History of Rocketry and Astronautics

Proceedings of the Twentieth and Twenty-First History Symposia of the International Academy of Astronautics

Innsbruck, Austria, 1986

Brighton, United Kingdom, 1987

Lloyd H. Cornett, Jr., Volume Editor

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AAS History Series, Volume 15

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 9

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 1993

ISSN 0730-3564

ISBN 0-87703-376-5 (Hard Cover)
ISBN 0-87703-377-3 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198

Printed and Bound in the U.S.A.

Chapter 27

PEENEMÜNDE AND LOS ALAMOS: TWO STUDIES*

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World War II produced two great and memorable scientific and technological teams; the German Peenemünde rocket team under the direction of Wernher von Braun, and the American Los Alamos atomic bomb team under the direction of J. Robert Oppenheimer. Taken together, these teams helped create the post-war capability for intercontinental nuclear warfare. These teams, though working in different countries under radically different political systems, also encountered severe political difficulties during and after the war. Each, in its own way, had to live with its deeds, endure public suspicions, and bear the judgment of history on its efforts.

INTRODUCTION

Late in 1982, the United States Justice Department's Office of Special Investigations (OSI) began a series of interrogations of former von Braun Rocket Team member, Arthur Rudolph. Rudolph had been one of the central figures in the American Apollo Lunar Program, having been the Saturn 5 Project Manager. Having left his previous home in Huntsville, Alabama, site of the George C. Marshall Space Flight Center, Rudolph was then residing in San Jose, California.

Through 1983, OSI continued its investigations, and late that year the representatives from OSI informed Rudolph that, in their opinion, there was sufficient evidence to link him to war crimes activities at the World War II German Rocket facility, Mittelwerk. They threatened prosecution and indictment unless Rudolph signed an agreement to leave the country and renounce his citizenship. After agonizing over the prospects of a long and expensive trial or doing as the OSI requested, Rudolph decided in November, 1983, to leave the United States. On March 27, 1984, Rudolph and his wife boarded a plane in San Francisco en route to Germany.

In late 1983 and early 1984, Konrad K. Dannenberg and I were beginning a project at the University of Alabama in Huntsville which would add to the recorded recollection of members of Wernher von Brauns' Peenemünde rocket team. Dannenberg, himself, was a former member of that team, having served as a propulsion

* Presented at the Twenty-First History Symposium of the International Academy of Astronautics, Brighton, United Kingdom, 1987.

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engineer on the first successful A-4 (later termed V-2) launch in October of 1942. Later, among other duties in the United States, he had served as Deputy Director of the Saturn Program at the George C. Marshall Space Flight Center. For over 20 years, I have served as an associate and colleague of many members of the original Peenemünde team. Both Dannenberg and I were most interested in seeing that these early pioneering memories of German rocketry were preserved. Likewise, we were interested in obtaining comments about the future of space development as anticipated by these early pioneers. Hence, our project was entitled, "Our Future in Space: Messages from the Beginning."

As a sociologist, I was also interested in obtaining a sense of the human responses to the conditions under which scientific and technical work was conducted in the totalitarian environment of Nazi Germany. Epochal work was being done. It was work that would literally begin the space age. The popular perception dates the beginning of the space age to the famous Soviet Sputnik launch on October 4, 1957, but the first human-designed object ever to ascend into the environment of space was launched some 15 years and one day earlier—October 3, 1943. That object was the German A-4 rocket, launched from the Peenemünde test facility, reaching an altitude of over 80 kilometers (50 miles) and a range of 192 kilometers (120 miles).

Thus, at a place now almost forgotten, humanity began its ultimate adventure into the cosmos. As a realist, I know that the "driver" of much of human technology has been the military advantage that it might give. As an idealist, I have never been at ease with the use of science to further human destructiveness. As a behavioral scientist, I wanted to understand how men refined by sophisticated scientific and technological training could be reduced to the service of tyranny and human oppression.

My two decades of association with these gentlemen, who stood at the beginning of the age of space, I believe, has given me some understanding about the questions I have asked. It has always been difficult, at best, to discuss such matters with them. Even in the most relaxed of times, the subject is not easily an object of reflection. I had hoped that our project to video tape the remembrances of key scientific and technical personnel at Peenemünde would be able to probe for answers to these most difficult and sensitive moral and political questions. The news of the Rudolph case, and the fact that other members of the original rocket team were also under investigation by the United States Department of Justice, put a heavy pall on any such discussion.

Many of the group, who had originally agreed to hour-long video sessions, decided that they did not wish to grant such an interview under the existing circumstances of rumor and suspicion. Major American television networks and newspapers were, at the time, contacting me in attempts to obtain any materials we might have to assist in compiling their own reports on the possible connection of the Peenemünde Team to Nazi atrocities. Some of the group, who decided to go ahead with the interviews, let it be known that, as a condition for their appearance, they would talk about the history and circumstances of technological development, but they did not wish to enter into a discussion relating to politically sensitive subjects. Although existing circumstances made our project most difficult, a grant from the

University of Alabama in Huntsville, and assistance from the Huntsville affiliate of the Alabama Public Television Network, allowed us to obtain 13 hours of video-taped interviews from a dozen members of the original Peenemünde rocket team. For the reasons stated, I have, in writing this account of my impressions, relied more on information obtained in my 20 years of association with members of the Peenemünde team than on comments made directly in the video interviews.

During the same period that we were recording the recollections of the Peenemünde pioneers, I, along with several of my students, was engaged in an in-depth analysis of the experience of the Los Alamos atomic bomb team, directed by the late J. Robert Oppenheimer. Through an extensive search of the literature, and an analysis of several hours of video-taped interviews with key members of that team, we compiled what we thought were some interesting points of comparison between the experiences of the members of the Los Alamos project and those working at Peenemünde. We felt that such a comparison could, perhaps, put the whole question of the moral and political posture of those at Peenemünde into somewhat sharper focus.

As well as providing this sharper focus on the contributions of the Peenemünde pioneers, I have at least two additional reasons to seek such a comparison. Taken together, the contributions of these two great scientific teams made the age of intercontinental nuclear warfare possible. This was an end result that was completely at variance with the original purpose of the members of these two groups, as they, in their early lives, anticipated their careers in science and technology. The young men, who were later to go to Peenemünde and begin the space age, dreamed of interplanetary spaceflight. They were captivated by the challenge and adventure of conquering the void between the worlds. Almost all with whom I have talked have specifically mentioned their thrill and excitement with the early German science fiction movie *Frau im Mond* (Girl on the Moon). This Fritz Lange movie, filmed with the consultation of the early Romanian space pioneer Hermann Oberth, stimulated an entire generation of young idealists into seeking careers in space technology.

Likewise, as youths, the men who were to go to Los Alamos to begin the atomic age had their own captivating visions that stirred within them. The young Oppenheimer was intrigued by a box of minerals given to him as a gift, and he was soon exploring the rock formations of Central Park in New York City. At the age of 11, he was accepted into the New York Mineralogical Club by members who had no idea that the applicant who showed so much knowledge of the subject was a mere lad. The young Edward Teller was seized by the excitement of science through the works of Jules Verne. The young Leo Szilard showed an almost prescient childhood fascination with the classic Hungarian poem of pessimism, "The Tragedy of Man," which, perhaps, accounts in part for his lifelong mission to forestall nuclear tragedy.

The dreams and aspirations of these men as youths did not involve the development of weapons of destruction. Rather, they hoped as adults to understand the laws of nature and to travel into interplanetary space. The world as it was, however, demanded that their noble aspirations be put into service of much less noble ends.

Though these young men of a new age were to move to the very edge of human understanding and technology, they could not escape the political, economic, and social forces that were to drag them down into the belly of human bestiality. Their dreams were laid aside, while their professional talents were channeled into becoming weaponeers, designing means of human death and destruction. What type of readjustment does such an awesome redirection of one's own purpose for existence have? Such questions as these led me to search the experience of these two groups for answers.

Finally, I am interested in comparing these two groups because they shared an early experience that an increasing number of scientists and technologists in our current world now face. Out of the processes set in motion at Peenemünde and Los Alamos, the world has now evolved into a global, militarized culture. A very substantial portion of scientists and technologists trained for participation in our modern world economy find themselves in a situation where their prime opportunity for employment and career development lies in the service of the ever-expanding international arms race. Increasingly, the talents of modern scientists and the resources of their parent nations are dissipated in the dismal and deadly specter of the search for military superiority. As this happens, more productive and hopeful goals of humankind are canceled or delayed. Do the men of Peenemünde and Los Alamos have a message to share with our current age? If so, what is their message? If not, why has their message been lost?

LOS ALAMOS AND PEENEMÜNDE: A SENSE OF PERSPECTIVE

In seeking to gain perspective through comparison of Los Alamos and Peenemünde, it is informative to consider the forces that led each group to come together as a team. As previously stated, members of neither group anticipated careers associated with the military establishments of their respective countries. Both groups, nevertheless, found that the military utilization of their knowledge was the prime source for career development and professional advancement.

In the case of the Peenemünde group, many of its members had been affiliated with small German rocket societies such as the Society for Space Travel (Verein für Raumschiffahrt or VfR) that had been forming since the late 1920s [1]. Such organizations were not taken seriously by established governmental organizations in their early days. However, their dedicated work, assisted by publicity efforts that played upon the intriguing possibilities of interplanetary spaceflight, made them an object of public curiosity. It is a well recorded fact of the history of rocketry, that the reason this seemingly impractical and visionary activity was eventually taken seriously by German officialdom, was that the test firings of early-generation experimental rockets demonstrated to the German military authorities that there might be a way around the restrictions placed on the development of artillery weapons in the Treaty of Versailles, which ended World War I. Rocketry, it seemed, could not be classified as artillery, and therefore was a legitimate object of development by the German military [2].

Early military development of German rocketry fell upon Walter Dornberger, an artillery captain, who in 1930 had graduated from the *Techniche Hochschule*,

Berlin. In the fall of 1932, Dornberger recruited Wernher von Braun as his chief technical assistant, thus making von Braun the ranking civilian of the rocket program. Subsequently, von Braun obtained his doctorate in physics in 1934 at Army expense. In the meantime, on January 30, 1933, Adolf Hitler had been officially appointed chancellor, and the National Socialist Party of Germany quickly consolidated its power. Thus, as the Weimar Republic crumbled, the young von Braun was completing his formal education under circumstances that were to legally obligate him to serve the Army of the new National Socialist Party.

It should also be remembered that the economic forces of the great depression fell upon Germany with a vengeance. The severe economic climate motivated individuals to take employment anywhere it could be found, and with the early rocketeers it could be found only with the Army. Neither German universities nor private industry showed the slightest interest in rocketry. In the best of times, private funding for studying rocket propulsion would have been most difficult to obtain, but with the depression threatening the very survival of German industry, any such venture into basic research was out of the question. Arthur Rudolph, like so many of his counterparts, found himself without work, and without money. Captain Dornberger moved through this cadre of unemployed engineers looking for ideas that might serve the Army's interest in rocketry. From his recruitment efforts, and from the lack of any available economic alternative, several young rocketeers were brought to the government military payrolls. For reasons completely beyond their control, and toward ends they could not as yet envision, an increasing number of young German space visionaries found themselves in the service of a military establishment that was later to serve Nazi Germany.

As the activities of the early rocket pioneers grew, it became obvious that they would need a more expanded and elaborate facility to test their new generation of vehicles. The first test facilities at Kummersdorf, some 25 kilometers south of Berlin, were rapidly becoming inadequate. The lands around the small fishing village of Peenemünde on the Baltic Coast seemed to provide the perfect place. First suggested to von Braun by his mother, the site offered isolation and a firing range for the still highly experimental vehicles. As political conditions deteriorated in Europe, the advance guard of the Peenemünde team was almost totally preoccupied with the elaborate preparations involved in the opening of the world's first large-scale rocket test facility. The Army Research Center at Peenemünde became fully staffed in August, 1939. On September 1, 1939, Hitler ordered his troops to invade Poland, thus formally beginning World War II. By 1942, the facility at Peenemünde employed 1,960 scientists and technicians and some 3,852 other workers. Work on rocket development was then proceeding at maximum intensity.

The nearly complete mobilization of German society during World War II saw many individuals with scientific and technical skills pressed into the military service. Lieutenant Krafft Ehricke, who had been wounded at Dunkirk, was serving in the bitter drive toward Moscow when he was called to Peenemünde. Lance Corporal Ernst Stuhlinger also was serving on the Russian front as an infantryman when he received orders to report to Peenemünde, to a place and a project of which he had never heard. Konrad K. Dannenberg, himself an infantry Lieutenant in France, and

later to be the propulsion section chief for the V-2, was called out of battlefield activities to join the rocket development center. For individuals such as these, the motivation was clear—build rockets or dodge bullets.

In contrast, the forces that led to the assembly of the Los Alamos atomic bomb team were remarkably different. The scientists who were to comprise the core group at Los Alamos came from the well-established scientific field of physics. Physics as a discipline had become increasingly important since the turn of the century. It had gradually acquired the respect in major universities that had been denied it during the 19th century. In Germany, during the 19th century, the area of general learning or philosophical studies (Wissenschaft) was deemed superior to the mere study of nature (Naturwissenschaft), or what we now call science. The growth of the industrial age dictated that this distinction should change.

With the rise of the Nazi Party, German physics was to suffer a terrible blow under its avowed anti-Semitic policies. The Jewish community was well represented in academic physics during the Weimar Republic. With Hitler's new policies, fully 25% of academic physicists in Germany, almost all Jewish, found themselves forced from their positions shortly after he came to power. By 1934, one of every five institute directorships in Germany was vacant [3].

The quantity of physicists who left Germany was large, but the quality of those who left was truly astounding. Many of the brightest young minds at German universities, who had not yet made an international reputation, also felt compelled to leave. Many from other central European nations, who had come to Germany for an education, and who later stayed to teach, felt the oppressive spread of anti-Semitism throughout the region and decided to emigrate to a more politically tolerant environment. Fascism in Germany, Italy, and the occupied countries flushed away the cream of European physics. Their names read like a *Who's Who* of 20th century physics: Albert Einstein, Hans Bethe, Edward Teller, Leo Szilard, Eugene Wigner, John von Neumann, Michael Polanyi, Theodore von Kármán, George de Hevesy, Felix Bloch, James Franck, Lothar Nordheim, Enrico Fermi, Niels Bohr, and Eugene Rabinowitch. Along with some sympathetic non-Jewish scientists such as Erwin Schrödinger and Martin Stobb, these men were to become the driving force behind atomic research in England and America.

These individuals were a welcome addition to the British and American ranks of academic physicists. They were soon able to move into and occupy prestigious positions in both countries. Hence, the contrast between the unemployed and unknown engineers and technicians who were seeking affiliation with the German Army and the relatively affluent and widely known physicists who were leaving Germany in droves was rather stark. The Peenemünde team was comprised overwhelmingly of engineers and technicians. Only a few major members could be considered to have outstanding credentials in science—among them, von Braun, with a Ph.D. in physics; Ernst Stuhlinger, also with a Ph.D. in physics; and Carl Wagner, a Ph.D. physical chemist.

As mentioned, the traditional German academic ranking favored philosophy over the natural sciences, such as physics. Although by the 1920s and 1930s that was

giving way to more modern views, those who pursued engineering and technical educations were still considered at least third-rate citizens of the intellectual community. Lingering traces of this attitude could be seen in America in the 1950s and 1960s, when the transplanted Peenemünde Team was often referred to as "von Braun's plumbers."

Neither group was particularly politically active. In fact, the prevailing attitude of both was, in so far as possible, to ignore the political world and get on with their chosen professions. There were exceptions, most notably among the academic physicists, such as Leo Szilard, Niels Bohr, and Erwin Schrödinger, but the activist attitude was not the norm. Alan D. Beyerchen, in his study of the political posture of the physics community in the Third Reich, refers to this attitude as a form of "inner emigration" [4]. Edward Teller expressed much of the same early rejection of political involvement by noting that the continuing European political difficulties forced him to be "enveloped in the feeling that only science is lasting" [5].

If the largely Jewish physics emigrés were reluctant to become politically involved, this apolitical posture was even more pronounced for the non-Jewish Peenemünde group. Their educational backgrounds had certainly not predisposed them to ask political questions or seek out political activities. Beside that, there was no doubt that their lot was improving under the rule of the Third Reich. They were plain, practical men, largely members of the *volkisch* ideal, the German or Nordic middle class. Their training was in practical, not theoretical matters. They were, in the eyes of the Aryan thinkers, the finest example of native German utilitarianism.

Among the Aryan ideologies, the applied was preferred over the theoretical. Applied physics was German, theoretical physics was Jewish. Technology was preferred over theory. Engineering rapidly assumed the status previously held by physics, and the engineers at Peenemünde were the beneficiaries of this new-found prestige. The physical and social isolation of the Baltic research facility, in addition to the fact that the engineers and technicians were working at an intense pace to meet the increased demands on them, left little opportunity for this group to reflect on political philosophy and social conditions in Germany.

Hence, as the decade of the 1930s drew to a close, we see an interesting phenomenon among the community of scientists and technologists. The old intellectual elite was being dethroned, while the new emergent technological elite was being ennobled. Under the existing conditions, neither group could, or would, rise to express the sentiments of humanitarian restraint on the passions of the times. The existing social changes were overwhelming. The engineers and technicians at Peenemünde were absorbed by new and seemingly unlimited opportunities. The physicists who had left the terrible persecution of the Third Reich were busily directing their efforts toward rescue of their families and colleagues. What time was left was spent urging the British and American governments to prepare to develop the ultimate weapon against Fascism—the atomic bomb.

THE WAR YEARS

As previously stated, the Peenemünde research facility became fully operational in August, 1939. It was not until April, 1943, that the Los Alamos atomic development facility was opened. Some comparisons of these two major research and development facilities are useful in understanding the behavior of those who worked at each. Both facilities were highly secret and highly isolated. Whereas Peenemünde had nearly 6,000 operational personnel at its height, the Los Alamos facility had a total work force of nearly 5,000. Both facilities were heavily dependent upon support facilities in other parts of their respective countries.

In Germany, these support facilities were increasingly disabled by allied attacks as the war progressed. In the United States, the support facilities were secure, and increasingly grew more productive. Peenemünde itself came under direct bombing attack in August, 1943. Los Alamos never had these concerns. The mission at Peenemünde was open-ended and growing. It was assigned to develop, produce, and supply an increasingly variety of rocket-propelled vehicles for military use. The mission at Los Alamos was singular and finite—produce an atomic weapon. Both Peenemünde and Los Alamos operated under a military commander; by then, General Walter Dornberger in Germany, and General Leslie R. Groves in the United States. Both project directors were civilian scientists—Wernher von Braun and J. Robert Oppenheimer—and both were natives of their respective countries. Obviously, Peenemünde operated in the totalitarian environment of war-ravaged Germany, whereas Los Alamos operated in the more open and democratic environment of secure America.

Because collaborative scientific and technological enterprises require a great deal of free discussion and exchange of ideas, both facilities seemed to maintain a good deal of internal freedom with regards to discussion of the best strategies to achieve their stated mission. Open discussions of other applications of technologies, most specifically space travel, were strictly forbidden at Peenemünde. Political discussions were most certainly forbidden in the Peenemünde facility, while the political ramifications of their work were an open, but infrequently discussed topic at Los Alamos.

From the date the Peenemünde facility became fully operational (August 1939), to the date of the first successful A-4 test (October 3, 1942), was a lapse of three years and two months. From the date that Los Alamos opened (April 1943), to the first successful test of the atomic bomb at the Trinity Site (July 1945), was a lapse of two years and three months. The time from the first successful A-4 test launch in October, 1942, to the time of its first successful military use in September of 1944, was one year and eleven months. The less complex V-1 weapon was ready some 2-1/2 months earlier, and was first used on the battlefield on June 13, 1944. The time from the test of the atomic weapon at the Trinity Site in New Mexico on July 16, 1945, to its first use in warfare at Hiroshima on August 6, 1945, was a mere three weeks. It is estimated that the German V-weapon effort cost approximately three billion war-time U.S. dollars. The Manhattan atomic bomb project cost approximately two billion dollars [6].

While it is impossible to judge with quantitative certainty, the general conditions under which the two research and development facilities existed, and the missions they were assigned to accomplish, suggest that the task faced by the Peenemünde group was more difficult than that faced by Los Alamos. The industrial, university, and governmental support facilities that were necessary for the completion of the Manhattan Project were enormous, but they were existing in a country that was not under direct territorial attack. The administrative and production challenges faced by Peenemünde, being open-ended and constantly subject to disruptions through enemy attack, were far greater than those of Los Alamos.

The Peenemünde facility first came under direct physical attack with the allied aerial bombardment of August 17, 1943. Although the British Royal Air Force and the United States 8th Army Air Corps specifically intended its mission to kill as many of the expert technical and administrative personnel as possible, in fact only two key figures were killed—Walter Thiel and Erich Walther. Seven hundred and thirty-three other individuals did die in the raids, and major damage was done to personnel housing and development works. Following the Peenemünde raids, a systematic set of raids were launched against supporting assembly plants and hydrogen peroxide production facilities [7].

It was in an increasing atmosphere of desperation that the decision to move the rocket production facilities underground into the infamous Mittelwerk facility was made. The site was the location of an old gypsum mine in the Harz Mountains in central Germany. The conversion process from mine to missile production facility was a harsh and dirty task, performed under intense pressure and using forced labor that was a mixture of criminals, homosexuals, prisoners of war, and individuals who were there because of their political beliefs or Jewish identity. Wernher von Braun described the conditions of the labor force at Mittelwerk as "horrible;" and, Arthur Rudolph called the treatment of prisoners "primitive," and "awful." Prisoners were literally worked to death, or exposed to such unsanitary conditions that they died of disease. Those who resisted faced summary execution. Bodies were disposed of in a local crematorium. Strangely, only 11 months after General Dornberger proclaimed that the A-4 vehicle had opened the doorway to the heavens, it was being produced in the dungeons of hell.

Rudolph and others at Mittelwerk were frequently reminded that they, too, could join the forced labor teams, if they did not fully cooperate with the S.S. authorities. Previously, in March of 1943, Wernher and Magnus von Braun, Klaus Riedel, Helmut Gröttrup, and Hannes Lührsen had been arrested by the Gestapo at Peenemünde and charged with treason for describing the A-4 as a space vehicle rather than a weapon of war. Obviously, this arrest was not over mere semantics, but was designed as a warning to key members of the team that nobody was immune from the force of S.S. control.

The madness of war became complete. German atrocities at home and in occupied territories mushroomed. This was followed by the growing insensitivity to human suffering among the allies. In July of 1943, the largely civilian city of Hamburg was fire-bombed, and in one night 45,000 Germans died—most of them old people, women, and children [8]. Other cities such as Cologne and Dresden were to

follow in this ghastly fate. Hostility had reached its flashpoint, and had escalated into mutual barbarity. With these developments, the world's first generation of space vehicles changed their name from A-weapons, which innocuously meant assembly—to V-weapons, which ominously meant **Vengeance**.

By comparison, the scene surrounding the isolated and peaceful mesa that was home to the Los Alamos laboratory appeared almost serene. Here, the desperation that existed was nowhere apparent on the landscape, but was, rather, hidden in the emotions and fears of the men who labored frantically against a possibility that proved eventually to be a phantasm. These scientists worked with a fair certainty that Japan would not be able to develop the bomb, but it was much less certain what the German potential might be. In any event, in their minds, the real enemy was Germany. Japan was a force to be dealt with after the demise of Hitler was assured. Every ounce of their personal and professional dispositions were involved in a loathing of Hitler, and the Nazi Third Reich which he headed.

Such emotions were intensified beyond those of most Americans because of the personal backgrounds and associations that many had had with the Third Reich. Furthermore, several, including Oppenheimer, had relatives that were suffering and dying under Nazi persecution. Being rooted in personal experience or not—Jewish, non-Jewish, American-born, and foreign-born—were, at Los Alamos, melded together into a coordinated and determined force to produce the product of mass destruction that they knew was possible.

The motivation here had been internalized. They did not work under the threat of midnight arrest. There was no possibility of being assigned to forced-labor parties. They worked voluntarily for a cause they considered essential. This, too, made the task of Los Alamos easier. There were reservations and even some resignations, but the team as a whole had an *esprit de corps* that was remarkable.

Caught up as they were in the enthusiasm for their task, members of the Los Alamos team, like their German counterparts, were to come to accept and take pleasure in the perditious products of their science and technology. No member of the Los Alamos team, during the course of his work, ever had to witness a summary execution. No member ever lost one of his immediate family or a close colleague to enemy bombing of the research facility. No member of the Los Alamos team ever had to look into the wretchedly pitiful face of a slave laborer dying in the process of being forced to serve a cause he detested. Yet in the benign conditions of Los Alamos, the war culture prevailed. Its all-consuming power instilled into the Los Alamos scientists a growing moral callousness that would not allow them to escape without their share of guilt.

Donald A. Strickland, in his study of the atomic scientists' political movement of 1945 and 1946, notes that at Los Alamos there was "no political arousal before the end of the war, save for a few private conversations." He calls this an "arresting" fact, considering that the politically active Niels Bohr, Enrico Fermi, Eugene Wigner, and Leo Szilard were frequent visitors to this remote site [9]. The drive to achieve the task was too intense for reflection. It was after the grizzly weapon was a *fait accompli* that the ponderous questions of morality were asked.

While most at Los Alamos simply lost themselves in the task at hand, there were more poignant examples of growing insensitivity to humanitarian considerations. Almost from the time Edward Teller arrived, he set his sights not on the mission at hand, but at the even greater destructive potential of the hydrogen bomb, or the "super" as he almost affectionately called it. The lack of Teller's ability to give up his passion for the thermonuclear device led to his being given his own small group at the laboratory for investigation of the development of such a weapon. Such seemed the only way to manage Teller, who had come to a point of absolutely refusing to work under Hans Bethe on further calculations concerning "mere" fission weapons [10].

In addition to this minority thrust toward overkill, there was a disquieting theoretical possibility that the ignition of the fission weapon might just produce enough heat to cause the reaction between deuterium and nitrogen, and thereby to set fire to the world's atmosphere. On hearing this, Oppenheimer immediately set Hans Bethe to work checking Teller's initial calculations. Was this, the ultimate catastrophe, really possible? For the first, but not the last, time in history, human beings had to make a decision as to whether a task at hand was worth the risk—albeit infinitesimal—of ending our collective existence. The logic we used then may give us a hint of the logic we shall have to use again.

According to Teller, the matter was firmly laid to rest in 1942, when some of his initial calculations were found to be in error. As Peter Goodchild notes in his classic study of Oppenheimer, several scientists were, over the next three years, to make the same calculations as Teller; and because his initial calculations had been kept secret, they too came to Oppenheimer with great alarm [11]. Calculations were checked and rechecked right up to 1945, shortly before the first test detonation at the Trinity site. Rumors of the potential total human catastrophe had become so widespread among all levels of personnel at Los Alamos, that the authorities drew up contingency plans for psychiatrists at the Oak Ridge facility to be flown to Los Alamos, should panic ensue.

Arthur H. Compton has said that his group calculated a three-in-a-million chance of destroying the world, and that was an acceptable risk. Edward Teller, on the other hand, insists that they were able to dismiss the possibility entirely. At that time, such statements of high confidence seemed most reassuring. Looking back from the perspective of a generation that has heard similar confident risk assessments before events such as Three Mile Island, Chernobyl, and the Space Shuttle *Challenger*, those expressions of high confidence toll a more hollow ring. The lesson seems to be that humanity will accept what it believes to be a small risk to its own existence, but the procedures for determining the level of that risk are far from certain. In an age that is now coming to terms with the potential catastrophic lethality of deliberately-engineered microorganisms, and the unknown physical properties of conditions near the singularity that could be created in future generations of high-energy particle accelerators, we shall again and again have to make that dreadful choice. Is knowledge worth some small chance of the ultimate human sacrifice?

A final observation on the darker face of Los Alamos is now in order. The prevailing pathos of the general culture had affected all who labored there, but

perhaps the extent to which it had changed basic human values is best illustrated by J. Robert Oppenheimer himself. Based on information recently obtained under the Freedom of Information Act, Joseph Rotblat, a physicist who assisted in bomb design and one of the few who left prior to project completion, related the following story. In a letter dated May 25, 1943, from Robert Oppenheimer to Enrico Fermi, the issue of using radioactive materials to poison German food supplies was raised. Oppenheimer was asking Fermi whether he could produce enough strontium without letting too many in on the secret. Oppenheimer continued that, "I think we should not attempt a plan unless we can poison food sufficient to kill a half a million men." Then Rotblat offers the following observation:

> I am sure that in peacetime these same scientists would have viewed such a plan as barbaric; they would not have contemplated it even for a moment. Yet during the war it was considered quite seriously and, I presume, abandoned only because it was technically unfeasible [12].

Richard Rhodes comments on the same incident as follows:

> There is no better evidence anywhere in the record of the increasing bloody-mindedness of the Second World War than that Robert Oppenheimer, a man who professed at various times in his life to be dedicated to *Ahisma* ('the Sanskrit word that means doing no harm or hurt,'. . .), could write with enthusiasm of preparations for the mass poisoning of as many as five hundred thousand human beings [13].

AFTER THE WAR

Their accomplishments in World War II made the members of the Los Alamos and Peenemünde teams into legends. Their actions and statements after the war shaped and molded the public perceptions of these legends. The environments that the two groups faced after the war were radically different. It is those differences that have done much to shape our post-war evaluations of them.

Members of the teams at Peenemünde and Mittelwerk fled their posts as the allied forces closed their grip around Germany in early 1945. They arranged a rendezvous at a small Austrian village named Reutte. There they surrendered to the American forces, and their journey to the United States began. The code name "Project Paperclip" was given to this movement. Some 118 individuals comprised the first group of Peenemünde personnel coming to America. Later, several hundred additional individuals, including family and colleagues, joined them. One member of the core group, Helmut Gröttrup, decided to remain in what was to become East Germany and work with the Soviet missile program. A small cadre of other German rocket personnel joined him, and were later transferred to the Soviet Union.

From the time von Braun and his group surrendered, until some years after their arrival at Fort Bliss, Texas, they remained, in the description of Ordway and Sharpe, "prisoners of peace" [14]. Though they were allowed substantial freedom of movement and association, they were subject to governmental restrictions and objects of continued surveillance by the FBI and other government agencies. Although acceptance by the American public was generally polite, some degree of suspicion and hostility was occasionally apparent.

In contrast, the key figures at Los Alamos, their mission completed for the most part, sought to leave weapons work and return to academic environments. They did so with an enhanced prestige that made them instant scientific celebrities wherever they went. They existed in an atmosphere of honor and respect, and they were encouraged to freely express their views on what they had done and what it might mean for our future.

The pressures on the atomic scientists were to speak, to express their fears and desires, and to help us think about the new issues we faced in the nuclear age. The academic settings that they were in allowed them to do this. Their organization into politically active groups, and their launching of the influential *Bulletin of the Atomic Scientists*, were reflections of this type of environment. But for those who had come from Peenemünde conditions were very different. Between 1945 and 1950, there was very little public discussion of their role or their activities. Working as they were for the U.S. Army on the remote missile test ranges of Texas and New Mexico, their actions were shrouded in secrecy. Occasional announcements of V-2 launchings were made, but very little was said about the German team that assisted. The United States government was still too uncertain as to what the public reaction might be to play up the presence of these men from Peenemünde.

It was not until the early 1950s that the public began to learn of the activities of this team. Shifting as they did from the sparsely populated regions of Texas and New Mexico to the more populated regions surrounding Huntsville, Alabama, they came increasingly to public attention. The focus of attention was on Wernher von Braun. His charismatic manner and his ability to capture public attention were immediately apparent. He began to publish books such as *Across The Space Frontier*, *Man on the Moon*, and *Mars Project*, in the early 1950s. With the advent of the Soviet launch of Sputnik in October of 1957, an explosion of attention fell on the Germans at Huntsville. The nation increasingly began to look at them to save our international prestige by answering the Soviet challenge with our own successful orbital vehicle. After dismal failures by the Navy in their Vanguard program, Wernher von Braun's team at Huntsville was given the task, and on January 31, 1958, the Redstone rocket lifted America's first satellite, *Explorer I*, into orbit. The space age for the United States had now really begun, and Wernher von Braun was "our leader."

The passions of the late 1950s and 1960s were assertive and not reflective. This was mirrored in von Braun's writings. Articles, books, and other published information from von Braun became commonplace in the scientific and popular press. These dealt almost entirely with the prospects of new hardware in space and new missions for space vehicles. The more sensitive subject of science, and its relation to political and foreign policy issues, was almost never discussed. By contrast, the atomic scientists made such issues their central focus.

Suspicions concerning the historical role of the Peenemünde team were occasionally expressed in public dialogue in the late 1960s and 1970s, but they were seldom answered by the team itself. Their continued affiliation with the Army, and later NASA, dampened any thought of embroiling themselves in controversial questions.

After the successful Apollo Lunar Program, there was a feeling among several of von Braun's close associates that he was a victim of lingering prejudice against Germans by not being considered for the top job at NASA. His resignation from NASA in 1972 was rumored to be a product of such forces, but in traditional low-key style, he and his colleagues shied away from discussion of such allegations.

As the ultimate demise of J. Robert Oppenheimer's career with government came from the Atomic Energy Commission's denial of his security clearance because of past political associations, it was thought by many that von Braun was also being penalized because of his past associations. In the case of Oppenheimer, the issue was accompanied by strong expressions of support from his colleagues and much public debate, but with von Braun there was a minimum of public discussion. Right up until 1984, when the U.S. Department of Justice completed its investigation of Arthur Rudolph, and he chose to leave the country rather than face trial, the Peenemünde team avoided public airing of their sentiments.

The news of the Rudolph affair shook the German group. Virtually all had now retired, and were free to express themselves on their side of events in Germany. Some did, but most felt that their best interest would be served by remaining silent. Their many long decades of silence about the political winds that had constantly buffeted them throughout their careers had crippled their capacity of public expression about these issues. It was as if, by spending a lifetime in difficult circumstances, where silence was the seeming solution, when public expression was demanded, there was no capacity for it. At this point, they as a group, their ranks now thinned by death and debility, stood wounded and demoralized. Their great goal of leading humans to the Moon, though accomplished, had been followed—not by respect—but what they perceived as a sense of public rejection.

LOS ALAMOS AND PEENEMÜNDE: A REFLECTION

Forty-two years after the last great war, emotions have not yet cooled enough to look dispassionately on the events of the epoch. The exile of Rudolph and the continuing investigation of other members of the Peenemünde group attest to this fact. It is not the purpose of this work to attempt to assess guilt or innocence of any individual, or to try to place a moral judgment on either team. It is the purpose to place them side-by-side, and note the points of similarity and the points of contrast. In so doing, it has been my attempt to show that both were products of the peculiar and pathological forces of their time.

In attempting to judge what this study may mean for us, I view the matter as a behavioral scientist, not as a historian. Behavioral scientists have repeatedly demonstrated the ease with which individuals can be conditioned to perform actions and participate in behaviors that they themselves abhor under "normal" circumstances. In the 1960s, Stanley Milgram's classic experiments on compliance with authority showed how perfectly ordinary individuals under the proper authorizing conditions can be encouraged to administer what they believe to be potentially dangerous electrical shocks to their fellows in the experiment [15]. Similar studies have demonstrated how readily experimental subjects, deliberately chosen for their gentle tendencies, may become tyrants when placed in absolute or unrestrained control of

others [16]. While no such personal barbarity has been alleged against any member of either team, it is clear that both, as a group during the reigning pathos of the war years, suffered a vastly diminished capacity for humanitarian response. But, was this not also the case for the world at large?

The clear implication of the behavior of those at Peenemünde and Los Alamos is that the fault lies not within their individual character, but rather in the sustaining ambience of those behaviors. The growing social malignancy that infected both the Allied and Axis powers of World War II sowed its destructive seeds in all echelons of the warring populations from scientists to school children. The nearly 13,000 that died as a result of the machines built by the men of Peenemünde, were dwarfed by the some 340,000 that ultimately died as a result of the bombing of Hiroshima and Nagasaki. It was in the context of those times that such numbers became but abstractions in a cultural ambience that had come to admire atrocity [17].

George Kistiakowsky, the chemist who designed the trigger for the first nuclear weapons, in a 1982 interview with Carl Sagan, when asked, "Would you do it again?" responded:

> I think that is a meaningless question. You have to put it into a context of the world situation . . . Certainly, the way I feel now I would answer no, I wouldn't do it. But, I was intensely influenced by my hatred of authoritarianism in politics . . . . [18]

Kistiakowsky's answer reflects a recognition that he knew his behavior at that time was a product of a larger array of events and circumstances around him. His answer demonstrates the all important concept that it is the context of the times that counts. To his credit, after being a distinguished advisor to presidents, he sought to—in his words—"undo what he had done as a weaponeer." He sought in his last years to move the world toward peace by speaking forcefully against the vested interests driving the international arms race to ever-greater heights.

Herein lies, perhaps, the most important message that Los Alamos and Peenemünde can leave us. The echoes from their historical experience sound a clear warning to policy makers today. We stand now in the early years of the great human adventure into space. The choice before us is clear and will have profound influence on our future as a species. From Peenemünde we acquired our ability to travel in space. From Los Alamos we acquired the ability to end the human experiment. Now there is a clamor to take the latest evolutionary offspring of the technology they set in motion and militarize the heavens in the name of defense. Our previous experience demonstrates that if we choose to travel this dreary and dangerous path, we shall find sufficient high caliber scientists and technologists to further our destructive designs. Economic opportunity and suspicions encouraged by the policy itself will allow this generation of "star warriors" to conjure the necessary justifying ideologies and thrill in the excitement of their tasks [19].

A sustained movement toward the militarization of space will produce a plethora of powerful forces, whose very existence depends upon continuation of an international atmosphere of mistrust. Such will again poison "the context of the times." The very nature of the tasks toward which we would turn would, of their own essence, breed fear and suspicion. These tasks are often justified as "technological

drivers," producing all sorts of technical breakthroughs, such as better materials, smaller computers, more sensitive instruments of calibration, *ad infinitum*. As Carl Sagan has so well demonstrated, each of these can be pursued in its own right, and under conditions of cooperation rather than competition [20]. Joint ventures, such as the early Soviet-American Apollo-Soyuz project and new potentials such as a cooperative Mars venture, hold the hope of the future. The "technological drivers" are helpless to create a better world without sound "sociological steering."

The cultural fallout of grand designs based on distrust is likely to poison the human spirit beyond acceptable limits. The suspicions that such a policy will generate could easily push us ever nearer the flashpoint of international tensions. As Los Alamos and Peenemünde demonstrate, when such a point is reached, the finest minds and the most noble of dreams are likely to be caught up in a maelstrom of events that are remembered with regret. Their equivalent in tomorrow's world may be able to assure that no one remains to remember.

REFERENCE NOTES

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5. Richard Rhodes, *The Making of the Atomic Bomb*, New York: Simon and Schuster, 1986, p.113.
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10. Peter Goodchild, *J. Robert Oppenheimer: Shatterer of Worlds*, New York: Fromm International, 1985, p.105.
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12. Joseph Rotblat, "Leaving the Bomb Project," *Bulletin of the Atomic Scientists* Vol. 47, No. 7, August, 1985, p.18.
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14. Ordway and Sharpe, *The Rocket Team*, p.362.
15. Stanley Milgram, *Obedience to Authority*, New York: Harper and Row, 1974.

16. P. G. Zimbardo, E. B. Ebbesen and C. Maslach, *Influencing Attitudes and Changing Behavior: An Introduction to Method, Theory, and Applications of Social Control and Personal Power*, 2nd ed., Reading, Mass.: Addison-Wesley, 1977.

17. These figures were obtained from Ordway and Sharpe, *The Rocket Team*, p.252, and Rhodes, *The Making of the Atomic Bomb*, p.734 & p.740. Varying studies produce different numbers, but these seem to be approaching the norm of estimates.

18. Carl Sagan, "Confessions of a Weaponeer," P.B.S. Interview with Dr. George Kistiakowsky, 1987.

19. The reader is recommended to read the following reference to understand the extent to which such a process is already in action: William J. Broad, *Star Warriors*, New York: Simon and Schuster, 1985.

20. Among other places, Dr. Sagan has elaborated on these ideas in remarks delivered to the National Press Club, Washington, D.C., January, 1987, and at The University of Alabama in Huntsville, June 24, 1987.