or secretly arming the upper stages, to which the General would repeatedly reply, *"No we cannot do that!"*[79] Between January and October 1957, when the Soviet Sputnik was launched into orbit, there were several such opportunities for Debus' Missile Firing Lab.

First U.S. Space Mail On one of these opportunities a Jupiter-C, designated Missile 40, was launched from the Cape downrange on Thursday, August 8, 1957. The von Braun team specially designed the nose cone to be recovered. The reentry heating problem for long-range ballistic missiles was a technical challenge. Recovery of the nose cone was needed to prove that a warhead could reenter intact and hit long-range targets.

On Saturday, August 10, 1957, General Medaris was working at home in his study when he received a phone call and was asked if he would receive Kurt Debus, Chief of the Missile Firing Lab. As Medaris recalled:

> *Within a few minutes Kurt showed up with the look on his face of the cat that had eaten the canary. He was carrying a small packet… Inside was a letter, stamped and postmarked at Canaveral, addressed to me by 'rocket mail.' The letter was in perfect condition, and he presented it to me with pride.*[80]

The letter was a simple was a simple statement that it was a first-of-a-kind "space mail" delivery, established by overcoming the reentry-heating problem. His daughters recall that he was an avid stamp collector.[81]

Early October 1957 found the ABMA preparing to brief the new incoming Secretary of Defense, Mr. McElroy. On October 4, the Soviets became the first to launch a satellite

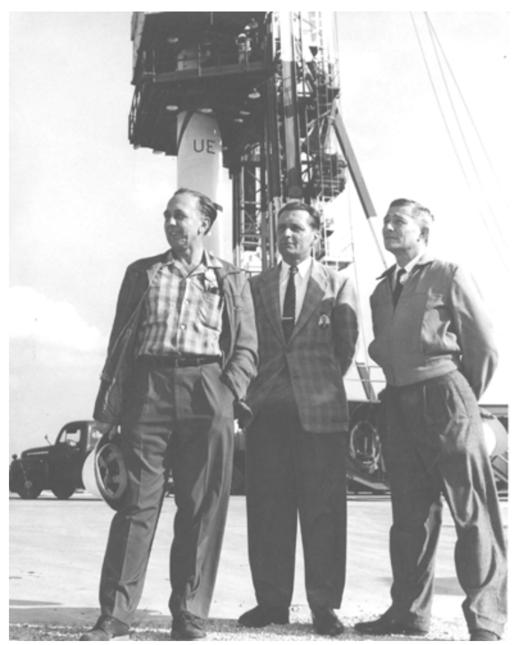


FIGURE 13—*Dr. Debus, Al Zeiler, and Hans Gruene in front of an ABMA Jupiter-C at the Cape.*

into Earth orbit. During a cocktail party that evening, Medaris, von Braun, and Secretary-designate McElroy received the news of the Soviet success. Pleading passionately as they did, official authorization was long in coming. The pressure was now on the Vanguard. Debus, Medaris, and the others were concerned that the several stage vehicle had never test flown any of the stages and that disaster was, in all probability, not to be left to chance but was a certainty.

On November 3, when Sputnik II was launched, there still was no Vanguard launch and still no authorization for ABMA to go ahead with the Explorer. On December 6, 1957, the Vanguard launch operation finally proceeded but ended tragically and exploded on its pad at Cape Canaveral in full worldwide public view. President Eisenhower's earlier promise to the nation that it would launch a satellite in the IGY was looking doubtful.

Meanwhile, Dr. Debus' crew was heavily engaged in support of Operation Hardtack, which was a nuclear ballistic missile test in the Pacific through mobile deployment of the Redstone. In the wake of the national Vanguard disaster, however, the Missile Firing Lab was finally called upon to launch Missile 29. Debus obtained range clearance for an attempt starting on January 29, 1958. Vanguard was scheduled for a second attempt on February 3. The missile was ready, the Explorer I earth satellite provided by the Jet Propulsion Laboratory was ready, Debus' Missile Firing Lab was ready—all that was needed was a weather clearance.

The Jupiter-C/Explorer configuration was sensitive to high-altitude wind shear. Instrumented weather balloons were detecting high levels of wind shear and without the benefit, obviously, of today's weather satellites, Medaris, Yates, and Dr. Debus had to predict the jet stream's course and its wind shear effect on Missile 29. General Yates, who had been General Eisenhower's weather advisor for the D-Day invasion, became most interested in the problem. The attempt was scrubbed before loading of the special hydyne fuel. Once the special fuel was loaded on the vehicle it had to be launched within a certain amount of time or the vehicle had to be dried due to the hydyne's deleterious effect on engine seals and other sensitive parts. Debus and the team made another attempt the following day but then scrubbed again.

On January 31 the situation was looking better. There was still a lot of pessimism due to the local thunderstorms predicted by most of the experts. A young Lieutenant Meisenheimer approached Dr. Debus and said that he would stake his reputation on a forecast that the wind shear would drop to tolerable levels. Debus persuaded Medaris to commit to tanking. That evening Mr. Zeiler, in charge of fueling, returned to the blockhouse at T minus 20 minutes, at which time the blockhouse doors were sealed from the toxic gases occurring at ignition. Zeiler, Dr. Gruene, Sendler, and General Medaris were at Debus' side and the count proceeded down to ignition. Test Conductor, Bob Moser, called out, *"We have a jet vane deflection, shall I hold?"* Debus, evaluating the data and weighing the probability of an instrumentation failure versus a real flight control system failure, quickly waved his hand to continue. At 10:58 p.m., Eastern Time, it roared off into history placing the free world in space for the first time.[82]

NASA and a Renewed Purpose in Space Launch In the aftermath of Sputnik and with the recognition of ABMA's space launch successes, the year 1958 saw the creation of the National Aeronautics and Space Act. It reorganized and shaped a profound change in America's capability to carry out a new civil-oriented rather than a military-oriented national space program. Still lacking a concrete objective, von Braun's team in Huntsville sketched out in December 1957 a timetable for U. S. space achievement:[83]

Spring 1960 ....2,000 pounds in orbit
Fall 1960 ....Soft lunar landing
Spring 1961 ....5,000-pound satellite
Spring 1962 ....Circumnavigation of the Moon
Fall 1962 ....Two-man satellite
Spring 1963 ....20,000 pounds in orbit
Fall 1963 ....Manned circumnavigation of Moon
Fall 1965 ....20-man permanent space station
Spring 1967 ....3-man lunar expedition
Spring 1971 ....50-man lunar expedition and outpost

Negotiations between Medaris, T. Keith Glennan of the newly formed National Aeronautics and Space Administration (NASA), von Braun, and others continued until the George C. Marshall Space Flight Center (MSFC) came into being in 1960 in Huntsville. Finally, the opportunity of a lifetime materialized for von Braun and his longtime German associates. The von Braun-Debus team was now part of an organization that could pursue its shared dream of space travel and literally reach for the stars through peaceful means.

MERCURY-REDSTONE

With the formation of NASA, the space race now heated up as the United States and the Soviet Union rushed to launch one of its own into space. The U.S. response was Project Mercury. Early on, NASA decided to use the *old reliable* Redstone booster for the first suborbital missions. The nation would now look to the experienced and capable von Braun-Debus team to begin pulling the free world ahead in this race for space.

Note that during the 1950s, Dr. Debus' Missile Firing Lab was by no means the only occupant of the Cape Canaveral launch area. The Air Force and the Navy, for example, were engaged in various launch programs, with the Air Force Missile Test Center operating the Atlantic Missile

Range. With the addition of the Space Task Group (STG) from Langley Research Center in Virginia, new groups dedicated to launching Americans into space began to set up shop on the Florida coast.

Dr. Debus began in 1959 to convert the Redstone facilities, Launch Complexes 5 and 6, into Launch Complex 56 for the Mercury-Redstone program. Likewise, the Vanguard team that occupied Hanger S began accommodating G. Merritt Preston and the Space Task Group.

Many histories cover the details of the Mercury-Redstone development and the many complexities that now had to be considered, such as abort scenarios and specific techniques for detecting and initiating emergency scenarios, "split counts," and so forth. Of interest, is the story of Dr. Debus' role in the actions NASA took in early 1961 to gain confidence in launching its first astronaut.

The MR-BD Flight Mercury-Redstone precursor flights had been accomplished with chimps on board by early 1961. The question of what level of confidence was needed before committing an astronaut to a flight on-board a ballistic missile was high on Dr. Debus' mind and his assigned project manager, Emil Bertram.

In the latter months of 1960 and into 1961, there had been some doubt arising as to the reliability of booster technology in general in launching man into space. Ham, the chimp, had experienced a rather bumpy ride into space during the flight of MR-2. In the meantime, the Russians were experiencing similar failures. The Sputnik flight on December 2, 1960, for instance, had ended in failure, as had the Sputnik IV and V interplanetary missions to Venus. The von Braun-Debus team, despite the successful recovery of Ham and the positive publicity, began in earnest to understand the over-acceleration issue in the wake of the MR-2 results.

MR-3 was scheduled as the first flight of one of the Mercury Seven astronauts. The von Braun-Debus team however, began insisting on postponement and adding one more booster development flight. In Dr. Debus' journal one can read his personal opinion of the situation: *"At least one unmanned shot must be obtained with flawless performance of the Mercury-Redstone mission booster flight, or at least no major shortcoming must be discovered in the vehicle system."*[84] There it was again, Dr. Debus' insistence on demonstrated reliability.

As a result, Eberhard Rees, von Braun's Deputy Director for Research and Development, informed von Braun of Dr. Debus' concern. Rees, in turn, contacted his man Joachim P. Kuettner, in charge of man-rating the Redstone for NASA. Ten items specifically identified as "weak spots" by Dr. Debus were discussed in Huntsville with the Space Task Group and NASA Headquarters officials, as they decided whether Mercury-Redstone flight MR-3 would be a "man or no-man" mission. The result was consensus on one more booster flight to gain the confidence needed to launch America's first astronaut into space with full public attention and press coverage.[85]

The MR-BD (Mercury-Redstone/Booster Development) flight, which was conducted on March 24, 1961, was a complete success. NASA and its Mercury-Redstone, with Dr. Debus' courage and leadership, had now attained the confidence needed to "man-rate" the system and successfully launch Navy Commander Alan Shepherd as its first American into space on May 5. Even though the Russians had only 1 month earlier launched Yuri Gagarin into orbit, the new NASA team had their sights set on truly "leapfrogging" the Soviets with a visionary space transportation architecture fully capable of human lunar exploration.

Shortly after Shepherd's MR-3 flight, U.S. President John F. Kennedy proposed before Congress the ambitious and now legendary goal of landing a man on the Moon and returning him safely to the Earth.

ENGINEERING NASA'S SPACEPORT

A Mature Design Philosophy for Saturn Development Figuring heavily in the advanced space plans of the new agency and President Kennedy were the powerful capabilities of the Saturn launch vehicles then on the drawing boards in Huntsville. The Saturn I drew on the Redstone and Jupiter IRBM experience gained by the ABMA. However, more importantly for the new President, it offered the boost capability to leapfrog the Soviets.

As the Saturn designs emerged from the various systems laboratories at Huntsville, a design philosophy also began to distinguish itself. It involved robust, well-integrated system designs. Perhaps because of the hard operations lessons at Peenemunde and White Sands and now at Cape Canaveral, Dr. Debus' insistence on reliability and operability during the early Redstone era began to exert its influence during the design phases.

For example, by 1962 Dr. Walter Haeussermann, a fellow Darmstadt alumnus, laid out some of the fundamental principles that the von Braun-Debus team practiced:[86]

- *"The design of the system must be compatible with the checkout philosophy."* Likewise, *"in orbital operations, the system must be compatible with the orbital checkout scheme.*
- *"Volume and weight are no longer overriding considerations as was the case in past rocket development programs. Although they cannot be ignored…they can be made subservient to such prime considerations as accuracy, reliability, flexibility, and reparability.*

- *"Simple, straightforward means of checking and repairing components must be provided. The repair crew must be limited in number.*
- *"In design and development of the system, high reliability must be the overriding consideration. The ultimate reason for the emphasis on reliability, however, is that the vehicle must be 'manrated.'*
- *"Reliability is emphasized through proper attention to the conservative design of the individual components in the system. The key to reliable system design…is emphasis on simplicity.*
- *"The vehicle is simplified through the use of an integrated system. By using only one complete set of elements…unnecessary duplications are avoided.*
- *"The system is further simplified by attention to the design of each component so that it offers maximum utilization with a minimum of complexity."*[87]

Haeussermann expanded on this last point by showing how addition of a few parts to an existing guidance platform design could take on the function of many other separate components. This served to simplify the guidance and control system with fewer field replaceable parts, making the total system lighter weight and easier for the Debus team to operate, maintain, and service.

Joachim P. Kuettner, of the Saturn-Apollo Systems Integration Office, pointed out the need for dedicated ground infrastructure to test complete sections of the launch vehicle and not just component and system tests. For example, there had been a "rocking-and-shaking" fixture at Chrysler's Missile Division as part of an extensive reliability program during the Mercury-Redstone program. This attention to designing and operating dependable launch vehicles was the hallmark of the von Braun-Debus team.

FIGURE 14--*The von Braun-Debus team contemplates a launch pad concept (left to right: Dr. Debus, Gen. Don Ostrander, and Dr. von Braun).*

A New Launch Complex Once the Apollo lunar landing commitment was made, the development of the Saturn I booster took on a new dimension. Derivatives of the Saturn C-1 concepts (Saturn I, Saturn I Block II, Saturn IB) were enlarged to take on the lunar landing task and other NASA ambitions.

Simultaneously on the drawing boards were two new launch complexes to support the Saturn I, Saturn I Block II and the Saturn IB—Launch Complex 34 (LC-34) and Launch Complex 37 (LC-37). These launch complexes would scale up the ground support concepts previously built in the U.S. (Figure 14).

H. H. Koelle's Future Projects Office began working out options for a large-scale booster. By the fall of 1961, the team had reached consensus on a Saturn C-5 configuration. True to the design philosophy of maximizing integration and minimizing parts, the configuration reflected some of the lessons learned from operating the Saturn I series with its 8 H-1 engines—the C-5 would consist of stages with no more than 5 engines, for example.[88]

In the course of time, with further experience and as follow-on Saturn configurations grew to accommodate their vision of space travel to the Moon, an entirely new launch concept was conceived by von Braun and Debus—the mobile concept.

The Mobile Launch Concept Dr. Debus sketched out with von Braun how the massive Saturn C-5 would be fielded at the Cape (Figure 15). The mobile concept actually reflected ideas that stretched back to the late 1920s in Herman Oberth's work for the German film director Fritz Lang in his 1928 *Frau im Mond* (*Woman in the Moon*). In the film, a large gigantic spaceship was rolled out of a gargantuan hangar to the launching point. At Peenemunde, this concept emerged in the late 1930s where the fully assembled and tested A-4 rocket was transported to Pruf Stand VII for firing.[89]

Launch Operations Center Up to 1962, Debus' Launch Operations Directorate was organized under von Braun's Marshall Space Flight Center in Huntsville. With an increasingly complex number of tasks and the associated challenges of creating a ground support infrastructure to meet President Kennedy's lunar landing goal, it became apparent to NASA that a new center for developing the launch infrastructure and operations might be needed. In a letter to Dr. Joseph Shea of NASA Headquarters, Debus laid out the importance of Launch Operations Directorate employee functions. Many were of a research and development nature and are summarized below:[90]

- The backbone of his organization's test activities was a small number of systems engineers dedicated to the functions of propulsion, structural and mechanical systems, electrical

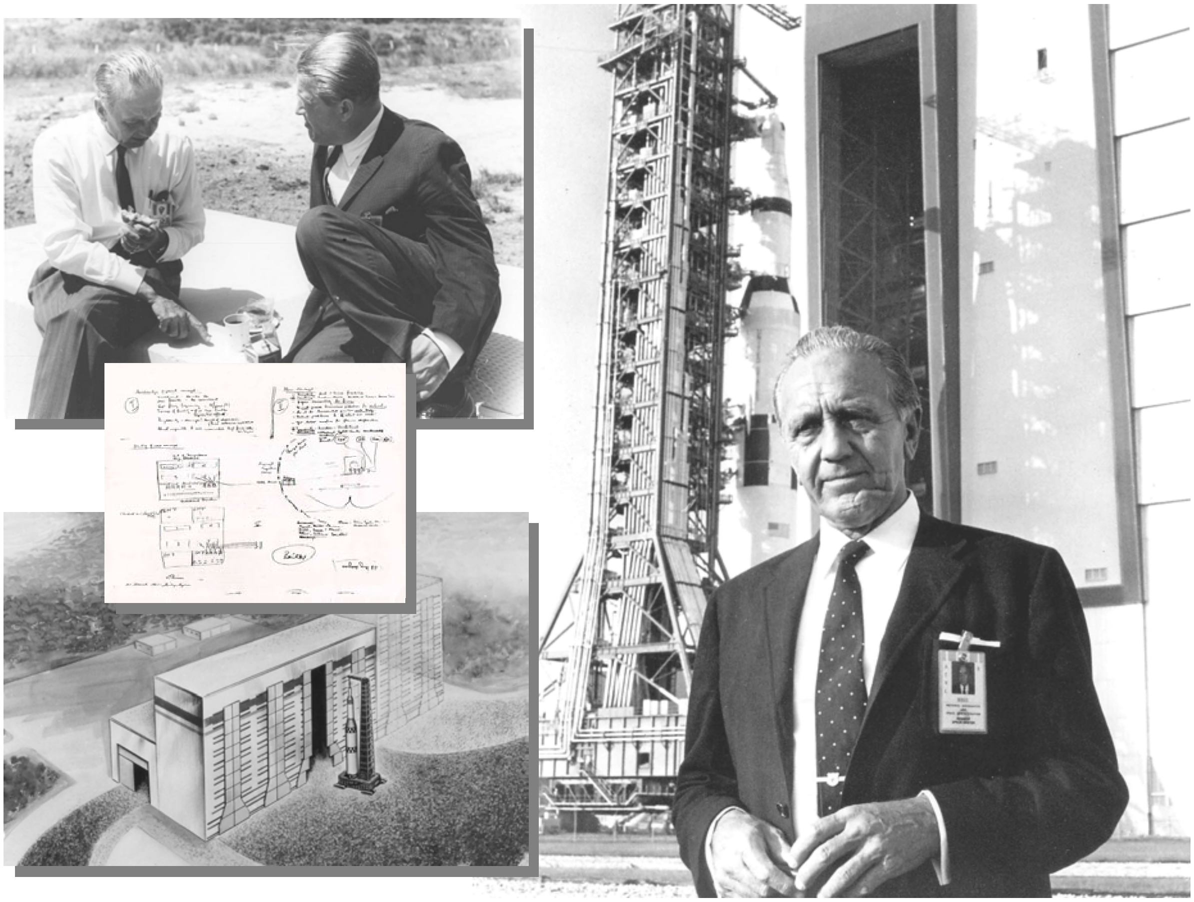


FIGURE 15—*The Apollo/Saturn C-5 launch concept sprung from the experience and vision of the von Braun-Debus relationship. Top left—Dr. Debus and Dr. von Braun discuss ideas over an informal lunch at the Cape; Center left—Original sketch by Dr. Debus of the mobile launch concept that would become Launch Complex 39; Bottom left—Concept definition drawing of a vehicle assembly building with pre-planned growth capability; Right—Dr. Kurt H. Debus in front of the Vehicle Assembly Building during the first Saturn-V rollout.*

systems, guidance and control, instrumentation, and communications and tracking.

- The systems test engineer was expected to be intimate with the designs they were responsible for at the launch site. As such, they were to spend a great deal of time with the associated design agency, their laboratories, and their technology pursuits.
- The systems engineers were also expected to spend a great deal of time in the labs working their operational experience into the design of upcoming space vehicles.
- Debus considered the systems test engineer at the launch site to be of equal merit with engineers in design, development, and assembly. For while a design engineer could make a mistake and have it discovered before launch at the Cape, mistakes made by his systems engineers would inevitably bring mission failure.

THE APOLLO MANAGEMENT CHALLENGE

Once Kennedy gave the word in May 1961, the von Braun-Debus team went to work meeting the challenge and the schedule. Driven by the fact that the U.S. was repeatedly seen as being behind the Russians, the NASA team began development of an architecture capable of supporting their gigantic Saturn concepts.

Visits to Cape Canaveral by President Kennedy Debus received President Kennedy in Florida on several occasions. The first was a simple ceremony on February 23, 1962, honoring the Mercury-Atlas flight of John Glenn. This was just a *"handshake and a welcome,"* according to Debus. A second, longer visit occurred on September 11, 1962. The visit was jointly planned with Major General Leighton Davis, USAF commander of the Atlantic Missile Range. While touring the Cape facilities by car, Kennedy continually asked Debus questions regarding what "firsts" he might expect from the Soviets. Lieutenant Colonel

Rocco Petrone, assigned to Debus gave the President a briefing at the Complex 34 blockhouse (Figure 17).[91]

By the time Kennedy visited Debus' Launch Operations organization on November 16, 1963, the Saturn-V/Launch Complex 39 architecture was just beginning to take shape. After a briefing by George Mueller, the NASA Headquarters Apollo Program Manager, in the Complex 37 blockhouse, Dr. von Braun briefed the President on the Saturn SA-5 vehicle presently on Pad-B. This vehicle would carry for the first time a live second stage and would be a crucial launch to put the U.S. ahead of the Soviets in booster capability—of great concern to the President.

Debus then had a prearranged helicopter overflight set up for the President. During the short flyby, Dr. Debus was able to show the President where the massive Launch Complex 39 was being cleared, including the crawlerway. Debus then requested the pilot to circle around the beams sticking out of the Florida sand where the 540 foot high Vertical Assembly Building (VAB) was under construction. Debus asked the pilot hover at the 540-foot height. However, a safety precaution prevented the pilot from hovering with the President on board. The pilot continued to circle instead at that altitude and Debus indicated to the President how high the building would be when complete. Debus and Dr. Robert Seamans pointed out some of the economies gained in the technique for pile driving being used. Towards the end of the overflight Debus was able to show the President the beginnings of the Industrial Area that would become the headquarters for the Launch Operations Center and would, tragically, bear his name all too soon—Kennedy was slain on November 22, within a week of the Cape Canaveral visit.[92]

The Apollo Management Council Dr. Debus had several key management interfaces to deal with as the Apollo Program developed in 1962. As Director of the Launch Operations Center, Debus had to deal not only with the Marshall center in Huntsville but also with the new Manned Spacecraft Center in Houston, Texas, the USAF Atlantic Missile Range and, of course, NASA Headquarters in Washington, D.C.

FIGURE 16—*Apollo Management Council: Dr. George Mueller, NASA Headquarters; Gen. Sam Phillips U.S.A.F.; Dr. Debus, Dr. Robert Gilruth, Manned Spacecraft Center; and Dr. von Braun, NASA Marshall Space Flight Center.*

FIGURE 17—*Dr. von Braun (left) and Dr. Debus (center) reveal plans for a flight and ground architecture that would achieve the goal of President John F. Kennedy (right) to land a man on the Moon and return him safely to the Earth.*

Initially, Brainerd Holmes was designated to lead the Apollo Management Council, which consisted of the Center Directors, and General Sam Phillips, USAF. In mid-1963, James Webb replaced Holmes with Dr. George Mueller. Mueller would now lead the Apollo Management Council (Figure 16). Dr. Mueller would recall that Kurt Debus was *"a marvelous human being…one of the persons who made things work effectively,"* and was *"one of the steadying influences over time."*[93]

The working relationship between the centers varied, but the "seamless engineering" that Debus was used to was maintained, at least, through Gruene's Launch Vehicle Operations (LVO) Division. In the critical early stages of the Saturn-V design cycle, the Division was both an operating element of Debus' new Center and an engineering element of Marshall. Debus wrote:

> *Through this arrangement launch operations requirements are fed back into the design organization and become incorporated in design criteria. For example, the Astrionics Division Electrical Systems Integration Branch…incorporates into the design the operational requirements obtained from LVO…*[94]

Communicating the Vision As the mobile launch concept took root, Dr. Debus helped to communicate NASA's vision for human space flight to the world. For example, in September 1962, he presented a detailed and yet extraordinarily authoritative paper on "Novel High Efficiency Facilities for Assembly, Test and Launch of

Space Vehicles," to The German Rocket Society in Koblenz, Germany. Debus presented 1) the fundamental characteristics of the existing launch infrastructure and operations, 2) NASA's space program plans, 3) the limiting factors in operational launch systems and the need for novel launch concepts and architectures, and 4) future plans to meet the Kennedy challenge of human lunar landings within the decade.[95]

Dr. Debus also loved to take along a 16-foot model of the Saturn-V stack with the mobile launcher and crawler. He really enjoyed talking about it and it's what everybody wanted to hear about when he spoke.[96]

The development of the Saturn launch vehicle and the "Moonport" at the Kennedy Space Center is well documented.[97,98] It is an astounding success story that has been and should often be retold. Dr. Debus' achievements in molding the Kennedy Space Center, as its first Center Director are innumerable. However, an often-overlooked aspect of the story is that Dr. Debus made good use of the free and open society that allowed him to pursue these great endeavors. For instance, the establishment of an "open door" policy that enabled the public to see and understand the complex activities that went into their space program. He pushed for and won approval from NASA and Congress to establish a world-class visitor's center with bus tours through the Kennedy Space Center facilities. Gordon L. Harris, a public affairs director for Debus, indicated his reasoning, *"the people—without regard to race, nationality, or any other consideration—should have access in order to witness the engineering marvels that made Apollo possible and paved the way for today's Space Shuttles."*[99]

Integrity and Openness in Dealing With the Press When asked about often biting and negative stories about NASA appearing in the press, Dr. Robert Seamans recalled a specific event with Dr. Debus:

> *I talked to Kurt Debus about [these concerns] quite a bit, because he was the most, to me, the most intellectual of all of the Germans, the most objective overall. Just before I left NASA we launched the first Saturn V at the Cape. I went down there for the launching, and it was a big deal. We must have had a thousand press people there, a big number, and big stands, and we set the thing up so that, as we had our press conference, you could see the Saturn V with steam coming out of it behind us, and we actually had the Soviet press there. We got some terrible questions.*
>
> *So going inside afterwards I said to Kurt, "That was pretty rough. I'm sorry you have to go through this kind of thing." He said, "It is rough, but you've got to realize that during World War II, we didn't have any competition in the press, and I really believed, I really believed what Goebbels told me. This is tough, but it's a lot better than the alternative."*[100]

A TIME FOR REFLECTION

Dr. Debus announced his intention to retire from NASA on September 17, 1974. Mr. Lou Frey, Jr., Representative from Florida, honored his outstanding career in astronautics on the floor of the U.S. House of Representatives and entered a short recounting of his life and achievements in the Congressional Record.[101] One of Dr. Debus' last acts as Director of the Kennedy Space Center was a groundbreaking ceremony for the 18,000-foot Space Shuttle landing runway located on the center in April 1974.

On November 19, 1974, hundreds of Debus' followers, along with von Braun, politicians, and others in the space program gathered to honor and praise Dr. Debus in Cocoa Beach, Florida. Von Braun's warm and witty testimonial kidded Debus that he got the glamour of launching the rockets while von Braun got the unsung task of developing them. *"Interest in designing rockets,"* he said, *"is comparable to interest in Lady Godiva's horse!"* Von Braun indicated a common set of interests while in Germany and said he invited Dr. Debus to Peenemunde. *"Kurt's first debut in this country was not so successful as some of his later efforts,"* von Braun went on to add. *"He almost hit a house of ill-repute in Juarez, Mexico, with his first launch from White Sands Proving Ground."*[102]

Setting the record straight, Debus replied, *"Wernher didn't quite tell the truth about my coming to Peenemunde. Actually, I was given two choices. One, go to Peenemunde or two, go to the Eastern Front!"*[103]

Dr. Debus then gave an *"old man's point of view,"* as an age of space exploration came to a close. *"This is not an ending, but a point of departure. I don't fear overpopulation or that the Earth will poison itself with pollution. The Earth will find ways to become that beautiful island that our astronauts saw when they viewed it from the moon…and I can say, 'I told you so.' "*[104]

FIGURE 18—*Dr. Debus enjoying a lifelong passion for music.*

A hint of what Dr. Debus' retirement years would be like was published in another Congressional Record item on December 3, 1974. Debus would not work, he told the reporter, on a full-time basis for industry, *"At least not as long as good music is being written, scientific journals are being printed, fish continue to spawn, flowers continue to grow, or work needs to be done around the house."*[105]

Dr. Debus did indeed love music. He would help with selecting classical music content on a local Florida FM radio station (Figure 18). He would visit his two daughters, Ute in Washington, D.C. and Sigried 'Sigi' Debus Northcutt with her family in Florida. He would take his two young granddaughters (by Sigi and Bill Northcutt) Monica and Michelle, to a NASA launch in 1975, where they played with their grandfather and actor Hugh O'Brien.[106]

Dr. Debus would become, for a time however, the chairman of the board of a West German aerospace firm, Orbital Transport und Raketen A.G. (OTRAG). The company had plans to provide cut-rate commercial launches from a site in Africa. The enterprise never came to fruition.

A LEGACY FOR US TO BUILD ON

Clifton Fadiman, introducing a series of 1950s science fiction stories for Arthur C. Clarke, once wrote:

> *"Some Futurians write stories…others manufacture the future in the laboratory, on the drawing board, on the proving grounds at White Sands…Such men, many of them very young, never ask whether a job has a future; their job is the future."*[107]

Dr. Debus was, indeed, such an individual. He passed away on Columbus Day, October 10, 1983, at the age of 74 in a Rockledge, Florida, hospital. Today NASA is working on several fundamental questions facing the future of humankind as it enters space. Dr. Debus energetically pursued one of these fundamental questions: whether we can provide access to space for anyone, anytime, and anywhere. His legacy was the ability to envision, promote, build, operate, and transfer an enduring space launch infrastructure to a succeeding generation.

Through a life-long commitment to a dream of human space exploration and development and through a commitment to the people holding on to this dream, a free people met President Kennedy's challenge of landing a man on the moon before 1970. By applying Dr. Debus' principles, values, and discipline, his development team created an effective ground support architecture in an extraordinarily short length of time to meet the Kennedy challenge—in the end, they not only created it, they made it work. His personal sense of accountability for safe and reliable human space flight shaped 50 years of Cape Canaveral's infrastructure and its operations. Equally important to remember is his legacy of opening up the wonders of space travel to the public—to all of us.

What fundamental challenges do we face in launching our future in space? Much remains to advance space transportation architectures and to fulfill that previously mentioned promise to the young reader of 1960—*You Will Go to the Moon*. We must overcome fundamental logistical challenges associated with chemical propellant production, storage, and transfer to achieve daily flights from futuristic spaceports. Questions of whether ground launch assist and other advanced concepts, like the MagLev launch assist concept, require much more research and development to be useful. Much greater confidence in space launch systems (ground systems, as well as flight systems) must be demonstrated to avoid frequent change out and overhaul of engines and other flight-critical components. Packaging and handling of cargo to and from space—without delicate, time-consuming, labor-intensive, and one-of-a-kind approaches—these are all grand challenges to attain more affordable, dependable and responsive access to the space frontier.

Summary and Conclusion In summary, Dr. Debus's extensive contributions to astronautics and ground operations, from Peenemunde to Apollo, were indeed pioneering and extensive. His human qualities led many others to great achievements in astronautics, and these deserve to be more thoroughly recorded and honored than presented here. Despite the many great achievements leading to the incredible lunar landings of Apollo, Debus was quick to add, *"To go to the moon is symbolic of man's leaving Earth, the opening of a vast new frontier."*[108] His achievements were only a beginning, leaving a challenge for us: are we satisfied to leave the level of human access to space where Dr. Debus' generation left it? Or, peering into the future, did he see us heading on a path of progress that allows you and me to also enter "the vast new frontier?"

Dr. Kurt Heinrich Debus
1908 - 1983

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